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NUREG-2182
Volume 1

Final Safety Evaluation Report for the Combined License for Enrico Fermi 3

Docket Number 52-033

DTE Electric Company

Chapters 1 to 9

Office of New Reactors

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ABSTRACT

This final safety evaluation report[1] (FSER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's technical review of the combined license (COL) application for the Enrico Fermi Unit 3.

In a letter dated September 18, 2008, DTE Electric Company (DTE, formerly Detroit Edison Company[2]) submitted an application to the U.S. Nuclear Regulatory Commission (NRC or the Commission) for a COL to construct and operate an Economic Simplified Boiling-Water Reactor (ESBWR) pursuant to the requirements of Section 103 and 185(b) of the *Atomic Energy Act of 1954 as Amended (AEA),* Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications and Approval for Nuclear Power Plants," and the associated material licenses under 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material"; 10 CFR Part 40, "Domestic Licensing of Source Material"; and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material." This reactor will be identified as Fermi 3 and will be located on the existing Fermi site in Monroe County, Michigan. The initial application incorporated by reference the General Electric-Hitachi's (GEH's) application for the ESBWR design certification, as described in Revision 4 of the design control document (DCD) (submitted September 8, 2007). In a letter dated October 31, 2014, (COL application submittal Revision 8), the applicant incorporated by reference ESBWR DCD, Revision 10. The results of the NRC staff's evaluation of the ESBWR DCD are in NUREG–1966, "Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling-Water Reactor Standard Design," and its supplement.

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[1] This FSER documents the NRC staff's position on all safety issues associated with the combined license application. The Advisory Committee on Reactor Safeguards (ACRS) independently reviewed those aspects of the application that concern safety, as well as the advanced safety evaluation report without open items (an earlier version of this document), and provided the results of its review to the Commission in a report dated September 22, 2014. This report is included as Appendix F to this SER.

[2] By letter dated December 21, 2012, the Detroit Edison Company informed the NRC that effective January 1, 2013, the name of the company would be changed to "DTE Electric Company." The legal entity remains the same.

This FSER presents the results of the staff's review of information submitted in conjunction with the COL application, except those matters resolved as part of the referenced design certification rule. In Appendix A to this FSER, the staff has identified certain license conditions and inspections, tests, analyses and acceptance criteria (ITAAC) that the staff recommends the Commission impose, should the COL be issued to the applicant. In addition to the ITAAC in Appendix A, the ITAAC found in the ESBWR DCD Revision 10, Tier 1 material will also be incorporated into the COL should the COL be issued to the applicant.

On the basis of the staff's review [3] of the application, as documented in this FSER, the staff recommends that the Commission find the following with respect to the safety aspects of the COL application: 1) the applicable standards and requirements of the Atomic Energy Act and Commission regulations have been met, 2) required notifications to other agencies or bodies have been duly made, 3) there is reasonable assurance that the facility will be constructed and will operate in conformity with the license, the provisions of the Atomic Energy Act, and the Commission's regulations, 4) the applicant is technically and financially qualified to engage in the activities authorized, and 5) issuance of the license will not be inimical to the common defense and security or to the health and safety of the public.

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[3] An environmental review was also performed of the COL application and its evaluation and conclusions are documented in NUREG-2105, "Final Supplemental Environmental Impact Statement for Combined License (COL) for Enrico Fermi Unit 3."

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ABBREVIATIONS

A&NS	alert and notification system
A2LA	American Association for Laboratory Accreditation
ABWR	advanced boiling-water reactor
ac	alternating current
ACA	Anorthosite Complex Anomaly
ACES	Automated Coastal Engineering System
ACLASS	ACLASS Accreditation Services
ACI	American Concrete Institute
ACP	access control point
ACRS	Advisory Committee on Reactor Safeguards
ADAMS	Agencywide Documents Access and Management System
ADB	ancillary diesel building
ADG	ancillary diesel generator
ADS	automatic depressurization system
AEA	Atomic Energy Act
AEOF	Alternate EOF
AF	amplitude function
AFT	as-found tolerance
AFU	air filtration unit
AHEX	Atlantic Highly Extended
AHS	auxiliary heat sink
ALARA	as low as reasonably achievable
ALT	as-left tolerance
ANI	American Nuclear Insurers
ANS	American Nuclear Society
ANSI	American National Standards Institute
ANSS	Advanced National Seismic System
AOO	anticipated operational occurrence
AOV	air-operated valve
API	American Petroleum Institute
AQCR	Air Quality Control Region
ART	adjusted reference temperature
ASA	applicable safety analysis
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASCE	American Society of Civil Engineers
ASR	alkali-silica reaction
ASTM	American Society of Testing and Materials
ATWS	anticipated transient without scram
AV	allowable value

B&V	Black & Veatch
BDBE	beyond-design-basis event
BE	best estimate
BL	bulletin
bpf	blows per foot
BPV	Boiler and Pressure Vessel
BPVC	Boiler and Pressure Vessel Code
BRE	bullet resisting enclosure
BTP	branch technical position
Btu	British thermal unit
BWR	boiling-water reactor
C	Celsius
cc	Cubic-centimeters
C&FS	condensate and feedwater system
CAM	continuous air monitor
CAR	corrective action request
CAS	central alarm station
CAV	cumulative absolute velocity
CB	control building
CD-144	card deck-144 (format used in NCDC meteorological data)
CDA	critical digital asset
CDF	core damage frequency
CDI	conceptual design information
CEM	Coastal Engineering Manual
CENA	central and eastern North America
CEUS	central and eastern United States
CEUSSSC	Central and Eastern United States Seismic Source Characterization
CF	chemistry factor
cfm	cubic feet per minute
CFR	*Code of Federal Regulations*
CHS	Charleston
CHV	Charlevoix
CIRC	circulating water system
CLSM	controlled low-strength material
cm	centimeter(s)
CMZ	Commerce fault zone
COCORP	Consortium for Continental Reflection Profiling
COL	combined license
COLA	combined license application
COLR	Core Operating Limits Report
COOP	Cooperative Observation Program
CPS	condensate purification system
CR	control room
CRD	control rod drive

CRHA	control room habitability area
CS&TS	condensate storage and transfer system
CSAT	Cyber Security Assessment Team
CSDRS	certified seismic design response spectra
CSF	condensate storage facility
CSIRT	Cyber Security Incident Response Team
CSP	cyber security plan
CST	condensate storage tank
CVAP	Comprehensive Vibration Assessment Program
CWS	circulating water system
DAC	design acceptance criteria
DAW	dry active waste
DB	dry bulb
DBA	design-basis accident
DBE	design-basis event
DBT	design-basis threat
DBT	design basis tornado
DC	design certification
dc	direct current
DCA	Design certification application
DCD	design control document
DCF	damping correction factor
DCIS	distributed control and information system
DCR	design certification rule
DCRA	Design Centered Review Approach
DE	deagregation earthquakes
DEM	digital elevation model
DG	diesel generator
DGFOSTS	diesel generator fuel oil storage and transfer system
DM	direct method
DOE	Department of Energy
DOT	Department of Transportation
DPV	depressurization valve
D-RAP	design reliability assurance program
DTE	Detroit Edison Company
DTPG	defined test plan group
DZO	depleted zinc oxide
EAB	exclusion area boundary
EAC	emergency alternating current
EAL	emergency action level
EAS	emergency alert system
ECC-AM	Extended Continental Crust – Atlantic Margin
ECCS	emergency core cooling system

ECGH	East Continent Gravity High
ECL	effluent concentration limit
ECRS	east continent rift system
ED	emergency director
EDG	emergency diesel generator
EF	Enrico Fermi
ELAP	extended loss of alternating current power
EMD	emergency management division
EMDG	extensive damage mitigation guideline
EMI	electromagnetic interference
EMS	emergency medical service
ENS	emergency notification system
EOC	emergency operations center
EOF	emergency operations facility
EOL	end of life
EOP	emergency operating procedure
EP	emergency planning
EP	Emergency Preparedness
EP ITAAC	emergency planning inspections, tests, analyses, and acceptance criteria
EPA	Environmental Protection Agency
EPAct	Energy Policy Act of 2005
EPG	emergency procedure guideline
EPIP	Emergency Plan Implementing Procedure
EPRI	Electric Power Research Institute
EPZ	emergency planning zone
EQ	environmental qualification
EQD	environmental qualification document
EQMEL	Environmental Qualification Master Equipment List
ER	environmental report
ERDS	emergency response data system
ERF	emergency response facility
ERM-N	Eastern Rift Margin – North
ERM-S	Eastern Rift Margin – South
ERO	emergency response organization
ESBWR	economic simplified boiling-water reactor
ESF	engineered safety feature
ESP	early site permit
ETE	evacuation time estimate
ETS	emergency telecommunications system
E_{ur}	unload-reload modulus
F	Fahrenheit
FAC	flow-accelerated corrosion
FAPCS	fuel and auxiliary pools cooling system

FATT	fracture appearance transition temperatures
FB	fuel building
FDA	Final Design Approval
FE	finite element
FEA	finite element analysis
FEIS	Final Environmental Impact Statement
FEM	finite element model
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FFD	fitness for duty
FFS	free flow speed
FHA	fire hazards analysis
FHA	fuel handling accident
FIRS	foundation input response spectra
FIV	flow-induced vibration
FLEX	diverse and flexible coping strategy
FMG	failure mode group
FNPP	Fermi Nuclear Power Plant
FPS	fire protection system
FPWS	fire protection water system
FR	Federal Register
FRMAC	Federal Radiological Monitoring and Assessment Center
FRPP	fiberglass reinforced polyester pipe
FRS	floor response spectra
FS	factor of safety
FSAR	final safety analysis report
FSER	final safety evaluation report
ft	feet/foot
FTS	Federal Technology Services
FWSC	fire water service complex
g	acceleration of gravity
Ga	billion years ago
GALL	generic aging lessons learned
GCRP	Global Change Research Program
GDC	general design criterion/criteria
GDCS	gravity-driven cooling system
GE	General Electric
GEH	General Electric – Hitachi (Nuclear Energy)
GFTZ	Grenville Front Tectonic Zone
GI	generic issue
GIA	glacial isostatic adjustment
GL	generic letter
GLERL	Great Lakes Environmental Research Laboratory
GLIMPCE	Great Lakes International Multidisciplinary Program on Crustal Evolution

GMH	Great Meteor Hotspot
GMM	ground motion model
GMPE	ground motion prediction equation
GMRS	ground motion response spectrum
gpm	gallons per minute
GPS	global positioning system
GSI	generic safety issue
GSI	geological strength index
GTG	generic technical guidance
GTS	generic technical specification
GWMS	gaseous waste management system
hr	hour
HAB	hostile action based
HCLPF	high confidence of low probability of failure
HCM	Highway Capacity Manual
HCU	hydraulic control unit
HEC	Hydrological Engineering Centers
HEC-HMS	Hydrological Engineering Centers-Hydrological Modeling System
HEPA	high-efficiency particulate air
HF	high frequency
HFE	human factors engineering
HFI	human factor issue
HMR	Hydrometeorological Report
HMS	Hydrological Modeling System
HPM	human performance monitoring
HPN	Health Physics Network
HPS	Health Physics Society
HRA	human reliability analysis
HUSWO	Hourly U.S. Weather Observations
HVAC	heating, ventilation, and air conditioning
HWCS	hydrogen water chemistry system
Hz	Hertz
I&C	instrumentation and control
IAS	International Accreditation Service
IBC	International Building Code
IBEB	Illinois Basin Extended Basement
IC	isolation condenser
IC/PCC	isolation condenser/passive containment cooling system
ICS	isolation condenser system
IE	inspection and enforcement
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IFR	Interim finding report

IGLD	International Great Lakes Datum
ILAC	International Laboratory Accreditation Cooperation
IN	information notice
in.	inch(es)
INPO	Institute of Nuclear Power Operations
IPCS	integrated plant computer system
IR	intermediate range
ISFSI	independent spent fuel storage installation
ISG	interim staff guidance
ISHD	Integrated Surface Hourly Data
ISI	inservice inspection
IST	inservice testing
ITAAC	Inspections, tests, analyses, and acceptance criteria
ITC	International Transmission Company
ITP	initial test program
ITS	International Transmission Company
JFD	joint frequency distribution
JIC	joint public information center
JLD	Japan lesson-learned project directorate
JPIC	joint information center
ka	thousand years ago
KI	potassium iodide
km	kilometer(s)
kPa	kilopascals
kV	kilovolt
L-A-B	Laboratory Accreditation Bureau
LAN	local area network
LB	lower-bound
lb/ft^2	pounds per square-foot
LCO	limiting condition for operation
LF	low frequency
LiDAR	light detection and ranging
LLEA	local law enforcement agency
LLNL	Lawrence Livermore National Laboratory
LLRW	low-level radioactive waste
LOA	Letters of Agreement
LOCA	loss-of-coolant accident
LOLA	loss of large area
LOOP	loss-of-offsite power
LOPP	loss of preferred power
Lpm	liter per minute
LPZ	low population zone

LR	lower-range
LSS	low strategic significance
LTOP	low temperature overpressure protection
LTR	licensing topical report
LTSP	limiting trip setpoint
LWMS	liquid waste management system
LWR	light water reactor
M	magnitude (earthquake)
m	meter(s)
M&TE	measuring and test equipment
Ma	million years ago
MASR	minimum alternating stress ratio
MBtu	one million BTU
MC&A	material control and accounting
MCL	management counterpart link
MCPR	minimum critical power ratio
MCR	main control room
MCWB	mean coincident wet-bulb
MDCH	Michigan Department of Community Health
MDCT	mechanical draft cooling tower
MDEQ	Michigan Department of Environmental Quality
MEB	modified energy balance
MEI	maximally exposed individual
MEMP	Michigan Emergency Management Plan
MGA	Mid-Michigan Gravity Anomaly
MHz	megahertz
m_i	material index
mi	mile(s)
MIDC	Midcontinent-Craton
MIS	marine isotope stage
MJ	megajoules
MMGH	Mid-Michigan Gravity High
MMIS	man-machine interface system
MMP	Meteorological Monitoring Program
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MOV	motor-operated valve
MPa	megapascals
MPaG	megapascals gauge
mph	miles per hour
MPSC	Michigan Public Service Commission
MR	maintenance rule
MRA	Mutual Recognition Arrangement
MRCSP	Midwest Regional Carbon Sequestration Partnership

Mrem	millirem
MRS	midcontinent rift system
MSM	modified subtraction method
MST	mitigative strategies table
MW	megawatt
NAAQS	National Ambient Air Quality Standards
NACE	National Association of Corrosion Engineers
NAP	Northern Appalachian
NAVD	North American Vertical Datum
NCDC	National Climatic Data Center
NCS	nuclear criticality safety
ND	Nuclear Development
ND QAPD	Nuclear Development Quality Assurance Program document
N-DCIS	nonsafety-related distributed control and information system
NDCT	natural draft cooling tower
NDE	nondestructive examination
NDT	nil ductility temperature
NEDB	National Earthquake Database
NEHRP	National Earthquake Hazards Reduction Program
NEI	Nuclear Energy Institute
NEIC	National Earthquake Information Center
NERC	National Electric Reliability Council
NESC	National Electrical Safety Code
NFEMP	Nuclear Facilities Emergency Management Plan
NFPA	National Fire Protection Association
NGA	Next Generation Attenuation
NGVD	National Geodetic Vertical Datum
NIRMA	Nuclear Information and Records Management Association
NIST	National Institute of Standards and Technology
NMF	New Madrid fault
NMFS	New Madrid fault system
NMSZ	New Madrid Seismic Zone
NNE	north-northeast
NOAA	National Oceanic and Atmospheric Administration
NOC	Nuclear Operations Center
NOMMAD	Northwest Ohio and Michigan Mutual Aid District
NOV	notice of violation
NPHS	normal power heat sink
NQA	nuclear quality assurance
NRC	Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NRO	Office of New Reactors
NS	nonseismic
NSAC	Nuclear Safety Analysis Center

$NTSP_F$	nominal trip setpoint (final)
NTTF	Near-Term Task Force
NUMARC	Nuclear Utilities Management and Resources Council
NVLAP	National Voluntary Laboratory Accreditation Program
NWS	National Weather Service
OBE	operating-basis earthquake
OCA	owner controlled area
OCANS	owner controlled area notification system
ODCM	offsite dose calculation manual
OE	Owner's Engineer
OEM	original equipment manufacturer
OGS	offgas system
OIS	oxygen injection system
OM	Operation and Maintenance Code
ORE	occupational radiation exposure
ORO	offsite response organization
OSC	operational support center
OTV	optical televiewer
P&ID	piping and instrumentation diagram
P/T	pressure/temperature
PA	protected area
PA/PL	plant announcement (page)/party-line
PAA	protective action area
PABX	private automatic branch exchange
PAG	Protective Action Guide
PAM	postaccident monitoring
PAR	protective action recommendation
PAS	post-accident sampling
PASS	post-accident sampling system
PAT	power ascension test
PBSRS	performance-based surface response spectra
PCC	passive containment cooling
PCCS	passive containment cooling system
PCP	process control program
PCTMS	plant cooling tower makeup system
PEER	Pacific Earthquake Engineering Research
PERMS	process effluent radiation monitoring and sampling
PEZ	Paleozoic Extended Zone
PGA	peak ground acceleration
PGD	peak ground displacement
PGP	procedures generation package
PGV	peak ground velocity
PIP	plant investment protection

PMCL	protective measures counterpart link
PMF	probable maximum flood
PMH	probable maximum hurricane
PMP	probable maximum precipitation
PMT	probable maximum tsunami
PMWP	probable maximum winter precipitation
PMWS	probable maximum windstorm
PO	Purchase Orders
PORV	power-operated relief valve
POV	power-operated valve
ppb	parts per billion
PPS	preferred power supply
PRA	probabilistic risk assessment
PRMS	process radiation monitoring system
P-S	compression (P) - shear (S)
PSD	power spectral density
psf	pounds per square-foot
PSHA	probabilistic seismic hazard analysis
PSI	preservice inspection
psi	pounds per square inch
psia	pounds per square-inch absolute
psig	pound per square inch gauge
PSP	Physical Security Plan
PSS	process sampling system
PST	preservice testing
PSWS	plant service water system
PTLR	pressure and temperature limits report
PTS	plant-specific technical specifications
PWS	potable water system
PWSS	pretreated water supply system
QA	quality assurance
QAP	quality assurance program
QAPD	quality assurance program description
Q-DCIS	safety-related distributed control and information system
RAI	request for additional information
RAP	reliability assurance program
RAS	River Analysis System
RAT	reserve auxiliary transformer
RB	reactor building
RCC	roller compacted concrete
RCCV	reinforced concrete containment vessel
RCCW	reactor closed-cooling water
RCCWS	reactor component cooling water system

R-COL	reference-COL
R-COLA	reference-COLA
RCPB	reactor coolant pressure boundary
RCS	reactor coolant system
RCTS	resonant column torsional shear
RE	reference earthquakes
rem	roentgen equivalent man (a unit of radiation dose)
REMP	radiological environmental monitoring program
REP	radiological emergency preparedness
RERP	radiological emergency response preparedness
RET	radiological emergency team
RFI	radio frequency interference
RG	regulatory guide
RIS	regulatory issue summary
RLME	repeated large magnitude earthquake
RM	resolution method
RMS	radiation monitoring system
RO	reverse osmosis
RP	radiation protection
RPP	Radiation Protection Program
RQD	rock quality designation
RR	Reelfoot Rift
RR-RCG	Reelfoot Rift-Rough Creek Graben
RSCL	reactor safety counterpart link
RSW	reactor shield wall
RT	radiographic testing (or technique)
RT_{NDT}	reference temperature nil ductility temperature
RTNSS	regulatory treatment of non-safety systems
RV	reactor vessel
RVSP	reactor vessel (materials) surveillance program
RVT	Random Vibration Theory
RWB	radwaste building
RWCU	reactor water cleanup
RWMS	radioactive waste management systems
s	second
SACTI	Seasonal/Annual Cooling Tower Impact
SAM	startup administrative manual
SAMSON	Solar and Meteorological Surface Observational Network
SAS	secondary alarm station
SASW	spectral analysis of surface wave
SAT	systems approach to training
SB	service building
SBO	station blackout
SBWR	simplified boiling-water reactor

SCC	stress corrosion cracking
SCOR	soil column outcrop response
SCP	Safeguards Contingency Plan
SCRRI	selected control rod run in
SDC	shutdown cooling
SDG	standby diesel generator
SDM	shutdown margin
SDMP	Steam Dryer Monitoring Plan
SDOF	single-degree-of-freedom
SE	safety evaluation
SEC	Securities and Exchange Commission
SER	safety evaluation report
SFP	spent fuel pool
SFPC	spent fuel pool cooling
SGI	safeguards information
SLC	standby liquid control
SLCS	standby liquid control system
SLR	St. Lawrence Rift
SM	subtraction method
SNM	Special Nuclear Material
SNMPPP	Special Nuclear Material Physical Protection Plan
SOG	Seismic Owners Group
SPDS	safety parameter display system
SPT	standard penetration test
SR	surveillance requirement
SRI	select rod insert
SRM	staff requirements memorandum
SRO	senior reactor operator
SRP	Standard Review Plan
SRV/SV	safety relief valve/safety valve
SSC	structure, system, and component
SSE	safe-shutdown earthquake
SSEMP	Safety, Security and Emergency Planning
SSEP	safety, security, and emergency preparedness
SSHAC	Senior Seismic Hazard Analysis Committee
SSI	soil-structure interaction
SSSI	structure-soil-structure interaction
SSW	south-southwest
Std	Standard
STS	standard technical specifications
SUNSI	Sensitive Unclassified Non-Safeguards Information
Sv	Sievert
SWDS	sanitary waste discharge system
SWMS	solid waste management system
SWS	station water system

SWST	station water storage tank
T&QP	Training and Qualification Plan
TAF	top of active fuel
TB	turbine building
TBS	turbine bypass system
TCCWS	turbine component cooling water system
TCP	traffic control point
TEDE	total effective dose equivalent
TG	Technical Guide
TGCS	turbine generator control system
TGSS	turbine gland seal system
THA	time-history accelerograph
TLD	thermoluminescent dosimeter
TMI	Three Mile Island
TMSS	turbine main steam system
TR	technical report
TS	technical specifications
TSC	technical support center
TSCR	truncated soil column response
TSCVS	technical support center heating, ventilation, and air conditioning subsystem
TSTF	Technical Specifications Task Force
UAT	unit auxiliary transformer
UB	upper-bound
UC	unconfined compression
UHF	ultra high frequency
UHRS	uniform hazard response spectra
UHS	ultimate heat sink
UPS	uninterruptible power supply
UR	upper-range
US	United States
USACE	U.S. Army Corps of Engineers
US-APWR	U.S. Advanced Pressurized Water Reactor
USCG	United Sates Coast Guard
USGS	United States Geological Survey
USI	unresolved safety issue
USNRC	United States Nuclear Regulatory Commission
UT	ultrasonic technique
UTM	Universal Transverse Mercator
V&V	verification and validation
V	volt
V/H	vertical-to-horizontal

Vac	volt alternating current
VBS	vehicle barrier system
Vdc	volt direct current
VHRA	very high radiation area
V_p	compression wave velocity
Vpc	volt per cell
V_s	shear wave velocity
WB	wet bulb
WBGT	wet bulb globe temperature
WNA	Western North America
WV	Wabash Valley
WVSZ	Wabash Valley Seismic Zone
ZIS	zinc injection system

1.0 INTRODUCTION AND INTERFACES

This chapter of the safety evaluation report (SER) is organized as follows:

- Section 1.1 provides an overview of the entire combined license (COL) application.
- Section 1.2 provides the regulatory basis for the COL licensing process.
- Section 1.3 provides an overview of the principal review matters in the COL application and where the staff's reviews of the ten parts of the COL application are documented. .
- Section 1.4 documents the staff's review of Chapter 1 of the Final Safety Analysis Report (FSAR) and documents regulatory findings that are in addition to those directly related to the staff's review of the FSAR.

1.1 Summary of Application

In a letter dated September 18, 2008 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML082730763), the Detroit Edison Company (Detroit Edison, DTE)[1] submitted an application to the United States Nuclear Regulatory Commission (NRC or the Commission) for a COL to construct and operate an Economic Simplified Boiling-Water Reactor (ESBWR) pursuant to the requirements of Section 103 and 185(b) of the Atomic Energy Act of 1954 as Amended, Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications and Approval for Nuclear Power Plants," and the associated material licenses under 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material"; 10 CFR Part 40, "Domestic Licensing of Source Material"; and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material." This reactor will be identified as Fermi 3 and will be located on the existing Fermi site in Monroe County, Michigan.

In a letter dated October 15, 2014 (ADAMS Accession No. ML14295A354) DTE Electric Company submitted Revision 7 of the Fermi 3 FSAR. Subsequent to the submission of Revision 7, in a letter dated October 31, 2014 (ADAMS Accession No ML14308A337), DTE Electric Company submitted Revision 8 of the Fermi 3 FSAR. This revision incorporates by reference the codified version of the ESBWR design certification rule (DCR) which is contained in 10 CFR Part 52, Appendix E, "Design Certification Rule for the U.S. Economic Simplified Boiling Water Reactor." The ESBWR DCR was published on October 15, 2014 (79 FR 61944) and is effective November 14, 2014. This revision only affected the content of the Chapter 1 FSAR and supports the closure of Confirmatory Item 01-1 in Section 1.2.2 of this SER. The NRC staff's findings and conclusions for the other chapters based on Revision 7 of the Fermi 3 FSAR remain valid for Revision 8. The ESBWR DCR references Revision 10 of the ESBWR design control document (DCD). The ESBWR nuclear reactor design is a 4,500-megawatt thermal reactor that uses natural circulation for normal operations and has passive safety features.

In developing the Final Safety Evaluation Report (FSER) for Fermi 3, the staff reviewed the ESBWR DCD to ensure that the combination of the information in the DCD and the information

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[1] By letter dated December 21, 2012, the Detroit Edison Company informed the NRC that effective January 1, 2013, the name of the company would be changed to "DTE Electric Company." The legal entity will remain the same (see ADAMS Accession No. ML12361A437).

in the COL application represents the complete scope of information relating to a particular review topic.

There is a Fermi 3 FSER chapter that was issued without a corresponding ESBWR DCD chapter. Specifically, Fermi 3 FSER Chapter 20, "Requirements Resulting from Fukushima Near-Term Task Force Recommendations," does not have a corresponding ESBWR DCD Chapter 20. The FSER Chapter 20 describes the staff's evaluation and findings for the requirements resulting from the Fukushima Near-Term Task Force recommendations that are applicable to the Fermi 3 COL. The applicable recommendations address the following four topics:

- A reevaluation of the seismic hazard (related to Recommendation 2.1).
- Mitigation strategies for beyond-design-basis external events (related to Recommendation 4.2).
- Spent fuel pool instrumentation (related to Recommendation 7.1).
- Emergency preparedness staffing and communications (related to Recommendation 9.3).

For more information on the staff's review of the above four topics, see Chapter 20 of this FSER.

The Fermi 3 COL application is organized as follows:

- **Part 1 General and Administrative Information**

Part 1 provides an introduction to the application and includes certain corporate information regarding Detroit Edison pursuant to 10 CFR 50.33(a)–(d).

- **Part 2 Final Safety Analysis Report**

Part 2 contains information pursuant to the requirements of 10 CFR 52.79 "Contents of applications; technical information in final safety analysis report," and, in general, adheres to the content and format guidance in Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

- **Part 3 Environmental Report**

Part 3 contains environmental-related information pursuant to the requirements of 10 CFR 52.80 and 10 CFR 51.50(c).

- **Part 4 Technical Specifications and Bases**

Part 4 addresses how the ESBWR generic technical specifications (TS) and bases of the design are incorporated by reference into the Fermi 3 plant-specific TS and bases.

- **Part 5 Emergency Plan**

Part 5 contains the Fermi Emergency Plan with supporting information such as evacuation time estimates for the Fermi plume exposure pathway and applicable offsite state and local emergency plans.

- **Part 6 [Not Used - reserved for Limited Work Authorization/site redress information]**

- **Part 7 Departures Report**

Part 7 contains information from the applicant regarding departures and exemptions. The Fermi 3 application contains one departure (EF3 DEP 11.4-1) titled "Long-Term, Temporary Storage of Class B and C Low-Level Radioactive Waste." The staff evaluated and reviewed this departure in SER Chapter 11. Part 7 also includes requests for exemptions from 10 CFR 70.22(b); 70.32(c); 74.31, "Nuclear material control and accounting for special nuclear material of low strategic significance"; 74.41, "Nuclear material control and accounting for special nuclear material of moderate strategic significance"; and 74.51, "Nuclear material control and accounting for strategic special nuclear material." The staff evaluated these exemptions in Section 1.4.4 of this SER chapter.

- **Part 8 Safeguards and Security Plans**

Part 8 was submitted concurrent with the application to the NRC as separate licensing correspondence in order to fulfill the requirements of 10 CFR 52.79(a)(35) and 10 CFR 52.79(a)(36). Part 8 contains the Fermi 3 Security Plan and Safeguards Information that is withheld from public disclosure pursuant to 10 CFR 73.21, "Protection of Safeguards Information: Performance Requirements." The information in Part 8 consists of the Physical Security Plan, the Training and Qualification Plan, the Safeguards Contingency Plan, and the Cyber Security Plan.

- **Part 9 Proprietary and Sensitive Information**

Part 9 identifies sensitive information that is withheld from public disclosure under 10 CFR 2.390, "Public inspections, exemptions, requests for withholding." Part 9 also includes sensitive, unclassified, and non-safeguards information (SUNSI); figures from Part 2 of the application that meet the SUNSI guidance for information withheld from the public; the withheld portions of the Cyber Security Plan required by 10 CFR 73.54, "Protection of Digital Computer and Communication Systems and Networks"; and the withheld portions of Mitigative Strategies Description and Plans covering the loss of large areas of the plant from explosions or fire, as required in 10 CFR 52.80(d).

- **Part 10 ITAAC**

Part 10 states that the ESBWR DCD, Tier 1 is incorporated by reference and contains the Fermi 3 Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). The Fermi 3 COL ITAAC are addressed in four parts: (1) Design Certification (DC) ITAAC, (2) Emergency Planning ITAAC, (3) Physical Security ITAAC, and (4) Site-Specific ITAAC. In addition, Part 10 includes a list of proposed license conditions from the applicant.

1.2 Regulatory Basis

1.2.1 Applicable Regulations

10 CFR Part 52, Subpart C, "Combined Licenses," establishes the requirements and procedures applicable to the Commission-issued COL for nuclear power facilities. The following requirements are of particular significance:

- 10 CFR 52.79, "Contents of applications; technical information in final safety analysis report," identifies the technical information required in the FSAR.
- 10 CFR 52.79(d) provides additional requirements for a COL referencing a standard certified design.
- 10 CFR 52.80, "Contents of applications; additional technical information," provides additional technical information outside of the FSAR (ITAAC and the environmental report).
- 10 CFR 52.81, "Standards for review of applications," provides standards for reviewing the application.
- 10 CFR 52.83, "Finality of referenced NRC approvals; partial initial decision on site suitability," provides for the finality of the referenced NRC approvals (e.g., standard DC approvals).
- 10 CFR 52.85, "Administrative review of applications; hearings," provides requirements for administrative reviews and hearing.
- 10 CFR 52.87, "Referral to the Advisory Committee on Reactor Safeguards (ACRS)," provides for referral to the ACRS.

NRC staff reviewed this application according to the following requirements:

- 10 CFR Part 20, "Standards for Protection Against Radiation"
- 10 CFR Part 30
- 10 CFR Part 40
- 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities"
- 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions"
- 10 CFR Part 52
- 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants"
- 10 CFR Part 55, "Operators' Licenses"

- 10 CFR Part 70
- 10 CFR Part 73, “Physical Protection of Plants and Materials”
- 10 CFR Part 74, “Material Control and Accounting of Special Nuclear Material”
- 10 CFR Part 100, “Reactor Site Criteria”
- 10 CFR Part 140, “Financial Protection Requirements and Indemnity Agreements”

The staff evaluated the application against the guidance and acceptance criteria in the following:

- NUREG–0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)”
- NUREG–1520, “Standard Review Plan for the Review of a Licensing Application for a Fuel cycle Facility”
- NUREG-1555, Revision 1: “Standard Review Plans for Environmental Reviews for Nuclear Power Plants”
- NUREG–1556, “Consolidated Guidance About Materials Licenses”
- NUREG–1577, “Standard Review Plan on Power Reactor Licensee Financial Qualifications and Decommissioning Funding Assurance”

In addition, the staff considered the format and content guidance in RG 1.206 for the COL application.

1.2.2 Finality of Referenced NRC Approvals

In accordance with 10 CFR 52.83, “Finality of referenced NRC approvals; partial initial decision on site suitability,” if the application for a COL references a DCR, the scope and nature of matters resolved for the application and any COL issued are governed by the applicable relevant provisions. For the ESBWR DCR, finality is specifically addressed in 10 CFR 52.63, “Finality of standard design certifications.” Based on the finality afforded to referenced certified designs, the scope of this COL application review as it relates to the referenced certified design is limited to items that fall outside the scope of the certified design (e.g., COL information items, design information replacing conceptual design information (CDI), and programmatic elements that are the responsibility of the COL).

The contents of the FSAR are specified in 10 CFR 52.79(a), which requires the information submitted in the FSAR to describe the facility; identify the design bases and the limits on its operation; and present a safety analysis of the structures, systems, and components (SSCs) of the facility as a whole. For a COL application that references a DC, Section 52.79(d) requires the DCD to be included in or incorporated by reference into the FSAR. Additionally, a COL application that references a DC must also contain the information and analysis required to be submitted within the scope of the COL application but is outside the scope of the DCD. This combined information addresses plant- and site-specific information and includes all COL action or information items; design information that replaces CDI; and programmatic information that was not reviewed and approved in connection with the DC rulemaking. The initial step in the NRC staff's evaluation of the COL application is to confirm that the complete set of information required to be addressed in the COL application is also in the DC supplemented by the COL application or completely included in the COL application. Following this confirmation, the staff's review of the COL application is limited to the COL review items.

This FSER is based on the applicant's Revision 8 of the Fermi 3 FSAR, which incorporates by reference ESBWR DCD, Revision 10. Although the referenced version of the ESBWR design was docketed but not yet certified, 10 CFR 52.55(c) allows an applicant to take a risk to incorporate by reference a design that is not yet certified. The results of the staff's technical evaluation of the ESBWR DCD application are in NUREG–1966, "Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling-Water Reactor Standard Design," (ADAMS Accession No. ML14100A304), and it's Supplement 1 (ADAMS Accession No. ML14265A084). Because the ESBWR DC was not yet certified, the applicant had not incorporated the codified version of the DC into the application. The incorporation of the ESBWR DCR into the Fermi 3 COL application was tracked as Confirmatory Item 01-1. The staff verified that FSAR Revision 8 incorporates by reference the ESBWR DCR. Therefore, Confirmatory Item 01-1 is resolved.

1.2.3 Overview of the Design-Centered Review Approach

The design-centered review approach (DCRA) is described in Regulatory Issue Summary 2006-06, "New Reactor Standardization Needed to Support the Design-Centered Licensing Review Approach." The DCRA is endorsed by the Commission's Staff Requirements Memorandum SECY-06-0187, "Semiannual Update of the Status of New Reactor Licensing Activities and Future Planning for New Reactors," dated November 16, 2006. The DCRA is the Commission's policy intended to promote a standardization of COL applications; it is beyond the scope of information included in the DC. This policy directs the staff to perform one technical review for each standard issue outside the scope of the DC and to use this decision to support decisions on multiple COL applications. In this context, "standard" refers to essentially identical information and may include information provided by the applicant(s) to resolve plant-specific issues.

The first COL application submitted for NRC staff to review is designated in a design center as the referenced COL (R-COL) application, and the subsequent applications in the design center are designated as subsequent COL (S-COL) applications. The North Anna Unit 3 COL application was originally designated as the R-COL application for the ESBWR design center, and the staff issued an SER with open items that documented a review of both standard and site-specific information. In a letter dated May 18, 2010, Dominion Energy, Inc. informed the NRC that it had changed reactor technology and had selected the U.S. Advanced Pressurized-Water Reactor (US-APWR) for its North Anna Unit 3 COL application. As a result of Dominion's decision, Detroit Edison responded to all of the open items in the staff's North Anna Unit 3 SER that related to standard content on behalf of the ESBWR design center and consistent with its new position as the R-COL for the ESBWR design center.[2] Thus, this SER documents the

[2] By letter dated April 25, 2013 (ADAMS Accession No. ML13120A016), the applicant for the North Anna Unit 3 COL application informed the NRC that it had revised its technology selection and selected the General Electric (GEH) ESBWR nuclear technology for the North Anna Unit 3 project. The applicant submitted a revised North Anna Unit 3 COLA to the NRC on July 31, 2013 (ADAMS Accession No. ML13221A504). However, the Fermi COL application remains as the ESBWR design center R-COL.

staff’s review of both standard and site-specific information and is the first complete SER for a COL application in the ESBWR design center.

To ensure that the staff’s findings on standard content that were documented in the SER with open items issued for the North Anna Unit 3 COL application are equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna Unit 3 COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes to the Fermi 3 COL FSAR (and other parts of the COL application, as applicable) resulting from requests for additional information (RAIs) and open and confirmatory items identified in the North Anna Unit 3 SER with open items.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation (the North Anna Unit 3 SER) were endorsed.

- The staff verified that the site-specific differences are not relevant.

Where there were differences between the information provided by the Fermi 3 applicant and that provided by the North Anna Unit 3 applicant regarding details in the application for the standard content material, the staff evaluated the differences and determined whether the standard content material of the North Anna Unit 3 SER was still applicable to the Fermi 3 application. These evaluations are in the SERs that reference the standard content.

This standard content material is identified in this SER by using italicized, double-indented formatting. This SER also documents the staff’s findings with respect to the closure of all open items related to standard content, which will be used as the R-COL reference for other ESBWR S-COL application reviews. Finally, this SER documents the staff’s findings with respect to site-specific issues related only to the Fermi 3 site.

1.3 Principal Review Matters

The staff’s evaluations related to the COL application review are addressed as follows:

- **Part 1 General and Administrative Information**

The staff’s evaluation of the corporate information regarding DTE that is pursuant to 10 CFR 50.33, “Contents of applications; general information,” is in Section 1.4.1 of this SER.

- **Part 2 Final Safety Analysis Report**

The staff’s evaluation of information in the Fermi 3 FSAR is in the corresponding sections of this SER.

- **Part 3 Environmental Report**

The staff's evaluation of environmental information pursuant to the requirements of 10 CFR 51.50(c) addressed in the environmental report is in the staff's Final Environmental Impact Statement in NUREG–2105, "Final Environmental Impact Statement for Combined License (COL) for Enrico Fermi Unit 3."

- **Part 4 Technical Specifications**

Chapter 16 of this SER contains the staff's evaluation of the Fermi 3 plant-specific TS (PTS), and the associated PTS bases.

- **Part 5 Emergency Plan**

Chapter 13 of this SER includes the staff's evaluation of the Fermi 3 Emergency Plan, including related ITAAC, and the Federal Emergency Management Agency's review of State and local emergency plans.

- **Part 6 [Not Used - reserved for Limited Work Authorization/site redress information]**

- **Part 7 Departures Report**

The staff's evaluation of departures and exemptions is provided in the applicable chapters of this SER (i.e., Chapters 1 through 19). The staff's review of the requested exemptions is included in Section 1.4.4 of this SER.

- **Part 8 Safeguards and Security Plans**

The staff's evaluation of the Fermi 3 Security Plan and Safeguards Information is documented separately from this SER and is withheld from the public in accordance with 10 CFR 73.21. A non-sensitive summary of the staff's evaluation is in Section 13.6 of this SER.

- **Part 9 Proprietary and Sensitive Unclassified Non-Safeguards Information**

The staff's evaluation of the sensitive information, withheld information in Part 9 occurs in the context of the specific subject being reviewed and is documented by the staff accordingly throughout the staff's SER. In addition, the applicant has included withheld portions of the applicant's Cyber Security Plan as required by 10 CFR 73.54. The staff's evaluation of the cyber security-related plans is included in SER Section 13.8. Furthermore, the applicant has provided withheld portions of the Mitigative Strategies Description and Plans for the loss of large areas of the plant due to explosions or fire, as required by 10 CFR 52.80(d). A summary of the staff's evaluation of this information is in Appendix 19A of this SER. The staff's complete evaluation is documented separately from this SER and is withheld from the public in accordance with 10 CFR 2.390, "Public inspections, exemptions, requests for withholding."

- **Part 10 ITAAC and Proposed License Conditions**

Chapter 14 of this SER contains the staff's evaluation of the ITAAC, except for the Physical Security ITAAC in SER Section 13.6. In addition, Part 10 of the application includes a list of proposed license conditions that are evaluated by the staff throughout this SER. At the completion of the staff's Fermi 3 COL application review, the staff will identify all proposed license conditions and ITAAC for recommendation that the Commission should impose if a COL is issued to the applicant.

Organization of this SER

The staff's SER is structured as follows:

- The SER adheres to the "finality" afforded to COL applications that incorporate by reference a standard certified design. As such, rather than repeat any technical evaluation of material incorporated by reference, this SER points to the corresponding review findings of NUREG-1966. However, the referenced ESBWR DCD and the Fermi 3 COL FSAR are considered in the staff's safety evaluation—to the extent necessary—to ensure that the expected scope of information to be included in a COL application is adequately addressed in the DCD and/or in the COL FSAR.

- For sections that were completely incorporated by reference without any supplements or departures, the SER simply points to the ESBWR DCD and the related NUREG–1966 to confirm that all relevant review items are addressed in the ESBWR DCD and the staff's evaluation is documented in NUREG–1966.

- For subject matter within the scope of the COL application that supplements or departs from the DCD, this SER generally follows a six-section organization as follows:

    - "Introduction," which provides a brief overview of the specific subject matter.

    - "Summary of Application," which identifies whether portions of the review have received finality and clearly identify the scope of the COL review.

    - "Regulatory Basis," which identifies the regulatory criteria for the information addressed by the COL application.

    - "Technical Evaluation," which focuses on the information addressed by the COL application.

    - "Post Combined License Activities," which identifies the proposed license conditions, the ITAAC, or the FSAR information commitments that are post COL activities.

    - "Conclusion," which summarizes how the technical evaluation resulted in a reasonable assurance determination by the staff on the basis that the relevant acceptance criteria have been met.

1.3.1 Staff Review of Fermi COL FSAR Chapter 1

1.3.2 Introduction

There are two types of information in Chapter 1 of the Fermi 3 COL FSAR:

- General information that enables the reviewer or reader to obtain a basic understanding of the overall facility without having to refer to the subsequent chapters. A review of the remainder of the application can then be completed with a better perspective and recognition of the relative safety significance of each individual item in the overall plant description.

- Specific information relating to qualifications of the applicant, construction impacts, and regulatory considerations that applies throughout the balance of the application (e.g., conformance with the acceptance criteria in NUREG–0800).

This section of the Chapter 1 SER (1) identifies the information in Chapter 1 incorporated by reference, (2) summarizes all of the new information, and (3) documents the staff's evaluation of the sections addressing regulatory considerations.

1.3.3 Summary of Application

The information related to COL/SUP items included in Chapter 1 of the Fermi 3 COL FSAR includes either statements of fact or information recommended in RG 1.206. No staff technical evaluation was necessary where the statements were strictly background information. However, where technical evaluation of these COL/SUPs was necessary, the evaluation is not in this SER section, but in subsequent sections as referenced below.

<u>Section 1.1 – Introduction</u>

Section 1.1 of the Fermi 3 FSAR, Revision 8, incorporates by reference Section 1.1 of the ESBWR DCD, Revision 10. In addition, in COL FSAR Section 1.1, the applicant provides the following:

<u>COL Item</u>

- EF3 COL 1.1-1-A

The applicant provides information regarding the site-specific values for plant output.

<u>Supplemental Information</u>

- EF3 SUP 1.1-1 and EF3 SUP 1.1-2

The applicant provides supplemental information that includes general information regarding format and content of the application. The applicant also identifies systems and structures outside the scope of the ESBWR standard plant that are discussed in the applicable chapter (i.e., Chapters 2 through 19) of this SER.

- EF3 SUP 1.1-3

The applicant indicates that the Detroit Edison Company was submitting the application to the NRC under Section 103 of the Atomic Energy Act to construct and operate a nuclear plant to be located on the existing Enrico Fermi Atomic Power Plant (Fermi) site in Monroe County, Michigan.

- EF3 SUP 1.1-4

The applicant provides a description of the Fermi 3 plant location.

- EF3 SUP 1.1-5

The applicant provides the anticipated schedule for the construction and operation of the Fermi 3 plant.

Conceptual Design Information

- EF3 CDI

The applicant indicates that FSAR Figure 2.1-204 provides the orientation of the principal Fermi 3 plant structures.

Section 1.2 – General Plant Description

Section 1.2 of the Fermi 3 COL FSAR, Revision 8, incorporates by reference Section 1.2 of the ESBWR DCD, Revision 10. In addition, in COL FSAR Section 1.2, the applicant provides the following:

Departures Not Requiring NRC Approval:

- EF3 DEP 11.4-1

The applicant states that the radwaste building is configured to accommodate at least 10 years of packaged Class B and Class C waste and approximately three months of packaged Class A waste based on routine operations and anticipated operational occurrences. The applicant also provides the revised radwaste building elevation plans in Figures 1.2-21 to 1.2-25, which contain security-related information and are therefore withheld under 10 CFR 2.390. This departure is reviewed in Chapter 11 of this SER.

Supplemental Information:

- STD SUP 1.2-1

The applicant provides the following commitment:

> COM 1.2-001: To the extent practical, modular construction techniques that have been applied during ABWR construction projects will be adapted and/or modified for use during ESBWR construction. Modularization reviews will be performed to develop a plan for bringing the ABWR experience into the ESBWR.

Once completed, the results of the modularization reviews will be used as guidance to develop the detailed design of the areas affected by modularization.

Conceptual Design Information:

- STD and EF3 CDI

The applicant provides general plant descriptions of the main turbine, main condenser, hydrogen water chemistry system, zinc injection system, and freeze protection as well as other building structures. This information is discussed in the applicable chapter (i.e., Chapters 2 through 19) of this SER.

Section 1.3 – Comparison Tables

Section 1.3 of the Fermi 3 COL FSAR, Revision 8, incorporates by reference Section 1.3, "Comparison Tables", of the ESBWR DCD, Revision 10. In addition, in COL FSAR Section 1.3 the applicant provides the following:

COL Item

- EF3 COL 1.3-1-A

The applicant states that there are no updates to DCD Tier 2, Table 1.3-1 based on unit-specific information.

Section 1.4 – Identification of Agents and Contractors

Section 1.4 of the Fermi 3 COL FSAR, Revision 8, incorporates by reference Section 1.4, "Identification of Agents and Contractors", of the ESBWR DCD, Revision 10. In addition, in COL FSAR Section 1.4, the applicant provides the following:

Supplemental Information

- EF3 SUP 1.4-1

The applicant provides additional information to identify Detroit Edison[1] (the applicant) as the operator of the Fermi 3 plant. Detroit Edison also identifies GE-Hitachi Nuclear Energy Americas, LLC (GEH) as the reactor technology vendor for the design of the unit and the specialized consulting firm that assisted in preparing the COL application for Fermi 3. The contractors for the construction of the turbine island and the nuclear island have not yet been selected. However, the applicant states that the contractors will be selected based on their previous work in the nuclear industry; ongoing nuclear business; ability to deliver integrated engineering and construction services; and available resources. In addition, the applicant provides the following commitment:

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[1] By letter dated December 21, 2012, the Detroit Edison company informed the NRC that effective January 1, 2013, the name of the company would be changed to "DTE Electric Company." The legal entity will remain the same (see ADAMS Accession No. ML12361A437).

COM 1.4-001: The primary contractor for site engineering has not been selected at the time of COLA submittal; this information will be supplied in an FSAR update following selection.

Section 1.5 Requirements for Further Technical Information

Section 1.5 of the Fermi 3 COL FSAR, Revision 8, incorporates by reference Section 1.5 of the ESBWR DCD, Revision 10.

- STD SUP 1.5-1

The applicant provides information regarding Post-Fukishima Near-Term Task Force Recommendations.

Section 1.6 – Material Incorporated by Reference

Section 1.6 of the Fermi 3 COL FSAR, Revision 8, incorporates by reference Section 1.6, "Material Incorporated By Reference", of the ESBWR DCD, Revision 10. In addition, in COL FSAR Section 1.6, the applicant provides the following:

Supplemental Information

- EF3 SUP 1.6-1

Table 1.6-201 lists topical reports not included in DCD Section 1.6 that are incorporated by reference in whole or in part into the Fermi 3 FSAR.

Section 1.7 – Drawings and Other Detailed Information

Section 1.7 of the Fermi 3 COL FSAR, Revision 8, incorporates by reference Section 1.7 of the ESBWR DCD, Revision 10. In addition, in COL FSAR Section 1.7, the applicant provides the following:

Supplemental Information

- EF3 SUP 1.7-1

FSAR Table 1.7-201 supplements DCD Table 1.7-2 for those portions of the electrical system configuration drawings outside the scope of the DCD. FSAR Table 1.7-202 supplements DCD Table 1.7-3 for those portions of the mechanical system configuration drawings outside the scope of the DCD. In addition, COL Item 1.7-1-H was deleted from the referenced DCD.

Section 1.8 – Interfaces with Standard Design

Section 1.8 of the Fermi 3 COL FSAR, Revision 8, incorporates by reference Section 1.8, "Interfaces with Standard Design", of the ESBWR DCD, Revision 10. In addition, in COL FSAR Section 1.8, the applicant provides the following:

Supplemental Information

- EF3 SUP 1.8-1

The applicant states that information in FSAR Chapter 2 demonstrates that the site characteristics fall within the ESBWR site parameters specified in the referenced certified design.

- EF3 SUP 1.8-2

The applicant states that Section 1.10 identifies specific FSAR sections that address the COL information items from the referenced certified design and the COL action items.

- EF3 SUP 1.8-3

The applicant states that one site-specific departure (EF3 DEP 11.4-1) from the referenced certified design was identified, which is described in Part 7 of the COL application and listed in FSAR Table 1.8-201. This departure is evaluated in Chapter 11 of this SER.

- EF3 SUP 1.8-5

The applicant includes FSAR Table 1.8-202, which identifies systems that either adopt the CDI in the DCD as the actual system design information or replace the CDI in the DCD with site-specific design information. Information adopted from the DCD is evaluated by the NRC in NUREG–1966. Information replaced by site-specific design information is evaluated in the applicable chapters of this SER (i.e., Chapters 2 through 19).

- EF3 SUP 1.8-6

The FSAR states that the applicant reviewed site- and plant-specific information that included site meteorological data, site-specific population distribution, and plant-specific design information that replaced conceptual design information described in the DCD with respect to the DC probabilistic risk assessment (PRA). FSAR Section 19.5 documents the conclusion that there is no significant change from the certified design PRA. The staff's evaluation is in Section 19.5 of this SER.

- EF3 SUP 1.8-7

The applicant states that there are no current plans for an independent Fermi 3 spent fuel storage installation (ISFSI), and considerations for the location of a future ISFSI will include the impacts from external hazards as required by the associated 10 CFR 72 license for the ISFSI.

Conceptual Design Information

- STD CDI

The applicant states that DCD Tier 1 identifies significant interface requirements for those systems that are beyond the scope of the DCD.

Section 1.9 – Conformance with Standard Review Plan and Applicability of Codes and Standards

Section 1.9 of the Fermi 3 COL FSAR, Revision 8, incorporates by reference Section 1.9, "Conformance with Standard Review Plan and Applicability of Codes and Standards", of the ESBWR DCD, Revision 10. In addition, in COL FSAR Section 1.9, the applicant provides the following:

COL Item

- EF3 COL 1.9-3-A

The applicant adds three FSAR tables. Table 1.9-201 evaluates conformance with the SRP sections and the Branch Technical Positions (BTPs) that were in effect 6 months before submitting the COL application. Table 1.9-202 evaluates conformance with Division 1, 4, 5, and 8 RGs in effect 6 months before submittal of the COL application. Table 1.9-203 evaluates conformance with FSAR content information and format guidance in RG 1.206.

Supplemental Information

- EF3 SUP 1.9-1

The applicant provides FSAR Table 1.9-204, which identifies the industrial codes and standards applicable to those portions of the Fermi 3 design that are beyond the scope of the DCD and to the operational aspects of the facility.

- EF3 SUP 1.9-2

The applicant provides FSAR Table 1.9-205, which addresses operational experience information as described in the applicable NUREG reports, for those portions of the Fermi 3 design and operation that are beyond the scope of the ESBWR DCD. The comment column of Table 1.9-205 includes a reference to the applicable FSAR section that provides further discussion of the operational experience.

Section 1.10 – Summary of COL Items

Section 1.10 of the Fermi 3 COL FSAR, Revision 8, incorporates by reference Section 1.10, "Summary of COL Items", of the ESBWR DCD, Revision 10. In addition, in COL FSAR Section 1.10, the applicant provides the following:

Supplemental Information

- EF3 SUP 1.10-1

The applicant includes FSAR Table 1.10-201, which lists the FSAR locations that address the individual COL items from the DCD.

Section 1.11 – Technical Resolutions of Task Action Plan Items, New Generic Issues, New Generic Safety Issues, and Chernobyl Issues

Section 1.11 of the Fermi 3 COL FSAR, Revision 8, incorporates by reference Section 1.11, "Technical Resolutions of Task Action Plan Items, New Generic Issues, New Generic Safety Issues and Chernobyl Issues", of the ESBWR DCD, Revision 10. In addition, in COL FSAR Section 1.11, the applicant provides the following:

COL Item

- EF3 COL 1.11-1-A

The applicant provides FSAR Table 1.11-201, which supplements DCD Table 1.11-1 to address the site-specific aspects of activities required by the action plan that the COL applicant must complete (i.e., Note 2) and environmental issues that are outside the scope of the DCD (i.e., Note 7).

Supplemental Information

- EF3 SUP 1.11-1

The applicant adds FSAR Table 1.11-202, which supplements DCD Table 1.11-1 with references to FSAR locations that provide additional information on specific issues. It was discovered that Table 1.11-202 references EF3 SUP 1.11-2. By letter dated May 30, 2014, the applicant identified this as a typographical error and included a proposed FSAR change to correct Table 1.11-202 to reference EF3 SUP 1.11-1. The staff tracked the applicant's revision to this FSAR section as Confirmatory Item 01-2. The staff verified that FSAR Revision 7 corrected Table 1.11-202 to reference EF3 SUP 1.11-1. Therefore, Confirmatory Item 01-2 is resolved.

Section 1.12 – Impact of Construction Activities on Fermi 2

The applicant includes a supplemental information section not provided in the referenced DCD, which addresses an evaluation of the impacts from Fermi 3 construction activities on Fermi 2.

Supplemental Information

- EF3 SUP 1.12-1

The applicant provides FSAR Section 1.12, which summarizes the applicant's evaluation of the potential impact from the construction of Fermi 3 on Fermi 2 SSCs important to safety. Section 1.12 also describes the managerial and administrative controls used to provide assurance that Fermi 2 limiting conditions for operation (LCOs) will not be exceeded as a result of Fermi 3 construction activities. This evaluation involved the following sequential steps:

- Identification of potential construction activity hazards
- Identification of SSCs important to safety
- Identification of LCOs applicable to Fermi 2
- Identification of impacted SSCs and LCOs
- Identification of applicable managerial and administrative controls

In addition, the applicant provides the following commitment:

> COM 1.12-001: Managerial and administrative controls are utilized to identify preventive and mitigative measures and provide notification of hazardous activity initiation in order to prevent or minimize exposure of SSCs to the identified hazards. Applicable managerial and administrative controls are listed in Table 1.12-203.

1.3.4 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1966. In addition, the relevant requirements of the Commission regulations for the information in FSAR Chapter 1, and the associated acceptance criteria, are in Section 1.0 of NUREG–0800.

The applicable regulatory requirements are as follows:

- 10 CFR 50.43(e), as it relates to requirements for approving applications for a DC, COL, manufacturing license, or operating license that proposes nuclear reactor designs that differ significantly from light-water reactor designs licensed before 1997 or that use simplified, inherent, passive, or other innovative means to accomplish their safety functions.

- 10 CFR 52.77 and 10 CFR 52.79, as they relate to general introductory matters.

- 10 CFR 52.79(a)(17) ,as it relates to compliance with technically relevant positions of the Three Mile Island requirements.

- 10 CFR 52.79(a)(20), as it relates to proposed technical resolutions of those unresolved safety issues and medium- and high-priority generic safety issues that are identified in the current version of NUREG–0933, "A Prioritization of Generic Safety Issues," on the date up to 6 months before the docket date of the application and that are technically relevant to the design.

- 10 CFR 52.79(a)(31), as it relates to nuclear power plants that will be operated on multiunit sites and to an evaluation of potential hazards to the structures, systems, and components important to safety of operating units resulting from construction activities; in addition to providing a description of the managerial and administrative controls to be used to provide assurance that the limiting conditions for operation will not be exceeded as a result of construction activities at the multiunit sites.

- 10 CFR 52.79(a)(37), as it relates to the information necessary to demonstrate how operating experience insights are incorporated into the plant design.

- 10 CFR 52.79(a)(41), as it relates to an evaluation of the application against the applicable NRC review guidance in effect 6 months before the docket date of the application.

- 10 CFR 52.79(d)(2), which requires that for a COL referencing a standard DC, the FSAR must demonstrate that the interface requirements established for the design under 10 CFR 52.47 have been met.

- 10 CFR 52.97(a)(1)(iv), which states that an applicant is technically and financially qualified to engage in the activities authorized.

The related acceptance criteria are as follows:

- There are no specific SRP acceptance criteria associated with the general requirements.

- For regulatory considerations, acceptance is based on addressing the regulatory requirements discussed in FSAR Chapter 1 or in the FSAR section referenced in Chapter 1. The SRP acceptance criteria associated with the referenced section will be reviewed within the context of that review.

- For the performance of new safety features, the FSAR information should be sufficient to provide reasonable assurance that (1) the new safety features will perform as predicted in the applicant's FSAR; (2) the effects of system interactions are acceptable; and (3) the applicant's data are sufficient to validate analytical codes. The design qualification testing requirements may be met with either separate effects or integral system tests; prototype tests; or a combination of tests, analyses, and operating experience.

- For conformance with regulatory criteria, RG 1.206 states that an applicant should perform an evaluation for conformance with the RGs that were in effect six months before the submittal of the COL application.

1.3.5 Technical Evaluation

As documented in NUREG–1966, the staff reviewed and approved Chapter 1 of the certified ESBWR DCD. The staff also reviewed Chapter 1 of the Fermi 3 COL FSAR, Revision 8, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic. The staff's review confirms that information in the application and information incorporated by reference address the required information related to this chapter.

The staff notes that the information in the following sections of Fermi 3 FSAR Chapter 1 is for general informational purposes, and no specific technical or regulatory findings are made within the review scope of SER Chapter 1. The applicant's information in these sections is used as reference material to support the staff's technical reviews in Chapters 2 through 20 of this SER.

The staff reviewed the information in the Fermi 3 COL FSAR:

Section 1.1 – Introduction

In this section, the applicant briefly discusses the principal aspects of the overall application. There are no specific NUREG–0800 acceptance criteria related to the general information in Section 1.1 and no specific regulatory findings. The applicant's information gives the reader a basic overview of the nuclear power plant and the construct of the Fermi 3 FSAR itself.

Supplemental Information

- EF3 SUP 1.1-5

The staff notes the following for EF3 SUP 1.1-5 identified in this section:

The applicant previously provided the anticipated schedule for construction and operation of the Fermi 3 nuclear plant. However, in a letter dated April 18, 2013 (ADAMS Accession No. ML13109A427), the applicant removed this schedule and opted to provide the following commitment (COM 1.1-001) in order to provide construction and startup schedules after the issuance of a COL license and per RG 1.206, Regulatory Position C.I.1.1.5.

> COM 1.1-001: Construction and startup schedules will be provided after issuance of the COL once a positive decision to construct the plant has been made.

Revision 8 of the Fermi 3 COL application incorporates this proposed FSAR change. In conclusion, the staff finds that COM 1.1-001 and the information provided by the applicant in FSAR Section 1.1 is acceptable within the review scope of Chapter 1 and satisfies RG 1.206, Section C.I.1.1.

Section 1.2 – General Plant Description

In this section, the applicant summarizes the principal characteristics of the site and describes the facility. There are no specific NUREG–0800 acceptance criteria related to the general information in FSAR Section 1.2 and no specific regulatory findings. The applicant's information gives the reader a general plant description.

Departure Not Requiring NRC Approval:

- EF3 DEP 11.4-1

The staff notes the following for Departure EF3 DEP 11.4-1 identified in this section:

The applicant states that the radwaste building is configured to accommodate at least 10 years of packaged Class B and Class C waste and approximately three months of packaged Class A waste based on routine operations and anticipated operational occurrences. The applicant also provides the revised radwaste building elevation plans in Figures 1.2-21 to 1.2-25, which contain security-related information and are therefore withheld under 10 CFR 2.390. This departure is reviewed in Chapter 11 of this SER.

Supplemental Information

- STD SUP 1.2-1

The staff notes that STD SUP 1.2-1 provides the following commitment:

> COM 1.2-001: To the extent practical, modular construction techniques that have been applied during ABWR construction projects will be adapted and/or modified for use during ESBWR construction. Modularization reviews will be performed to develop a plan for bringing the ABWR experience into the ESBWR.

> Once completed, the results of the modularization reviews will be used as guidance to develop the detailed design of the areas affected by modularization.

In conclusion, the staff finds that the applicant's commitment (COM 1.2-001) and the departure information in FSAR Section 1.2 are acceptable within the review scope of Chapter 1 and satisfy RG 1.206, Regulatory Position C.I.1.2.

<u>Section 1.3 – Comparison Table</u>

In this section, the applicant provides a comparison with other facilities of a similar design and comparable power level. There are no specific NUREG–0800 acceptance criteria related to the general information in Section 1.3 and no specific regulatory findings.

<u>*COL Item*</u>

- EF3 COL 1.3-1-A

The applicant provided EF3 COL 1.3-1-A, which states that there are no updates to DCD Table 1.3-1 based on unit-specific information. The staff finds that the applicant's information satisfies COL Item 1.3-1-A, and the information in FSAR Section 1.3 is acceptable within the review scope of Chapter 1 and satisfies RG 1.206, Regulatory Position C.I.1.3.

<u>Section 1.4 – Identification of Agents and Contractors</u>

This section identifies primary agents or contractors for the design, construction, and operation of the nuclear power plant. There are no specific NUREG–0800 acceptance criteria related to the general information in Section 1.4 and no specific regulatory findings.

<u>*Supplemental Information*</u>

- EF3 SUP 1.4-1

The staff notes the following for EF3 SUP 1.4-1 identified in this section:

In accordance with RG 1.206, Regulatory Position C.I.1.4, "Identification of Agents and Contractors," the applicant's supplemental information identifies the primary agents for the design, construction, and operation of the proposed facility with the exception of contractors for the site engineering and for the construction of the turbine island and nuclear island. However, the applicant states that the contractors (for the construction of the turbine island and nuclear island) will be selected based on their previous work in the nuclear industry; ongoing nuclear business; ability to deliver integrated engineering and constructions services; and available resources. The applicant delineates the division of responsibility among the contractors cited in the FSAR.

In addition, the applicant provides the following commitment (COM 1.4-001) in EF3 SUP 1.4-1:

> COM 1.4-001: The primary contractor for site engineering has not been selected at the time of COLA submittal; this information will be supplied in an FSAR update following selection.

With respect to commitment (COM 1.4-001), the staff notes the following:

Fermi 3 FSAR Chapter 17, "Quality Assurance," and the Fermi 3 Quality Assurance Program Description (QAPD) describe the DTE QA Program and QA controls for contractors performing safety-related work activities associated with the Fermi 3 COL application. The COL applicant commits to ASME NQA-1-1994 edition as a method of meeting the requirements of Appendix B to 10 CFR Part 50. The COL applicant is responsible for meeting regulatory requirements and typically imposes applicable technical and quality assurance requirements through purchase orders (POs) with contractors. These contractors are then contractually required to meet the requirements imposed by the PO. The COL applicant typically performs QA audits of these contractors to verify their compliance with PO requirements. The NRC may also perform inspections of DTE contractors with Appendix B-compliant QA programs to verify compliance with regulatory requirements. The staff finds this supplemental information acceptable. The staff also finds that commitment (COM 1.4-001) is acceptable as a post-licensing activity because contractors performing safety-related work activities would have to meet the applicable Chapter 17 requirements, as specified in the applicant's purchase order. The staff's evaluation of Chapter 17 of the Fermi 3 FSAR is in Chapter 17 of this SER.

In addition, the NRC staff evaluated DTE's technical qualification to hold a 10 CFR Part 52 license in accordance with 10 CFR 52.97(a)(1)(iv). The financial qualifications that are also a requirement of 10 CFR 52.97(a)(1)(iv) are evaluated in Section 1.4.1 of this SER.

DTE owns and operates Fermi 2 which is a General Electric boiling-water reactor (BWR), rated at 3430 MWt. Because DTE holds a 10 CFR Part 50 license for a nuclear power plant and has demonstrated its ability to build and operate a nuclear plant, the staff finds that DTE is technically qualified to hold a 10 CFR Part 52 license.

In conclusion, based on the above, the staff finds that the applicant's commitment (COM 1.4-001) and the supplemental information in FSAR Section 1.4 are acceptable within the review scope of Chapter 1 and satisfy RG 1.206, Regulatory Position C.I.1.4. Additionally, based on DTE's experience with nuclear power plants and the staff's evaluation of DTE's QA Program, the staff finds that DTE is technically qualified to hold a 10 CFR Part 52 license in accordance with 10 CFR 52.97(a)(1)(iv).

Section 1.5 – Requirements for Further Technical Information

In this section, an applicant who does not reference a certified design should provide information to demonstrate the performance of new safety features. The Fermi 3 application references the ESBWR DCD application. There are no specific NUREG–0800 acceptance criteria related to the general information in Section 1.5 and no specific regulatory findings. The applicant incorporates by reference Section 1.5 of the ESBWR DCD. Per RG 1.206, Regulatory Position C.I.1.5, only an applicant who does not reference a certified design would need to provide additional information for this section. The staff finds that the applicant's information in FSAR Section 1.5 is acceptable within the review scope of Chapter 1 and satisfies RG 1.206, Regulatory Position C.I.1.5.

STD SUP 1.5-1

The applicant provides information regarding Post-Fukishima Near-Term Task Force Recommendations. The staff's evaluation of Fukishima Recommendations 2.1, 4.2, 7.1, and 9.3 are provided in Chapter 20 of the SER stated in Section 1.1, Summary of Application, above.

Section 1.6 – Material Incorporated by Reference

In this section, an applicant provides a tabulation of all topical reports that are incorporated by reference as part of the application. There are no specific NUREG–0800 acceptance criteria related to the general information in Section 1.6 and no specific regulatory findings.

COL Item

- EF3 SUP 1.6-1

In site-specific COL Item EF3 SUP 1.6-1, the applicant includes FSAR Table 1.6-201 which lists the topical reports that are incorporated by reference in whole or in part into the FSAR that were not included in ESBWR DCD, Section 1.6. The staff finds that the applicant's information in FSAR Section 1.6 is acceptable within the review scope of Chapter 1 and satisfies RG 1.206, Regulatory Position C.I.1.6.

Section 1.7 – Drawings and Other Detailed Information

In this section, the applicant provides a tabulation of all instrument and control functional diagrams cross-referenced to the related application sections. There are no specific NUREG-0800 acceptance criteria related to the general information in Section 1.7 and no specific regulatory findings.

Supplemental Information

- EF3 SUP 1.7-1

EF3 SUP 1.7-1 includes FSAR Tables 1.7-201 and 1.7-202, which list the supplemental drawings of electrical system and mechanical system configurations, in addition to the information in ESBWR DCD, Tables 1.7-2 and 1.7-3. The staff finds that the applicant's information in FSAR Section 1.7 is acceptable within the review scope of Chapter 1 and satisfies RG 1.206, Regulatory Position C.I.1.7.

Section 1.8 – Interfaces with Standard Design

In this section, an applicant who references a certified design has to satisfy interface requirements established for the certified design. There are no specific NUREG–0800 acceptance criteria related to the general information in Section 1.8 and no specific regulatory findings. The applicant provides the following supplemental information and CDI:

Supplemental Information

- EF3 SUP 1.8-1

The applicant states that FSAR Chapter 2 provides information demonstrating that site characteristics fall within the ESBWR site parameters specified in the referenced certified design. The review of the site characteristics is in Chapter 2 of this SER.

- EF3 SUP 1.8-2

The applicant states that FSAR Section 1.10 identifies specific sections that address the COL information items from the referenced certified design and the COL action items. The review of the COL items listed in Table 1.10-201 is in the applicable chapter (i.e., Chapters 1 through 19) of this SER.

- EF3 SUP 1.8-3

The applicant identifies one site-specific departure (EF3 DEP 11.4-1) from the referenced certified design, which is described in Part 7 of the COL application. The applicant provides Table 1.8-201 to identify FSAR sections affected by this departure. Chapter 11 of this SER evaluates this departure.

- EF3 SUP 1.8-5

The applicant provides FSAR Table 1.8-202, which identifies systems that either adopt the CDI in the DCD as the actual system design information or replace the CDI in the DCD with site-specific design information. The table also includes cross references to FSAR sections that address the CDI. The DCD conceptual design information that the applicant replaced with site-specific design information is reviewed in the applicable chapters of this SER (i.e., Chapters 1 through 19).

- EF3 SUP 1.8-6

As stated above, the applicant's review of site- and plant-specific information is in FSAR Section 19.5. The staff's review of the applicant's PRA conclusion is evaluated in Section 19.5 of this SER.

- EF3 SUP 1.8-7

As stated above, the applicant does not provide information pertaining to the ISFSI because no Fermi 3 ISFSI is currently planned. Therefore, the staff is not reviewing information associated with this supplemental information item.

Conceptual Design Information

- STD CDI

As indicated above in the evaluation of Supplemental Information EF3 SUP 1.8-5, the system design information is in FSAR Table 1.8-202.

In conclusion, the staff finds that the applicant's information in FSAR Section 1.8 is acceptable within the review scope of Chapter 1 and satisfies RG 1.206, Regulatory Position C.I.1.8.

Section 1.9 – Conformance with Standard Review Plan and Applicability of Codes and Standards

This FSAR section provides the information required by 10 CFR 52.47(a)(9) showing conformance with the Standard Review Plan (SRP) and applicable codes and standards. The section summarizes deviations from each SRP section and regulatory criteria (i.e., Division 1, 4, 5, and 8 RGs; RG 1.206; and industrial codes and standards). In addition, this section provides information on the applicability of operational experience.

COL Item

- EF3 COL 1.9-3-A

The applicant provides additional information in FSAR Tables 1.9-201 through 1.9-203 that evaluate the conformance of technical information in the Fermi 3 FSAR with the SRP and applicable regulatory criteria. The staff reviewed the information in these tables and evaluated the contents against the guidance in Chapter 1 of NUREG–0800. The staff also evaluated the information in Section 1.9 as part of the technical evaluations in Chapters 2 through 19 of this SER, as needed.

The staff's review of Table 1.9-201 noted that the applicant did not always clarify why a section or acceptance criterion was not considered applicable. The staff also found discrepancies in version and/or publication dates and inconsistent referencing to a specific acceptance criterion. The staff issued RAI 01-8 (ADAMS Accession No. ML13011A014) requesting the applicant to resolve these issues. On February 8, 2013 (ADAMS Accession No. ML13043A011), and February 22, 2013 (ADAMS Accession No. ML13057A016), the applicant responded to RAI 01-8 with proposed FSAR revisions that clarified the discrepancies the staff had found in Table 1.9-201. The staff finds this information acceptable, and RAI 01-8 is resolved. The staff confirmed that the applicant incorporated these changes into Revision 7 to the FSAR.

The staff's review of Table 1.9-202 found missing references to three RGs and discrepancies in versions and publication dates for eight listed RGs. In addition, the staff required justification for three RGs that the applicant had determined were not applicable. The staff's review of Table 1.9-203 found that the applicant did not clarify why two regulatory positions were not considered applicable to Fermi 3. To address these issues, the staff issued RAI 01-9. On February 8, 2013 (ADAMS Accession No. ML13043A011), and February 22, 2013 (ADAMS Accession No. ML13057A016), the applicant responded to RAI 01-9 with proposed FSAR revisions that clarified the discrepancies the staff had found in Tables 1.9-202 and 1.9-203. The staff finds this information acceptable, and RAI 01-9 is resolved. The staff confirmed that the applicant incorporated these changes into Revision 7 to the FSAR.

Supplemental Information

- EF3 SUP 1.9-1

As stated earlier, the applicant provides additional information in FSAR Table 1.9-204 that lists the industrial codes and standards applicable to those portions of the Fermi 3 design that are beyond the scope of the ESBWR DCD and are applicable to the operational aspects of the facility. The staff reviewed the information in this table against the guidance in Chapter 1 of NUREG–0800. In comparisons to ESBWR DCD, Tier 2, Table 19-22, the staff found that FSAR Table 1.9-204 lists recent versions of the codes and standards that were in effect 6 months before the docket date of the application. This table also identifies additional codes and standards referenced in various chapters of the COL application. The staff's technical evaluations of the additional industrial codes and standards are in the relevant chapters of this SER.

- EF3 SUP 1.9-2

In FSAR Table 1.9-205, the applicant provides additional information on the operational experience applicable to Fermi 3. The staff finds that the applicant has provided sufficient information to address conformance with the operational experience information, as described in applicable NUREG reports, for those portions of the Fermi 3 design and operation that are beyond the scope of the ESBWR DCD and are in accordance with the guidance in SRP Chapter 1 and RG 1.206, Regulatory Position C.I.1.9.4. The staff's technical evaluations of the applicable operational experience are in the relevant chapters of this SER.

In conclusion, the staff finds that the applicant's information in FSAR Section 1.9 is acceptable within the review scope of Chapter 1 and satisfies RG 1.206, Regulatory Position C.I.1.9.

Section 1.10 – Summary of COL Items

The applicant's supplemental information in this section specifies EF3 SUP 1.10-1 and provides FSAR Table 1.10-201, which lists COL items that include site-specific information; information related to operational program descriptions; and other required information to support the construction and operation of an ESBWR standard design at the Fermi site. The ESBWR DCD describes the information for each COL item that the COL applicant needs to provide in the application. FSAR Table 1.10-201 lists the COL items and the proper references to the FSAR sections that describe each item. The COL items listed in this table are reviewed in the applicable chapter (i.e., Chapter 1 through Chapter 19) of this SER. There are no specific NUREG–0800 acceptance criteria related to the general information in Section 1.10 and no specific regulatory findings. The staff finds that the applicant's supplemental information in FSAR Section 1.10 is acceptable within the review scope of Chapter 1.

Section 1.11 – Technical Resolutions of Task Action Plan Items, New Generic Issues, New Generic Safety Issus, and Chernobyl Issues

In accordance with 10 CFR 52.79(a)(20), this FSAR section provides technical resolutions of unresolved safety issues (USIs); new generic issues (GI); medium- and high-priority generic safety issues (GSIs); human factor issues (HFIs); and Chernobyl issues identified in NUREG-0933 and its supplements.

COL Item

- EF3 COL 1.11-1-A

In FSAR Section 1.11.1, the applicant provides Table 1.11-201 to supplement DCD Table 1.11-1 (Notes 2 and 7) and to address the site-specific aspects of activities required by the action plan that the COL applicant must complete (i.e., Note 2) and environmental issues that are outside the scope of the DCD (i.e., Note 7).

ESBWR DCD, Table 1.11-1 identifies Task Action Items (i.e., GI and USI) A-33, B-1, B-28, B-37 through B-43, and C-16 and the new GSI 184 requiring site-specific information. These issues are mainly associated with the site-specific environmental concerns addressed in the site environmental report. The applicant provides the required information in Table 1.11-201 with appropriate references to various sections in Parts 2, 3, and 4 of the COL application. The staff's technical evaluations of these GSI topics are in the final Environmental Impact Statement (FEIS) as NUREG–2105, "Final Environmental Impact Statement for Combined License (COL) for Enrico Fermi Unit 3," and the relevant sections of this SER.

The staff's review of FSAR Table 1.11-201 also noted that in ESBWR DCD, Table 1.11-1, the last new GSI evaluated was Issue 200. In mid- and late 2006, the staff added three additional GSIs (GSI 201 through 203), but all of these were eventually dropped as GSIs and required no further evaluation. However, these issues are not identified and included in FSAR Table 1.11-201 as dropped issues. For FSAR Table 1.11-201 to be complete, the staff issued RAI 01-10 requesting the applicant to revise Table 1.11-201 by adding these three latest GSIs with the applicable note that is similar to that used in ESBWR DCD, Table 1.11-1 or by justifying their exclusions.

On February 8, 2013 (ADAMS Accession No. ML13043A011), and February 22, 2013 (ADAMS Accession No. ML13057A016), the applicant responded to RAI 01-10 with FSAR revisions that clarified the noted discrepancies in FSAR Table 1.11-201. The staff finds the information acceptable, and RAI 01-10 is resolved. The staff confirmed that the applicant incorporated these changes into Revision 7 to the FSAR.

Supplemental Information

- EF3 SUP 1.11-1

In Table 1.11-202, the applicant provides supplemental information to DCD Table 1-11 on the issues in the Three Mile Island (TMI) Action Plan that relate to staffing, qualifications, quality assurance, post-accident sampling, in-plant radiation monitoring, and shift staff HFI. The table identifies the FSAR sections where each issue is discussed. The staff's evaluations of these issues are in Chapters 12, 13, and 17 of this SER.

In conclusion, based on its review of the information discussed above, the staff finds that the applicant's COL Item EF3 COL 1.11-1-A and supplemental information EF3 SUP 1.11-1 in FSAR Section 1.11 are acceptable and consistent with the guidance in NUREG–0800 and NUREG–0933 and the requirements of 10 CFR 52.79(a)(20). The staff finds that the applicant's information in FSAR Section 1.11 is acceptable within the review scope of Chapter 1 and satisfies RG 1.206, Regulatory Position C.I.1.9.3.

Section 1.12 – Impact of Construction Activities on Fermi 2

In this section of the SER, the applicant evaluates the potential hazards to the SSCs important to safety of the Fermi 2 operating unit that would result from future construction activities of Fermi 3. The applicant also describes the managerial and administrative controls to be used to provide assurance that the limiting conditions for operation (LCO) will not be exceeded as a result of construction activities, in accordance with 10 CFR 52.79(a)(31).

Supplemental Information

- EF3 SUP 1.12-1

The applicant provides FSAR Section 1.12 as supplemental information. Based on the Interim Staff Guidance (ISG) COL ISG-22, "Interim Staff Guidance on Impact of Construction (under a Combined License) of New Nuclear Power Plants Units on Operating Units at Multi-Unit Sites," the staff issued RAI 01-5 (ADAMS Accession No. ML111880181) requesting the applicant to address the requirements of 10 CFR 52.79(a)(31) with respect to ISG-22.

The requirements in 10 CFR 52.79(a)(31) can be viewed as having two subparts:

1. The COL applicant must evaluate the potential hazards from constructing new plants on SSCs important to safety for existing operating plants located at the site (i.e., Fermi 2).

2. The COL applicant must evaluate the potential hazards from constructing new plants on SSCs important to safety for newly constructed plants that begin operation at the site. This subpart will not be applicable to Fermi 3.

The applicant was requested to provide a construction impact evaluation plan that contains the following six elements discussed in the ISG:

- A discussion of the construction activity identification process and the impact evaluation criteria used to evaluate the construction activities that may pose potential hazards to the SSCs important to safety for operating unit(s).

- A table of those construction activities and the potential hazards that are identified using that construction impact evaluation plan, the SSCs important to safety for the operating unit potentially impacted by the construction activity, and proposed mitigation methods.

- Identification of the managerial and administrative controls, such as proposed license conditions that may involve construction schedule constraints or other restrictions on construction activities, that are credited to manage the safety/security interface and to preclude and/or mitigate the impacts of potential construction hazards to the SSCs important to safety for the operating unit(s).

- A discussion of the process for communications and interactions planned and credited between the construction organization and the operations organization to ensure appropriate coordination and authorization of construction activities and implementation of the prevention or mitigation activities as necessary.

- A memorandum of understanding or agreement (MOU or MOA) between the COL applicant and the operating unit(s) licensee as a mechanism for communications, interactions, and coordination to manage the impact of the construction activities.

- An implementation schedule corresponding to construction tasks or milestones to ensure the plan is reviewed on a recurring basis and maintained current as construction progresses.

On July 13, 2011 (ADAMS Accession No. ML11195A330), the applicant provided the following responses and FSAR revisions with respect to each of the above six elements:

- A discussion of the construction activity identification process and the impact evaluation criteria used to evaluate the construction activities that may pose potential hazards to the SSCs important to safety for operating unit(s).

The process and criteria used to evaluate potential Fermi 3 construction hazards associated with Fermi 2 SSCs important to safety are discussed in FSAR Section 1.12. Section 1.12.1 specifically outlines a series of sequential steps that are discussed in further detail in FSAR Sections 1.12.2 through 1.12.6. These steps include the identification of potential construction activity hazards, SSCs important to safety, limiting conditions for operation (LCOs), impacted SSCs and LCOs, and applicable managerial and administrative controls.

- A table of those construction activities and the potential hazards that are identified using that construction impact evaluation plan, the SSCs important to safety for the operating unit potentially impacted by the construction activity, and proposed mitigation methods.

Using the identification and evaluation process described above, the applicant developed FSAR Table 1.12-201, “Potential Hazards to Fermi 2 from Fermi 3 Construction Activities,” which delineates the Fermi 3 construction activities; identifies the potential hazards using this evaluation; and describes the potentially impacted Fermi 2 SSCs. The applicant also developed FSAR Table 1.12-202, “Potential Consequences to Fermi 2 Due to Potential Hazards Resulting from Fermi 3 Construction Activities,” which describes the potential hazards and consequences specifically related to Fermi 2 SSCs. In addition, the applicant developed FSAR Table 1.12-203, “Managerial and Administrative Controls for Fermi 3 Construction Activity Hazards,” which delineates the proposed mitigation methods.

- Identification of the managerial and administrative controls such as the proposed license conditions that may involve construction schedule constraints or other restrictions on construction activities that are credited to manage the safety/security interface and to preclude and/or mitigate the impacts of potential construction hazards to the SSCs important to safety for the operating unit(s).

The managerial and administrative controls to manage the safety/security interface and to mitigate the impacts of potential Fermi 3 construction hazards to the Fermi 2 SSCs important to safety and security are discussed in Section 1.12.6, “Managerial and Administrative Controls,” and in FSAR Table 1.12-203, “Managerial and Administrative Controls for Fermi 3 Construction Activity Hazards.” FSAR Section 1.12.6 also states that there are additional controls established during construction as described and addressed in FSAR Section 13AA.1.9, “Management and Review of Construction Activities.”

In addition, in FSAR Section 1.12, the applicant identifies commitment (COM 1.12-001), which states:

> COM 1.12-001: Managerial and administrative controls are utilized to identify preventive and mitigative measures and provide notification of hazardous activity initiation in order to prevent or minimize exposure of SSCs to the identified hazards. Applicable managerial and administrative controls are listed in Table 1.12-203.

As outlined in 10 CFR 52.79(a)(31), managerial and administrative controls are used to provide assurance that Fermi 2 LCOs are not exceeded as a result of Fermi 3 construction activities. Therefore, the staff finds COM 1.12-001 acceptable since it will ensure compliance with 10 CFR 52.79(a)(31).

- A discussion of the process for communications and interactions planned and credited between the construction organization and the operations organization to ensure appropriate coordination and authorization of construction activities and implementation of the prevention or mitigation activities as necessary.

FSAR Table 1.12-203 provides the managerial and administrative controls for preventative and mitigation activities that outline the planned interactions between Fermi 2 and Fermi 3. In addition, FSAR Subsection 13.AA.1.9 includes a description of the process for Fermi 2 and Fermi 3 communications and interactions to ensure organizational coordination and authorization requirements for construction activities with potential Fermi 2 impacts, as well as implementation plans for the mitigation controls identified.

- A memorandum of understanding or agreement (MOU or MOA) between the COL applicant and the operating unit(s) licensee as a mechanism for communications, interactions, and coordination to manage the impact of the construction activities.

The Fermi 3 COL applicant and the Fermi 2 operating unit licensee are the same entity. Therefore, an MOU or MOA is not considered necessary.

- An implementation schedule corresponding to construction tasks or milestones to ensure the plan is reviewed on a recurring basis and maintained current as construction progresses.

FSAR Section 1.12.6 describes the identification of specific hazards, impacted SSCs, and managerial and administrative controls including safety/security interfaces to be developed and implemented as work progresses on the site. FSAR Table 1.12-201 describes the work progression via identification of construction activities. FSAR Subsection 13.AA.1.9 states that assessments will be performed to facilitate an implementation schedule for the administrative and managerial controls that correspond with the scheduled construction activities. The applicant also describes periodic assessments involving both Fermi 2 and Fermi 3 organizations to identify Fermi 2 SSCs that could be reasonably expected to be impacted by scheduled construction activities.

In conclusion, based on a review of the information discussed above, the staff finds that the applicant's Supplemental Information EF3 SUP 1.12-1 in FSAR Section 1.12 is acceptable and consistent with the six program elements of 10 CFR 52.79(a)(31) as expressed in COL ISG-22. Therefore, RAI 01-5 is resolved and closed.

In addition, the staff notes that other mechanisms will be used by the licensee of the operating unit (Fermi 2) to address these considerations and to ensure that potential impacts from the construction of a new Fermi 3 unit are precluded and/or mitigated. Examples include the 10 CFR 50.59 change process, the 10 CFR 50.65 risk assessment process, the 10 CFR 73.58 safety/security interface process, the technical specification change process, the emergency preparedness (EP) change process, and the FSAR update process.

<u>Appendix 1A – Response to TMI Matters</u>

This FSAR Appendix supplements ESBWR DCD, Table 1A-1 with STD SUP 1A.1-1, which provides assessments of the TMI Action Plan items listed in 10 CFR 50.34(f). There are no specific NUREG–0800 acceptance criteria related to the general information in FSAR Appendix 1A. The applicant provides supplemental information to DCD Table 1A-1 that addresses site-specific items related to construction, operations, and quality assurance. The detailed technical evaluations of these items are in Chapters 13 and 17 of this SER. The staff finds that the applicant's information in FSAR Appendix 1A is acceptable within the review scope of Chapter 1.

<u>Appendix 1B – Plant Shielding To Provide Access to Areas and To Protect Safety Equipment for Post-Accident Operation [II.B.2]</u>

The applicant has incorporated by reference this section of the DCD with no departures or supplements.

<u>Appendix 1C – Industry Operating Experience</u>

This FSAR Appendix supplements ESBWR Tables 1C-1 and 1C-2 with FSAR Tables 1C-201 and 1C-202. The DCD tables review industry operating experience issued in the Generic Letters (GL) and Bulletins (BL) that are potentially applicable to the ESBWR design or operation. These tables address GLs and BLs that were in effect/issued up to six months before a COL application submittal, and after the SRP revisions that are applicable to the FSAR. They also address GL 82-39 and IE BL 2005-02, which were identified in the DCD as the responsibility of the COL applicant. There are no specific NUREG–0800 acceptance criteria related to the general information in Appendix 1C and no specific regulatory findings; however, the applicant provides its evaluation results in Table 1C-201. The applicant states that GL 82-39 is not applicable and is an administrative communication. The site has an approved procedure for handling Safeguards Information including how to mail such information to authorized recipients. IE Bulletin 2005-02 is discussed in COLA Part 5, Emergency Plan. The staff's evaluation of the Emergency Plan is in Section 13.3 of this SER.

Departures Not Requiring NRC Approval

- EF3 DEP 11.4-1

In FSAR Table 1C-201, the applicant states under GL 81-38 that the radwaste building includes space for processing and storing low-level radioactive wastes. The radwaste building provides storage space for at least 10 years of packaged Class B and Class C wastes and approximately 3 months of packaged Class A waste. FSAR Section 11.4 provides additional information regarding the onsite storage of low-level radioactive wastes. This departure is reviewed in Chapter 11 of this SER.

COL Items

- STD COL 1C.1-1-A

In FSAR Table 1C-201, the applicant states that the site has an administrative procedure for handling safeguards information that meets the requirements of 10 CFR 73.21, "Protection of Safeguards Information: Performance requirements." This procedure also includes how to mail safeguards information to authorized recipients.

The staff finds that this response adequately addresses COL Item STD COL 1.C.1-1A, because the Fermi site has a procedure for handling safeguards information. However, the staff's review noted that ESBWR DCD, Table 1C-1 conforms to the applicable GLs up to June 2006. The staff's review of the GLs in effect 6 months before the submittal date of the Fermi 3 COL application identified GL 2007-01, "Inaccessible or Underground Power Cable Failures that Disable Accident Mitigation Systems or Cause Plant Transients," as not listed in FSAR Table 1C-201. The staff's review finds that SER Section 8.2 evaluates the applicability of this GL to Fermi 3. According to SER Section 8.2, the applicant revised FSAR Section 17.6.4 to include the underground cable monitoring program regardless of the voltage. This FSAR section states that the condition monitoring underground or inaccessible cables is in the Maintenance Rule (MR) Program. The cable condition monitoring program incorporates lessons learned from industry operating experience (e.g., GL 2007-01); addresses regulatory guidance; and utilizes information from detailed design and procurement documents to determine the appropriate inspections, tests, and monitoring criteria for underground and inaccessible cables within the scope of the MR (10 CFR 50.65).

Based on the above information, the staff concludes that the applicant has already considered GL 2007-01 in the COL application. For Table 1.C-201 to be complete, the staff issued RAI 01-11 (ADAMS Accession No. ML13011A014) requesting the applicant to include GL 2007-01 in Table 1C-201 or justify its exclusion. On February 8, 2013 (ADAMS Accession No. ML13043A011), and February 22, 2013 (ADAMS Accession No. ML13057A016), the applicant responded to RAI 01-11 and provided FSAR revisions that added the requested item to FSAR Table 1.C-201 regarding GL 2007-01. The staff finds the information acceptable, and RAI 01-11 is resolved.

- STD COL 1C.1-2-A

In FSAR Table 1C-202, the applicant states that COL application Part 5 provides the Fermi 3 Emergency Plan. The staff finds that this response adequately addresses COL Item STD COL 1C.1-2-A. The staff's evaluation of the Fermi 3 Emergency Plan is in Section 13.3 of this SER.

- STD SUP 1C-1 encompasses both STD COL 1C.1-1-A and STD COL 1C.1-2-A

In conclusion, the staff finds that the applicant's supplemental information in FSAR Appendix 1.C is acceptable within the review scope of Chapter 1 and satisfies RG 1.206, Regulatory Position C.I.1.9.4.

1.3.6 Post Combined License Activities

The applicant identifies the following FSAR commitments that the staff finds acceptable:

- Commitment (COM 1.1-001) – Construction and startup schedules will be provided after the issuance of the COL once there is a positive decision to construct the plant.

- Commitment (COM 1.2-001) – To the extent practical, modular construction techniques that were applied during ABWR construction projects will be adapted and/or modified for use during the ESBWR construction. Modularization reviews will be performed to develop a plan for bringing the ABWR experience into the ESBWR. Once completed, the results of the modularization reviews will be used as guidance to develop the detailed design of the areas affected by modularization.

- Commitment (COM 1.4-001) - The primary contractor for the site engineering was not yet selected at the time of the COLA submittal; this information will be supplied in the FSAR update following the selection.

- Commitment (COM 1.12-001) – Managerial and administrative controls are utilized to identify preventive and mitigative measures and to provide notification of hazardous activity initiation, in order to prevent or minimize exposure of SSCs to the identified hazards. Applicable managerial and administrative controls are listed in Table 1.12-203.

1.3.7 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information; and no outstanding information is expected to be addressed in the COL FSAR related to these sections. Pursuant to 10 CFR 52.63(a)(5), all nuclear safety issues relating to these sections that were incorporated by reference have been resolved.

1.4 Additional Regulatory Requirements

1.4.1 Financial Qualifications

Pursuant to 10 CFR 52.97(a)(1)(iv) and 10 CFR 52.77, the application must contain all of the information required in 10 CFR 50.33.

1.4.1.1 Introduction

In September 2008, DTE submitted a COL application for the proposed Fermi 3 pursuant to 10 CFR Part 52, Subpart C. In this COL application, DTE requested the NRC to issue one Class 103 COL for the construction and operation of Fermi 3 to be located in the State of Michigan. DTE will be the licensed owner and operator of Fermi 3.

The COL application incorporates by reference the DCD for an ESBWR provided by GEH, the applicant for the ESBWR DC documented in the most current NRC review.

According to the COL application, DTE is located in Detroit, Michigan and is a wholly owned subsidiary of the DTE Energy Company with $23 billion in assets. DTE owns and operates 11,020 megawatts of generating capacity across a mix of electricity from fossil fuel, nuclear, and hydroelectric pumped storage power plants.

1.4.1.2 Regulatory Evaluation

The applicant's request for the NRC to issue one Class 103 COL for construction and operation is subject to (among other criteria) the requirements of the Atomic Energy Act of 1954 as amended; 10 CFR Part 52, Subpart C; 10 CFR Part 50; and 10 CFR Part 140. This section reviews issues related to (1) financial qualifications, (2) decommissioning funding assurance, (3) antitrust, (4) foreign ownership, and (5) nuclear insurance and indemnity.

1.4.1.3 Construction Costs

Pursuant to 10 CFR 50.33(f)(1):

> [T]he applicant[s] shall submit information that demonstrates that the applicant[s] possess or [have] reasonable assurance of obtaining the funds necessary to cover estimated construction costs and related fuel cycle costs. The applicant[s] shall submit estimates of the total construction costs of the facility and related fuel cycle costs, and shall indicate the source(s) of funds to cover these costs.

Under 10 CFR Part 50, Appendix C, Section I.A.1, "Estimate of construction costs":

> [E]ach applicant's estimate of the total cost of the proposed facility should be broken down as follows and be accompanied by a statement describing the bases from which the estimate is derived:
>
> (a) Total nuclear production plant costs
>
> (b) Transmission, distribution, and general plant costs
>
> (c) Nuclear fuel inventory cost for first core

Total estimated cost

If the fuel is to be acquired by lease or an arrangement other than a purchase, the application should state this. The items to be included in these categories should be the same as those defined in the applicable electric plant and nuclear fuel inventory accounts prescribed by the Federal Energy Regulatory Commission or an explanation given as to any departure therefrom.

As stated in the COL application, the projected overnight costs[3] for the construction of one ESBWR nuclear unit at the Fermi 3 site is outlined in **Table 1-1**.

Table 1-1 Projected Project Cost of Fermi 3

	Billions in 2008 $
Total Nuclear Production Plant Costs	3.8–4.6
Transmission, Distribution, and General Plant Costs	1.5–2.3
Nuclear Fuel Inventory and Cost for the First Core	0.3
Total (Overnight Cost)	5.6–7.2

The applicant describes the basis for the above cost estimates. According to the COL application, the estimates were derived from the 2003 Massachusetts Institute of Technology interdisciplinary study, "The Future of Nuclear Power"; the 2004 examination of nuclear power plant costs by the Energy Information Agency of the U.S. Department of Energy (DOE) as part of its "2004 Annual Energy Outlook"; the 2005 Nuclear Energy Agency update on "Projected Costs of Generating Electricity"; and the 2007 Keystone Center published report, "Nuclear Power Joint Fact-Finding." DTE calculated a reasonable estimate based on the above studies and then added a contingency of more than 30 percent for the reactor. Fermi 3 is expected to operate at an estimated gross electrical power output of approximately 1,535 megawatts electric (MWe). Therefore, the total overnight cost range of $5.6 billion to $7.2 billion is $3,500/kilowatt electric (kWe) to $4,500/kWe.

[3] Overnight cost is the cost of a construction project that did not incur an escalation in either interest or cost during construction, as if the project was completed "overnight." An alternate definition is the present value cost that would have to be paid as a lump sum up front to completely pay for a construction project. The overnight cost is frequently used when describing power plants.

The staff reviewed studies from independent sources[4] and collected projected cost estimates of projects from all COL applications as they are submitted for comparisons and reasonableness.[5] According to these studies, the cost of constructing a plant comparable to Fermi 3 is in the range of $3,222/kWe to $5,072/kWe installed.

The applicant's overnight cost estimate is within the range derived from the studies developed by independent sources and the construction cost estimates reviewed to date for comparable plants. Accordingly, the staff finds that the applicant's overnight cost estimate is reasonable.

1.4.1.4 Sources of Construction Funds

Pursuant to 10 CFR Part 50, Appendix C, Section I.A.2, "Sources of construction costs," the application should include a brief statement of the applicant's general plan for financing the facility that identifies the sources the applicant will rely on for the construction funds (e.g., internal sources, such as undistributed earnings and depreciation accruals, or external sources, such as borrowings).

According to the COL application, DTE plans to finance the costs to construct Fermi 3 through a combination of debt and equity. The relative amount of debt and equity may depend on the availability of federal loan guarantees under the provisions of the Energy Policy Act of 2005. If loan guarantees are available with satisfactory terms, DTE may limit its required equity to 20 percent of the costs by issuing federally guaranteed debt for the remaining 80 percent. If the loan guarantees are not available with satisfactory terms, an equity contribution of up to 50 percent could be required to maintain investment-grade ratings for the debt. In either case, DTE has sufficient capacity from a combination of internal and external funds for the equity and debt. The traditional capital markets will serve as sources for the funding.

Also, according to the COL application, DTE expects to be able to recover interest costs associated with construction of Fermi 3 through rate adjustments. Legislation enacted by the State of Michigan in November 2008 (*2008 Public Act No.286*) includes provisions for recovering interest costs during construction and establishes before beginning plant construction a certificate of need (process) that will determine how construction costs as well as the projected amount will be recovered.

[4] For example, see the 2009 Massachusetts Institute of Technology study, "Update on the Cost of Nuclear Power"; the 2003 Massachusetts Institute of Technology interdisciplinary study, "The Future of Nuclear Power"; the U.S. Department of Energy, Energy Information Agency "2004 Annual Energy Outlook"; the Nuclear Energy Agency of the Organization for Economic Cooperation and Development 2005 update, "Projected Costs of Generating Electricity"; and the Keystone Center 2007 report, "Nuclear Power Joint Fact-Finding."

[5] The staff's consideration of the costs submitted by the applicant focuses on the estimated production plant costs and on the estimated cost of fuel. Because the NRC has clear oversight of the plant and the fuel, unreasonably low plant construction and fuel cost estimates may have a nexus to a possible reduction in safety. The NRC does not have regulatory authority over transmission and distribution assets, which do not entail radiological safety issues. Thus, any cost estimate provided is deemed to be true and accurate under 10 CFR 50.9 and no further assessment of that estimate will be performed.

Financial Statements

Pursuant to 10 CFR Part 50, Appendix C, Section I.A.3, "Applicant's financial statements":

> The application should also include the applicant's latest published annual financial report, together with any current interim financial statements that are pertinent. If an annual financial report is not published, the balance sheet and operating statement covering the latest complete accounting year together with all pertinent notes thereto and certification by a public accountant should be furnished.

Detroit Edison

At the time of the application submittal, DTE provided current financial statements that have been filed with the Securities and Exchange Commission. The filed financial statements can also be viewed at http://phx.corporate-ir.net/phoenix.zhtml?c=68233&p=irol-sec.

Pursuant to 10 CFR Part 50, Appendix C, Section I.A.3, the applicant submitted annual financial statements to the NRC. The staff did not identify any data in DTE's financial statements that warranted further inquiry.

Operating License

Pursuant to 10 CFR 50.33(f)(3):

> If the application is for a combined license under Subpart C of Part 52 of this chapter, the applicant shall submit the information described in paragraphs (f)(1) and (f)(2) of this section.

Pursuant to 10 CFR 50.33(f), each application shall state:

> Except for an electric utility applicant for a license to operate a utilization facility of the type described in 10 CFR 50.21(b) or 50.22, information sufficient to demonstrate to the Commission the financial qualification[s] of the applicant to carry out, in accordance with the regulations in this chapter, the activities for which the permit or license is sought.

10 CFR 50.2, "Definitions" states, in part, what an electric utility is:

> [A]ny entity that generates or distributes electricity and which recovers the cost of this electricity, either directly or indirectly, through rates established by the entity itself or by a separate regulatory authority.

According to the COL application, DTE's business is subject to the regulatory jurisdiction of various agencies, including, but not limited to, the Michigan Public Service Commission (MPSC); the Federal Energy Regulatory Commission (FERC); and the NRC. MPSC considers rates, the recovery of certain costs including those of generating facilities and regulatory assets, conditions of service, accounting, and operating-related matters. The MPSC-approved rates charged to DTE customers have historically been designed to allow for the recovery of costs and an authorized rate of return on investments.

According to the COL application, DTE is an electric utility as defined in 10 CFR 50.2. DTE generates and distributes electricity and recovers the cost of this electricity through cost-of-service based rates established by the MPSC.

Based on the above information, the NRC staff finds that the applicant is an electric utility and is not subject to financial qualifications pursuant to 10 CFR 50.33(f).

1.4.1.5 Decommissioning Funding Assurance

Regulatory Requirements

Pursuant to 10 CFR 50.33(k)(1):

> [A]n application for [a …] combined license for a production or utilization facility, information in the form of a report, as described in § 50.75, indicating how reasonable assurance will be provided that funds will be available to decommission the facility.

Under 10 CFR 50.75, the financial report must certify that the applicant will provide financial assurance for decommissioning no later than 30 days after the Commission publishes the notice in the *Federal Register* (*FR*) under 10 CFR 52.103(a) using one or more of the methods allowed in 10 CFR 50.75(e). In addition, the amount of the financial assurance may be more but not less than the amount stated in the Table in 10 CFR 50.75(c)(1), as adjusted per 50.75(c)(2). Under 10 CFR 50.75(b)(4), a COL applicant does not need to obtain a financial instrument appropriate to the method to be used or submit a copy of the instrument to the Commission. Once the COL is granted, the holder of a COL must submit an instrument as provided in 50.75(e)(3).

Decommissioning Funding Estimate

The proposed plant is a simplified passive advanced light-water reactor that is being licensed in accordance with the General Electric ESBWR, which is currently under review by the NRC. This design has a per unit thermal power rating of 4,500 MWt.

The applicant intends to provide decommissioning funding assurance in the amount of $524,852,067 (2008 dollars). NRC staff calculated the minimum acceptable funding under 10 CFR 50.75(c) and finds the applicant’s amount acceptable.

Decommissioning Funding Mechanism

The applicant intends to use an external sinking fund as the method for providing decommissioning funding assurance. Under 10 CFR 50.75(e)(1)(ii), an external sinking fund may be used as an exclusive method by the following:

> a licensee that recovers, either directly or indirectly, the estimated total cost of decommissioning through rates established by ‘cost of service’ or similar ratemaking regulation.

NRC staff will assess the acceptability of the decommissioning funding mechanism and prospective financial instrument in the future consistent with the schedule, per 10 CFR 50.75(e)(3), for the submission of reports by a holder of the COL.

Therefore, at this time, the NRC staff finds that Fermi 3 has complied with the applicable decommissioning funding assurance requirements.

1.4.1.6 Antitrust Review

The Energy Policy Act of 2005 (EPAct) removed the antitrust review authority in Section 105.c of the AEA regarding license applications for the production or utilization of facilities submitted under Sections 103 or 104.b of the Atomic Energy Act of 1954, after the date of enactment of the EPAct. Accordingly, the NRC is not authorized to conduct an antitrust review in connection with this COL application.

1.4.1.7 Foreign Ownership, Control, or Domination

Section 103 of the Atomic Energy Act of 1954 prohibits the Commission from issuing a license for a nuclear power plant under Section 103(d) to the following:

> an alien or any corporation or other entity if the Commission knows or has reason to believe it is owned, controlled, or dominated by an alien, a foreign corporation or a foreign government.

10 CFR 50.38 is the regulatory provision that implements this statutory prohibition.

DTE is a corporation organized under the laws of the State of Michigan and is a wholly-owned subsidiary of DTE Energy Company. The COL application contains the names and addresses of the directors and officers of DTE and indicates that all are United States citizens. According to the COL application, DTE is not owned, controlled, or dominated by any alien, foreign corporation, or foreign government. The staff does not know or have reason to believe otherwise.

1.4.1.8 Nuclear Insurance and Indemnity

The provisions of the Price-Anderson Act (Section 170 of the Atomic Energy Act, as amended, of 1954) and the Commission's regulations in 10 CFR Part 140 require each holder of a license issued under 10 CFR Parts 50, 52, or 54 to operate a nuclear reactor to maintain financial protection. Power reactor licensees are also required to maintain onsite property insurance per 10 CFR 50.54(w). In Part 1, "General and Administrative Information," Attachment A, of the Fermi 3 COL application, DTE provided primary financial protection for the Fermi site and onsite property insurance. By letter dated November 29, 2012 (ADAMS Accession No. ML12334A318), DTE also provided satisfactory evidence that it has the financial ability to pay for deferred premiums for the Fermi site. Upon issuance of the license, the NRC staff will issue DTE an amended indemnity agreement to include Fermi 3.

1.4.1.9 Conclusion

Based on the above information, NRC staff finds reasonable assurance that DTE is financially qualified to engage in the proposed activities regarding the Fermi Unit 3 Nuclear Power Plant, as described in the application. There are no problematic decommissioning funding assurance issues, foreign ownership issues, or nuclear insurance and indemnity issues.

1.4.2 Nuclear Waste Policy Act

Section 302(b) of the Nuclear Waste Policy Act of 1982, as amended, states:

> The Commission, as it deems necessary or appropriate, may require as a precondition to the issuance or renewal of a license under Section 103 or 104 of the Atomic Energy Act of 1954 [42 U.S.C. 2133, 2134] that the applicant for such license shall have entered into an agreement with the Secretary for the disposal of high-level radioactive waste and spent nuclear fuel that may result from the use of such license.

In a letter dated September 12, 2011 (ADAMS Accession No. ML11257A134), the applicant stated that:

> On August 18, 2011, The Detroit Edison company entered into a contract with the United States Department of Energy (DOE) establishing the terms and conditions associated with DOE's responsibility for disposal of spent nuclear fuel and high-level radioactive waste generated at the proposed Fermi Unit 3 plant. The DOE contract number applicable to Fermi 3 is DE-CR01-11GC1126.

Because DTE has entered into contracts with the DOE for the disposal of high-level radioactive waste and spent nuclear fuel for Fermi 3, the staff accepts that DTE has met the applicable requirements of Section 302(b) of the Nuclear Waste Policy Act of 1982.

1.4.3 Consultation with Department of Homeland Security and Notifications

In accordance with Section 657 of the Energy Policy Act of 2005, the NRC consulted with the Department of Homeland Security.

As required by Section 182c of the AEA and 10 CFR 50.43(a), the NRC took the following actions. On March 14, 2013, the NRC notified the MPSC (ADAMS Accession No. ML13044A458) and FERC (ADAMS Accession No. ML13044A394) regarding the Fermi 3 COL application. In December 2008 and January 2009, the NRC published notices of the application in the local newspapers: *Detroit Free Press*, *Toledo Blade*, *Monroe Evening News*, and *Windsor Star*. In addition, the staff also published a notice of the application in the *FR* on (April 9, April 16, April 23, and April 30, 2014 (79 FR 19659, 79 FR 21493, 79 FR 22706, and 79 FR 24457).

Based on the staff's completion of notifications to regulatory agencies and the public notices described above, the staff concludes that, for the purposes of issuing a COL for Fermi 3, all required notifications to other agencies or bodies have been duly carried out.

1.4.4 Evaluation of Exemptions Associated with the Special Nuclear Material (SNM) Material Control and Accounting (MC&A) Program

In a letter dated July 15, 2011 (ADAMS Accession No. ML11200A042), the applicant proposed to update Part 7 of the application to include exemption requests from 10 CFR 70.22(b), 70.32(c), 74.31, 74.41, and 74.51. The provisions of 10 CFR 70.22(b) require an application for a SNM license to include a full description of the applicant's program for MC&A of SNM under

10 CFR 74.31, 10 CFR 74.33, 10 CFR 74.41; and 10 CFR 74.51[6]. The provisions of 10 CFR 70.32(c) require a license authorizing the use of SNM to include and be subject to a condition requiring the licensee to maintain and follow an SNM MC&A Program, a measurement control program, and other material control procedures that include corresponding record management requirements. However, 10 CFR 70.22(b), 70.32(c), 74.31, 74.41, and 74.51 contain exceptions for nuclear reactors licensed under 10 CFR Part 50. The regulations applicable to the MC&A of SNM for nuclear reactors licensed under 10 CFR Part 50 are in 10 CFR Part 74, Subpart B and 74.11 through 74.19, except for 74.17. The applicant states that the purpose of this exemption request is to seek similar exceptions for this COL under 10 CFR Part 52, so that the same regulations applicable to nuclear reactors licensed under 10 CFR Part 50 will apply to the SNM MC&A Program.

The applicant also states that that there is no technical or regulatory reason to treat nuclear reactors licensed under Part 52 differently from reactors licensed under Part 50, with respect to MC&A for SNM provisions in 10 CFR Part 74. The staff finds the applicant's justifications in Part 7 of the application acceptable in that nuclear reactors licensed under 10 CFR Part 52 should be treated the same as reactors licensed under 10 CFR Part 50 regarding MC&A for SNM.

For 10 CFR Part 52, an exemption request is evaluated under 10 CFR Part 52.7, which incorporates the requirements of 10 CFR 50.12 and states that the Commission may grant exemptions from the requirements of the regulations in 10 CFR 50.12 if (1) the exemption is authorized by law and will not present an undue risk to public health and safety and is consistent with common defense and security; and 2) special circumstances are present as specified in 10 CFR 50.12(a)(2). According to 10 CFR 50.12(a)(2)(ii), special circumstances are present whenever the application of the regulation in particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule. In addition, the criteria in 10 CFR 50.12 encompass the criteria for an exemption in 10 CFR 70.17(a) and 10 CFR 74.7, the specific exemption requirements for 10 CFR Part 70 and 10 CFR Part 74, respectively. Therefore, by demonstrating that the exemption criteria in 10 CFR 50.12 are satisfied, these exemption requests also demonstrate that the exemption criteria in 10 CFR 52.7, 10 CFR 70.17(a), and 10 CFR 74.7 will be satisfied.

NRC staff reviewed the subject exemption requests that will allow the applicant to have similar exceptions for the COL under 10 CFR Part 52. The same regulations applied to nuclear reactors licensed under 10 CFR Part 50 (i.e., the regulations under Part 74 Subpart B) will apply to the SNM MC&A Program. The staff determined that (1) these requested exemptions are consistent with the AEA and are authorized by law; (2) the exemptions will not present an undue risk to public health and safety; (3) these exemptions are consistent with common defense and security; and (4) special circumstances may exist so that the application of the regulations is not necessary to achieve the underlying purpose of the rule.

Because the staff finds that the applicant has satisfied the exemption criteria in 10 CFR 50.12, the staff considers these exemption requests to also satisfy the exemption criteria in 10 CFR 52.7, 70.17(a) and 74.7. Therefore, the staff finds that the exemptions from 10 CFR 70.22(b), 70.32(c), 74.31, 74.41 and 74.51 are justified.

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[6] Although it does not include an explicit exception for 10 CFR Part 50 reactors, 10 CFR 74.33 applies only to uranium enrichment facilities and thus is not directly impacted by this exemption request.

1.4.5 Receipt, Possession, and Use of Source, Byproduct, and Special Nuclear Material Authorized by 10 CFR Part 52, Subpart C

1.4.5.1 Introduction

The reviews conducted for compliance with the requirements of 10 CFR Part 52 to support the issuance of the COLs encompass those requirements necessary to support granting 10 CFR Parts 30, 40, and 70 licenses. As a result, the 10 CFR Part 52 COL for Fermi 3 will be consistent with the licensing requirements in 10 CFR Parts 30, 40, and 70 for nuclear power plant licenses in accordance with 10 CFR Part 50.

In SECY-00-0092, "Combined License Review Process," dated April 20, 2000, the Commission approved generic license conditions for 10 CFR Parts 30, 40, and 70. In addition, per the memorandum dated December 9, 2008, from the Director of the Division of New Reactor Licensing in the Office of New Reactors (ADAMS Accession No. ML083030065); holders of a COL under 10 CFR Part 52 will also be authorized to receive, possess, and use source, byproduct, and SNM in accordance with Commission regulations in 10 CFR Parts 30, 40, and 70 including 10 CFR Sections 30.33, 40.32, 70.23, and 70.31 under their 10 CFR Part 52 COL. Licensees will be required to comply with all applicable regulations in 10 CFR Parts 30, 40, and 70, as well as the regulations in 10 CFR Parts 20, 50, and 52.

In order to meet these requirements, the applicant needed to supplement the COL application with a request to receive, possess, and use source, byproduct, and SNM accordingly and provide sufficient information to support compliance with the applicable portions of 10 CFR Parts 30, 40, and 70. The staff reviewed this information and detailed the privileges to be granted under 10 CFR Parts 30, 40 and 70 licenses in the proposed "License Conditions" section specified below.

1.4.5.2 Parts 30, 40, and 70 License Requests

Pursuant to 10 CFR 52.8 Part 1, "General and Administrative Information"; Section 2 (e), "Information Required by 10 CFR 50.33," of the Fermi 3 COL application, DTE requested additional Parts 30, 40 and 70 licenses to be incorporated into the COL to receive, possess and use source, special nuclear, and byproduct material in connection with the operation of Fermi 3.

Pursuant to 10 CFR 52.8, this application also seeks licenses that would be incorporated into the COL to receive, possess, and use source, special nuclear, and byproduct material in connection with the operation of Fermi 3. Specifically, as the proposed operator of Fermi 3, DTE seeks authority for the following:

- To receive, possess, and use at any time special nuclear material as reactor fuel.
- To receive, possess, and use at any time any byproduct, source, and special nuclear material, as sealed neutron sources for reactor startup, sealed sources for instrumentation, and radiation monitoring equipment calibration and as fission detectors in the required amounts.

- To receive, possess, and use in the required amounts any byproduct, source, or special nuclear material without restriction to chemical or physical form, for a sample analysis or instrument and equipment calibration, or associated with radioactive apparatus or components.

- To possess, but not separate, such by-product, and special nuclear material, as may be produced by the operation facility.

1.4.5.3 Parts 30, 40, 70 License Request Clarifications

In order to support the staff's review of the additional 10 CFR Parts 30, 40 and 70 license requests, the staff issued RAI 01-2 on July 29, 2009 (ADAMS Accession No. ML092100072). In this RAI, the staff acknowledged that the additional license requests specified above would be in accordance with Commission regulations in 10 CFR Parts 30, 40 and 70. The staff thus requested the application to (1) determine whether the proposed standard license conditions outlined in the RAI for 10 CFR Parts 30, 40, and 70 are appropriate for the Fermi 3 COL application; and (2) address program elements ensuring that DTE will have in place the necessary controls to allow the receipt of byproduct and source materials before the 10 CFR 52.103(g) finding.

In the applicant's response dated September 24, 2009 (ADAMS Accession No. ML092720656), the applicant agreed that the proposed 10 CFR Parts 30, 40, and 70 license conditions were appropriate. Revision 8 lists the updated license conditions in Part 10 as described above. However, the staff notes that these initial license conditions have evolved based on the staff's review of information in the application. The full set of applicable license conditions in Parts 30, 40, and 70 proposed by the staff for Fermi 3 are listed below in Subsection 1.4.5.6, Parts 30, 40, and 70 License Conditions. The staff finds this information acceptable, and RAI 01-2 is resolved.

1.4.5.4 Exemptions from Part 70 License Request

In a letter dated June 21, 2011 (ADAMS Accession No. ML111720620), the staff requested the applicant to complete a table of cross-referenced regulations and regulatory guidance in support of the staff's review for the Parts 30, 40, and 70, as it relates to the staff's SNM MC&A review in RAI 01-4. As part of the applicant's Parts 30, 40, and 70 license request clarifications, the applicant responded to RAI 01-4 on July 15, 2011 (ADAMS Accession No. ML11200A042) to update Part 7 of the application to include requests for exemptions from 10 CFR 70.22(b), 70.32(c), 74.31, 74.41, and 74.51. The staff's review for the SNM MC&A is provided below and discusses these exemptions.

1.4.5.5 Parts 30, 40, and 70 Materials and Use Clarifications

In a letter dated November 9, 2011(ADAMS Accession No. ML113120325), the staff issued RAI 01-7 requesting the applicant to clarify the specific types of sources, byproducts, and SNMs; the chemical or physical forms; and the maximum amount at any one time of the requested material licenses under 10 CFR Parts 30, 40, and 70. The licensee responded in letters dated December 7, 2011 and February 1, 2012 (ADAMS Accession Nos. ML11343A014 and ML12034A064, respectively). Per 10 CFR 30.32 and 10 CFR 40.31, the staff requested the applicant to include specific information about the requested nuclear materials and their use or purpose for the licenses. In addition, in accordance with 10 CFR 70.22(a)(4), the applicant is required to include the name, amount, and specifications (including the chemical or physical form and isotopic content where applicable) of the SNM the applicant is requesting to possess and use under a 10 CFR Part 70 license.

In a letter dated December 7, 2011 (ADAMS Accession No. ML11343A014), the applicant indicated that the SNM shall be in the form of reactor fuel and spent fuel in accordance with the limitations for storage and the amounts required for reactor operation as described in the FSAR. Additionally, the byproduct, source, and SNM shall be in the form of sealed neutron sources for reactor startup and sealed sources for reactor instrumentation; radiation monitoring equipment; calibration; and fission detectors in the required amounts. In the supplemental response to RAI 01-7 dated June 28, 2013 (ADAMS Accession No. ML13183A145), the applicant revised FSAR Section 12.2 to reclassify californium (Cf)-252 as a 10 CFR Part 30 material instead of a 10 CFR Part 70 non-fuel SNM, as stated in the initial December 7, 2011, response to RAI 01-7. In preparation for the initial fuel loading, limitations on byproduct materials and Part 40 specifically licensed source materials are described below:

<u>10 CFR Part 30 Materials</u>

With respect to the amount of Part 30 materials specified by the applicant between the issuance of the COL and before the 10 CFR 52.103(g) finding, the applicant stated that the quantity of any sealed calibration and referenced sources of byproduct material with the atomic numbers 1 through 93 would not exceed 100 millicuries for a single source and 5 curies total. The maximum for americium-241 would not exceed 300 millicuries for a single source and a total of 500 millicuries. In the supplemental response to RAI 01-7, the applicant added STD SUP 12.2-1 to Subsection 12.2.1.1.2 of the Fermi FSAR. STD SUP 12.2-1 provides additional information on the Cf-252 reactor startup source, which is a sealed source that provides the total number of required curies to be contained in the six Cf-252 startup sources.

The applicant stated that this information remains in effect between the issuance of the COL and the 10 CFR 52.103(g) finding. The applicant included this information as Table 12.2-208 in FSAR Chapter 12. Further clarifications of the licensing for the receipt, possession, and use of Part 30 materials are outlined below in Subsection 1.4.5.6, Parts 30, 40, and 70 License Conditions.

<u>10 CFR Part 40 Materials</u>

The applicant states that no 10 CFR Part 40 specifically licensed material—including natural uranium, depleted uranium, and uranium hexafluoride—will be received, possessed, or used during the period between the issuance of the COL and the 10 CFR 52.103(g) finding. Accordingly, the license conditions described below only grant licenses for Parts 30 and 70 materials between the issuance of the COL and the 10 CFR 52.103(g) finding. Further clarifications of the licensing for the receipt, possession, and use of Part 40 materials after a 10 CFR 52.103(g) finding are outlined below in Subsection 1.4.5.6, Parts 30, 40, and 70 License Conditions.

<u>10 CFR Part 70 Materials (non-fuel)</u>

To specify these materials, the applicant states that the radioactive materials identified in the table below represent nominal values of known non-fuel SNM specifically required for use in

Fermi 3 fission chambers and on Fermi 3 neutron source wires. Table 1-2 includes the following data from Table 12.2-209 of the Fermi 3 COL FSAR:

Table 1-2 Non-Fuel Special Nuclear Material for Use

(a) Element and Mass Number	(b) Chemical or Physical Form	(c) Maximum Amount
U-234 (approx. 78%) U-235 (approx. 22%)	Local Power Range Monitor Assemblies – Each assembly includes four fission chambers (64 assemblies and 4 spares)	0.0104 grams of uranium per assembly. Total of approx. 0.71 grams.
U-234 (approx. 78%) U-235 (approx. 22%)	Startup Range Nuclear Monitor Assemblies – Fission chambers (12 installed assemblies and 1 spare)	0.0129 grams of uranium per assembly. Total approx. 0.17 grams.

The above information is in FSAR Revision 8 Subsection 12.2.1.5, "Other Contained Sources," addressing STD COL Item 12.2-4-A. The staff reviewed this information in SER Chapter 12 and finds it acceptable. In the supplemental response to RAI 01-7, the applicant proposes to remove the listing of Cf-252 from FSAR Table 12.2-209 because Cf-252 is a non-fuel SNM and adds it to Fermi 3 FSAR, Revision 8, Subsection 12.2.1.1.2, under STD SUP 12.2-1. STD SUP 12.2-1 describes the Cf-252 reactor startup source as a sealed source and states that six of these sources will be required. The staff confirmed that these changes are in Fermi 3 FSAR Revision 8. Further clarifications of the licensing for the receipt, possession, and use of Part 70 materials as a non-fuel are outlined below in Subsection 1.4.5.6, Parts 30, 40, and 70 License Conditions.

<u>10 CFR Part 70 Materials (fuel)</u>

The receipt, possession, and use of Part 70 SNMs as fuel are fully described in accordance with the limitations for storage and in the amounts necessary for reactor operation in the applicant's FSAR, as supplemented and amended. Further clarifications of the licensing for the receipt, possession, and use of Part 70 materials as fuel are outlined below in the license conditions.

1.4.5.6 Parts 30, 40, and 70 License Conditions

Based on the discussions above and the reviews outlined below, the staff proposes to include the following license conditions for the Fermi 3 COL as they relate to authorization pursuant to the regulations in 10 CFR Parts 30, 40, and 70:

- License Condition (1-1) – Subject to the conditions and requirements incorporated herein, the Commission hereby licenses DTE:

  (a) (i) Pursuant to the AEA and 10 CFR Part 70, to receive and possess at any time special nuclear material as reactor fuel in accordance with the limitations for storage and in the amounts necessary for reactor operation, as described in the FSAR as supplemented and amended.

  (ii) Pursuant to the AEA and 10 CFR Part 70, to use special nuclear material as reactor fuel, after a Commission finding under 10 CFR 52.103(g) has been made, in accordance with the limitations for storage and in amounts necessary for reactor operation, described in the FSAR, as supplemented and amended;

  (b) (i) Pursuant to the AEA and 10 CFR Parts 30 and 70, to receive, possess, and use, at any time before a Commission finding under 10 CFR 52.103(g), such byproduct and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts, as necessary;

  (ii) Pursuant to the AEA and 10 CFR Parts 30, 40, and 70, to receive, possess, and use, after a Commission finding under 10 CFR 52.103(g) any byproduct, source, and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as necessary;

  (c) (i) Pursuant to the AEA and 10 CFR Parts 30 and 70, to receive, possess, and use, before Commission finding under 10 CFR 52.103(g), in amounts not exceeding those specified in 10 CFR 30.35(d) and 10 CFR 70.25(d) required for establishing decommissioning financial assurance, any byproduct or special nuclear material that is (1) in unsealed form; (2) on foils or plated surfaces, or (3) sealed in glass, for sample analysis or instrument calibration or other activity associated with radioactive apparatus or components;

  (ii) Pursuant to the AEA and 10 CFR Parts 30, 40, and 70, to receive, possess, and use, after a Commission finding under 10 CFR 52.103(g), in amounts as necessary, any byproduct, source, or special nuclear material without restriction as to chemical or physical form, for sample analysis or instrument calibration or other activity associated with radioactive apparatus or components but not uranium hexafluoride; and

  (d) Pursuant to the AEA and 10 CFR Parts 30 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

- License Condition (1-2) – Before the initial receipt of special nuclear materials (SNM) onsite, the licensee shall implement the SNM Material Control and Accounting Program. No later than 12 months after issuance of the COL, the licensee shall submit to the Director of Office of New Reactors (NRO) a schedule that supports planning for and conduct of NRC inspections of the SNM Material Control and Accounting program. The schedule shall be update every 6 months until 12 months before scheduled fuel loading, and every month thereafter until the SNM Material Control and Accounting program has been fully implemented.

- License Condition (1-3) – The fire protection measures in accordance with RG 1.189 for designated storage building areas (including adjacent fire areas that could affect the storage area) shall be implemented before initial receipt of byproduct or special nuclear materials that are not fuel (excluding exempt quantities as described in 10 CFR 30.18).

- License Condition (1-4) – The fire protection measures in accordance with RG 1.189 for areas associated with new fuel (including all fuel handling, fuel storage, and adjacent fire areas that could affect the new fuel) shall be implemented before receipt of fuel onsite.

- License Condition (1-5) – Before the receipt of fuel onsite, a formal letter of agreement shall be in place with the local fire department specifying the nature of arrangements in support of the Fire Protection Program.

- License Condition (1-6) – All fire protection program features shall be implemented before initial fuel load.

1.4.5.7 Operational Programs to Support 10 CFR Parts 30, 40, and 70

The staff notes that Fermi 3 COL FSAR Table 13.4-201, "Operational Programs Required by NRC Regulations," provides milestones and commitments for the implementation of various operational programs. Important milestones for the portions of operational programs applicable to radioactive materials that support the issuance of licenses and requirements relative to 10 CFR Parts 30, 40, and 70 are included in the following programs:

- Item 8: Fire Protection Program
- Item 10: Radiation Protection Program
- Item 11: Non-Licensed Plant Staff Training Program
- Item 15: Security Program
- Item 23: SNM Control and Accounting Program

1.4.5.8 Part 70 License Staff Review

The applicant's compliance with several applicable 10 CFR Part 70 requirements regarding radiation protection, nuclear criticality safety, and environmental protection are already encompassed by the design information incorporated by reference from the ESBWR DCD. In addition, the staff evaluated the applicant's compliance with these requirements as part of the DC review. Other applicable 10 CFR Part 70 requirements to be addressed by the COL applicant are outlined below. In order to satisfy NRC regulations and requirements for licensing under 10 CFR Part 70 so as to receive, possess, and use SNM as fuel and non-fuel, the applicant addressed the following areas for review per the guidance in NUREG–1520 and NUREG–0800:

- General Information – Applicant identifications, location, licenses sought, financial qualifications, exemption requests, site layout, population, geography, nearby facilities, meteorology, hydrology, geology, and seismicity
- Organization and Administration – Structure, management, functions, qualifications, experience, communications, and turnover of the construction to operation
- Radiation Protection
- Criticality Safety
- Fire Safety
- Emergency Preparedness
- Environmental Protection
- SNM MC&A–Exemptions, MC&A, and Fixed Site Security Review
- Physical Security

General Information

The legal identities of the applicant and the site location are described in Part 1, Sections 1, 2(a-d), and Part 2, Subsection 1.1.2.2. The license action types requested by the applicant are described in Part 1, Section 2(e). However, the staff has further clarified the 10 CFR Parts 30, 40, and 70 licenses to be granted in the license conditions listed above and throughout this review. Financial qualifications are in Part 1, Section 2(f), which the staff reviewed in SER Section 1.4.1. The exemption requests for Part 70 licensing are in Part 7 of the application, which the staff reviewed in Section 1.4.4. The facility layout, property boundaries, geography, and population are described in FSAR Section 2.1. Locations of nearby facilities are described in FSAR Section 2.2. Meteorology is described in FSAR Section 2.3, and site hydrology is described in FSAR Section 2.4. Site geology and seismicity are described in FSAR Section 2.5. Based on the above information, the staff finds that the applicant has satisfactorily addressed general information.

Organization Information

The applicant's organizational structure and charts are in FSAR Section 13.1 and Appendix 17AA. This information includes functional descriptions of the organizational groups—including those responsible for managing the design, construction, operations, and modifications of the facility; in addition to responsibilities, reporting hierarchy, and communications. FSAR Subsection 13.1.1.4 discusses the education and experience qualifications for managers, supervisors, and technicians. FSAR Appendix 13AA describes the activities required to transition the unit from the construction phase to the operation phase. Based on the above information, the staff finds that the applicant has satisfactorily addressed organizational information.

Radiation Protection

The staff's safety review under 10 CFR Part 52 for radiation protection (RP) programs and systems for the construction and operation of Fermi 3 is in SER Chapter 12. The staff finds the applicant's RP programs and systems acceptable for construction and operation.

In FSAR Table 13.4-201, the applicant states that the following four commitments will be implemented for the RP Program at Fermi 3:

- Before the initial receipt of byproduct, source, or SNMs (excluding exempt quantities described in 10 CFR 30.18) for those elements of the RP Program necessary to support such receipt.

- Before the receipt of fuel for those elements of the RP Program necessary to support receipt and storage of fuel onsite.

- Before fuel load for those elements of the RP Program that are necessary to support fuel load and plant operation.

- Before the first shipment of radioactive waste for those elements of the RP Program that are necessary to support a shipment of radioactive waste.

The above commitments correspond to the four milestones for the Radiation Protection Program that is specified in NEI Template 07-03, "Generic FSAR Template Guidance for Radiation Protection Program Description". NEI 07-03 is incorporated by reference by Fermi in Chapter 12, Appendix 12BB, of the Fermi FSAR. By letter dated March 18, 2009 (ADAMS Accession No. ML090510379), the staff determined that NEI 07-03 provides an acceptable template for assuring that the RP program meets applicable NRC regulations and guidance. Therefore, the staff finds these commitments acceptable.

The staff also performed additional radiation protection reviews of 10 CFR Part 70 license. The regulatory basis for the review of the Fermi 3 RP Program that is applicable to the fresh fuel assemblies for the first reactor core before the commencement of operation is in 10 CFR Parts 19, 20, and 70. The purpose of this review is to determine whether the DTE Fermi 3 proposed RP Program is adequate to protect the radiological health and safety of workers, the public, and the environment during fresh fuel handling and storage operations under 10 CFR Part 70.

The applicable acceptance criteria for the NRC Part 70 review of the Fermi 3 RP Program are in Section 4.4 of NUREG–1520, Revision 1. Although some portions of the acceptance criteria in NUREG–1520, Section 4.4 are relevant to this incremental review, other portions are not. For example, certain RGs and other documents referenced in NUREG–1520, Section 4.4 are specific to fuel cycle facilities and are not applicable to reactor reviews. Also, reactors are not one of the engagements that require an integrated safety analysis per 10 CFR 70.60.

Operations pertaining to Part 70 include uncrating and inspecting fuel assemblies and storing them in the new fuel and spent fuel storage pool before loading into the reactor. As the fuel assemblies are effectively contained/sealed material with little associated external radiation, the radiological risks associated with this operation are considered minimal.

The review documented here is not applicable for determining the acceptability of the described program with respect to operations under 10 CFR Part 52. The RP methods and estimated occupational radiation exposures to operation and construction personnel during normal and anticipated operational occurrences will be reviewed with respect to the issuance of the combined construction permit and operating license in SER Chapter 12 for the Fermi 3 license application.

In general, the NUREG-1520 acceptance criteria require descriptions to ensure that the following topics will be adequately addressed at the facility: RP Program implementation; radiation exposures as low as reasonably achievable (ALARA); RP organization and qualifications; written procedures; training; ventilation and respiratory protection programs; radiation survey and monitoring programs; radiological risks associated with accidents; and additional programs that normally impact the RP functions. In the applicant's FSAR, Section 12.1 describes the operational RP Program. The program incorporates by reference Nuclear Energy Institute (NEI) Template 07-03A, "Generic FSAR Template Guidance for Radiation Protection Program Description, Revision 0" (ADAMS Accession No. ML091490684), with site-specific supplements or substitutions included elsewhere in the FSAR or the ESBWR DCD as the operational RP Program description. NEI 07-03A is the final accepted version of the NRC-reviewed NEI-07-03, Revision 7. NRC staff completed the review and safety evaluation of NEI 07-03, Revision 7, as documented in "Safety Evaluation Regarding the Nuclear Energy Institute Technical Report 07-03 'Generic FSAR Template Guidance for Radiation Protection Program Description, Revision 7' " (ADAMS Accession No. ML083380347). Table 13.4-201 in the applicant's FSAR indicates that all necessary aspects of the Fermi 3 RP Program will be implemented before the receipt of any byproduct, source, SNM (except as described in 10 CFR 30.18), or fuel.

The generic RP program template commits an applicant to NRC regulatory requirements and guidance; the acceptance criteria listed in RG 1.206; and Section 12.5 of NUREG–0800. Although NUREG–0800 is not as prescriptive regarding the required information for an RP program as NUREG–1520 is, the staff believes that a program established to address Part 52 operations will adequately address Part 70 operations as well. The staff reviewed NEI 07-03A and the modifications and supplements to that information described in the FSAR. The staff finds that the information adequately addresses the topics evaluated in Section 4 of the NUREG–1520 with the exceptions of ALARA, ventilation, and radiological risks associated with accidents.

With respect to ALARA, the applicant states in Appendix 12AA and Appendix 12BB of the FSAR that NEI 07-08A (ADAMS Accession No. ML093220178), "Generic FSAR Template Guidance for Ensuring That Occupational Radiation Exposures are As Low As Is Reasonably Achievable (ALARA), Revision 0," is incorporated with modifications or supplements as noted in the aforementioned appendices. Similar to NEI 07-03A, NRC staff previously reviewed NEI 07-08, Revision 3 and found it acceptable as documented via a letter dated October 15, 2009 (ADAMS Accession No. ML091130034). The template, in conjunction with template NEI 07-03A, generally describes operational policies; regulatory compliance; and operational considerations applicable to the ALARA program. Compliance with the template, when considering the minimal risks associated with the storage and handling of fresh fuel under Part 70, is adequate to ensure that operations will be ALARA. The applicant's RP program to achieve occupational doses ALARA also addresses regulatory requirements for radiation protection found in 10 CFR Part 20.

Regarding ventilation, NEI 07-03A did not contain sufficient detail regarding the facility's ventilation program for staff to fully evaluate. However, as mentioned previously, the materials of interest for this license are expected to be contained and pose little airborne potential for or risk of internal exposure. For this reason, the staff did not find it necessary to evaluate the facility's ventilation systems.

The Integrated Safety Analysis requirements for controlling the radiological risks discussed in Section 4.4.8 of NUREG–1520 are not applicable to Fermi 3, because the proposed operations are excluded from the list of activities defined in 10 CFR 70.60 to which 10 CFR Part 70, Subpart H applies. The applicant did submit an emergency plan (Part 5 of the application) that addresses responses to accident situations involving potential radiological exposures. As stated previously, the expectation is that the unirradiated uranium contained in the fuel will pose little radiological risk to the operations per Part 70.

The staff finds that DTE will establish and maintain an acceptable RP Program for Fermi 3, which addresses operations under 10 CFR Part 70 and includes the following:

- An effective documented program to ensure that occupational radiological exposures are ALARA.
- An organization with adequate qualification requirements for RP personnel.
- Approved and written RP procedures and radiation work permits for RP activities.
- RP training for all personnel who have access to restricted areas.
- A program to control airborne concentrations of radioactive material with engineering controls and respiratory protection.
- A radiation survey and monitoring program that includes requirements for controlling radiological contamination within the facility; requirements for monitoring external and internal radiation exposures.
- Other programs to correct upsets at the facility, maintain records, and generate reports in accordance with 10 CFR Parts 20 and 70.

The staff concludes that the applicant's RP Program for Fermi 3—with respect to the initial fresh fuel elements for the first reactor core as described in its License Application—complies with regulatory requirements in 10 CFR Parts 19, 20, and 70; and adequately addresses the applicable acceptance criteria in Section 4.4 of NUREG–1520, Revision 1. The staff finds that the applicant's RP Program for Fermi 3 is therefore acceptable.

<u>Criticality Safety</u>

The assessment of criticality safety of fresh and spent fuel storage and handling is based, in part, on the information in the ESBWR DCD. The applicant has incorporated by reference Sections 9.1.1 and 9.1.2 of the ESBWR DCD. The ESBWR DCD, Tier 2, Subsection 9.1.1.7, "Safety Evaluation," for criticality control designates DCD COL Item 9.1-4-A for the applicant to describe the programs that address criticality safety of fuel handling operations. The staff's safety review of fuel handling is in SER Section 9.1.4. The applicant has included commitment

COM 9.1-001, which specifies that fuel handling procedures will be developed 6 months before the receipt of fuel to allow sufficient time for familiarization by plant staff, to allow NRC staff adequate time to review the procedures, and to develop licensing examinations for operators. The staff finds this commitment acceptable. The staff therefore finds that the applicant has satisfactorily addressed fuel handling operations, including criticality safety.

In addition, in SER Section 13.3B, the staff finds that the applicant's request for a Part 70 SNM license did not involve an authorization to possess enriched uranium or plutonium for uranium hexafluoride in excess of 50 kilograms in a single container or 1,000 kilograms total; or in excess of 2 curies of plutonium in an unsealed form or on foils or plated sources. Therefore, a criticality alarm system is not required and implementation of the emergency plan before receipt of the SNM is also not required.

With respect to additional nuclear criticality safety review of 10 CFR Part 70 licenses, the staff performed the following review. The regulatory basis for the review of Fermi 3 nuclear criticality safety (NCS) is in 10 CFR 70.22, "Contents of applications"; 10 CFR 70.23, "Requirements for the approval of applications"; 10 CFR 70.24, "Criticality accident requirements"; and 10 CFR 70.52, "Reports of accidental criticality." The purpose of this review is to determine whether the Fermi 3-proposed NCS Program is adequate to protect the radiological health and safety of workers, the public, and the environment during fresh fuel handling and storage operations under 10 CFR Part 70. The acceptance criteria for the Part 70 review by the NRC of the Fermi 3 NCS Program are in Section 5.4 of NUREG–1520. However, the staff determined that few of those acceptance criteria are applicable to the proposed Fermi 3, Part 70 operations. The staff therefore limited the review to what was necessary to assure compliance with the applicable 10 CFR Part 70 requirements noted previously.

DTE submitted a combined construction permit and operating license application for one new ESBWR designated as Fermi 3. This review focused on criticality safety of the receipt, possession, inspection, and storage of SNM in the form of fresh fuel assemblies as applicable under 10 CFR Part 70. The operations relevant to the Part 70 portion of the license include uncrating and inspecting the fuel assemblies and storing them in the new fuel racks and spent fuel storage pool before loading into the reactor. FSAR Section 9.1 discusses criticality safety of fresh and spent fuel storage and handling.

The staff reviewed the criticality safety summaries, evaluations, and conclusions in ESBWR FSER Sections 9.1.1, and 9.1.2. These sections present the staff's criticality safety reviews of the ESBWR fuel storage and handling capabilities for fresh fuel and spent fuel. Included in the evaluation were seismic considerations, dropped loads, and fuel placement outside of the designated storage locations as well as the evaluations required to be compliant with 10 CFR 50.68. The evaluations presented encompass criticality safety considerations for fresh fuel handling and storage under Part 70. The staff's general conclusion is that subcriticality will be assured during fresh fuel handling and storage operations because the applicant meets General Design Criterion 62, as it relates to the prevention of criticality by physical systems or processes using geometrically safe configurations that will be compliant with 10 CFR 50.68.

Sections 9.1.1 and 9.1.2 of NUREG–1966 include statements that either verify or satisfy compliance with regulatory requirements under 10 CFR 50.68. As specified in 10 CFR 70.24(d)(1) and 10 CFR 50.68(a) and because Fermi 3 elected to comply with 10 CFR 50.68(b), the staff concludes that the requirements of 10 CFR 70.24 regarding criticality accident alarms will not apply. In accordance with 10 CFR 50.68(b)(6), radiation monitors will be provided in the storage and associated handling areas when fuel is present.

Finally, the staff has determined that reporting compliant with 10 CFR 70.52 would be self–evident since the licensee will comply with 10 CFR 50.68; and no elaboration in the application should be required to assure compliance with those regulations.

The staff reviewed the applicant's information ensuring that the applicant's equipment, facilities, and procedures will be adequate to assure subcriticality of the fresh fuel consistent with 10 CFR 70.23(a)(3) and (4), thus adequately protecting health and minimizing danger to life or property.

Fire Safety

The staff completed the safety review of the fire protection programs (FPPs) and systems under 10 CFR Part 52 for the licensing and operation of Fermi 3. This review is in SER Chapter 9, Section 9.5.1. FSAR Table 13.4-201 includes two commitments to establish operational program for the FPP:

1. Before initial receipt of byproduct, source, or SNM (excluding exempt quantities as described in 10 CFR 30.18) for portions of the FPP applicable to radioactive material.

2. Before the receipt of fuel for the elements of the FPP necessary to support the receipt and storage of fuel onsite.

The NRC staff finds that these commitments contribute to the reasonable assurance that adequate fire protection will be provided and maintained to meet the criteria of 10 CFR 70.23. Therefore, the staff finds these commitments acceptable.

The purpose of the staff's 10 CFR Part 70 licenses fire safety review is to determine, with reasonable assurance, that Fermi 3 has (1) designed a facility that provides adequate protection against fires and explosions, which could affect the safety of licensed materials and thus present an increased radiological risk; (2) considered the radiological consequences of fires; and (3) instituted suitable safety controls to protect workers, the public, and the environment.

The regulatory basis for the fire safety review includes the general and additional contents of the application, as required by 10 CFR 70.22. In addition, the fire safety review must provide reasonable assurance of compliance with 10 CFR 70.23(a)(3) and 10 CFR 70.23(a)(4). The acceptance criteria that the NRC uses for fire safety reviews of licensed materials are in Subsections 7.4.3.1 through 7.4.3.5 of NUREG–1520.

The fire protection review was performed relative to the guidance in NUREG–1520. The information to support this review was obtained from Revision 8 of the COL application. The facility and its fire protection systems are designed and will be constructed to industrial standards currently in effect. The licensee commits to meeting the prevailing codes whenever facilities are expanded or modified. Facilities are generally noncombustible masonry or metal construction. Lightning protection is incorporated into the facility design. Facility exit routes are posted throughout and are unimpeded by physical security requirements. In addition, workers are trained in evacuation and periodic drills are conducted to verify the adequacy of egress. Within the fuel building, which is a seismic Category I structure, new fuel bundles are brought in uncrated through the rail car bay; raised to the refueling floor; and transferred for storage on racks in the buffer pool within the reactor building, which is also a seismic Category I structure. The process itself utilizes methods and materials that have no fire safety concerns.

The fire protection equipment in the fuel handling area of the fuel building includes fire detection, portable fire extinguishers, and hose stations for manual firefighting.

Site procedures for the maintenance and surveillance testing of the equipment listed above include the fire pump, fire mains, standpipes, and hoses that were developed and will perform as described in the FPP. In addition, the compensatory actions described in the FPP will be used if any of the listed fire equipment becomes unavailable.

The staff has proposed the following license conditions regarding the FPP that require:

- Fire protection measures in accordance with RG 1.189 for designated storage building areas (including adjacent fire areas that could affect the storage area) shall be implemented before the initial receipt of byproduct or SNMs that are not fuel (excluding exempt quantities as described in 10 CFR 30.18).

- The fire protection measures in accordance with RG 1.189 for areas associated with new fuel (including all fuel handling, fuel storage, and adjacent fire areas that could affect the new fuel) shall be implemented before the onsite receipt of fuel.

- Before the onsite receipt of fuel, a formal letter of agreement shall be in place with the local fire department specifying the nature of arrangements in support of the FPP.

- All FPP features shall be implemented before initial fuel load.

These license conditions are included in Subsection 1.4.5.6, Parts 30, 40, and 70 License Conditions, above.

Effective handling of fire emergencies is accomplished by trained and qualified emergency responders. The fire response organization is staffed and equipped for firefighting activities. The fire brigade is composed of a fire brigade leader and four fire brigade members. The fire brigade does not include the Shift Manager or other members of the minimum shift crew necessary for a safe shutdown of the unit, nor any personnel required for other essential functions during a fire emergency. Additional support is available when needed through an agreement with the local fire department.

Training ensures that the capability of fire brigades to combat fires is established and maintained. The training program consists of initial (classroom and practical) training and recurrent training that includes periodic instruction, fire drills, and annual fire brigade training.

Firefighting equipment is provided throughout the plant. Fire emergency procedures and pre-fire plans specify the actions to be taken by the individual discovering the fire and by the emergency responders. A discussion of this pre-fire plan is included in the periodic classroom instruction training program provided for the emergency responders.

Combustibles are controlled to reduce the severity of a fire that might occur in a given area and to minimize the amount and type of material available for combustion. The use and application of combustible materials at Fermi 3 are controlled with the following methods:

- Instructions/guidelines provided during general employee training/orientation programs.
- The chemical control program.
- Periodic plant housekeeping inspections/tours by management and/or the fire protection organization for the plant.
- The design/modification review and installation process.
- Administrative procedures (e.g., Transient Combustible Control Program).

The use of ignition sources such as welding, flame cutting, brazing, grinding, arc gouging, torch-applied roofing, and open flame soldering within safety-related areas are controlled through the approval and issuance of an ignition source permit. Permits are reviewed and approved by appropriate plant personnel. The ignition source permit is valid for one job, and at the start of each shift with a permitted ignition source activity a job area inspection will be performed and documented.

The Fire Hazards Analysis (FHA) is part of the FPP. FHA results are documented on a fire area basis; they are broken down into separate discussions of classical fire protection features and a safe shutdown analysis for each fire area. The FHA is required to be updated before the receipt of the new fuel, as part of the license conditions above. The FHA includes the following:

- A summary of the evaluation performed to determine the adequacy of the fire protection features for each fire area.
- A discussion of the ability to achieve a safe shutdown in case of a fire in each fire area.

The fire hazards and safe shutdown evaluation are performed by qualified nuclear, mechanical, electrical, and fire protection engineers. FHA and pre-fire plans conform to the applicable guidance in NFPA 801, “Standard for Fire Protection for Facilities Handling Radioactive Materials.”

The staff concludes that the applicant’s capabilities meet the criteria in Chapter 7 of NUREG-1520. The staff has determined that the applicant’s equipment, facilities, and procedures provide reasonable assurance that adequate fire protection will be provided and maintained to meet the criteria of 10 CFR 70.23.

Emergency Preparedness

The staff’s evaluation of the application for emergency planning with respect to Parts 30, 40, and 70 licenses is in SER Section 13.3B.9. In this review, the staff finds that the applicant has met the requirements of 10 CFR 70.22(i)(1).

The staff finds that the applicant’s stated request for a Part 70 license does not involve the authorization to possess enriched uranium that requires a criticality accident alarm system, uranium hexafluoride in excess of 50 kilograms in a single container or 1,000 kilograms total, or in excess of 2 curies of plutonium in an unsealed form or on foils or plated sources. Hence, an emergency plan that meets 10 CFR 70.22(i)(3) is not required. Therefore, the implementation of the Emergency Plan before the receipt of SNMs was removed from FSAR Table 13.4-201, “Operational Programs Required by NRC Regulations,” in Revision 7 to the FSAR. Additionally, Chapter 12 FSAR Subsection 12.2.1.5 includes a requirement addressing the limitations during the period before the implementation of the emergency plan (before the initial fuel loading) following the finding that the acceptance criteria in the COL have been met, as provided in 10 CFR 52.103(g). The applicant’s Emergency Planning for Byproduct, Source, and Special Nuclear Material Licenses is evaluated in Section 13.3B.9 of this SER.

In addition, in SER Section 13.3B, the staff finds that the applicant’s request for Part 70 SNM did not involve an authorization to possess enriched uranium or plutonium for uranium hexafluoride in excess of 50 kilograms in a single container or 1,000 kilograms total; or in excess of 2 curies of plutonium in an unsealed form or on foils or plated sources. Therefore, a criticality alarm system would not be required, and the implementation of an emergency plan before the receipt of the SNM is not required.

Environmental Protection

The staff’s complete review of environmental protection for the licensing and operation of Fermi 3 under 10 CFR Parts 51 and 52 is in the Final Environmental Impact Statement in NUREG–2105.

With respect to environmental protection for 10 CFR Part 70 licenses, the staff performed the following review. The regulatory basis for the review of the Fermi 3 Environmental Protection Program applicable to the fresh fuel assemblies for the first reactor core before beginning operation is in 10 CFR Parts 20, 51, and 70.

The Fermi 3 facility will also use fission chamber detectors containing SNM for the reactor startup and neutron flux monitoring during reactor operations. NRC staff evaluated the use and handling of these fission chamber detectors for compliance against the applicable requirements in 10 CFR Parts 20, 51, and 70.

The acceptance criteria for the NRC Part 70 review of the portion of the Fermi 3 Environmental Protection Program described above are outlined in Section 9.4 of NUREG–1520, Revision 1. Although most portions of the acceptance criteria in Section 9.4 of NUREG–1520 are directly applicable to this review, other portions are not because of the scope of the proposed activities. For example, a review of an applicant’s Integrated Safety Analysis of accidents is conducted for fuel cycle facilities but not for reactors. In addition, certain regulatory guides and other documents referenced in Section 9.4 of NUREG–1520 are specific to fuel cycle facilities.

The radiological impacts assessment is based, in part, on information in the ESBWR DCD, Revision 10. The DCD is incorporated by reference into Revision 8 of the FSAR, which was prepared to be consistent with the guidance in NUREG–0800. This staff review focused on the incremental impact, if any, to the Fermi 3 Environmental Protection Program related to the receipt; possession; inspection; and storage of the SNM in the form of fresh fuel assemblies for the first reactor core loading; as applicable under 10 CFR Part 70. This review also evaluated the receipt, storage, use, and disposal of fission chamber detectors containing SNM. These detectors will be used for the reactor start-up and neutron flux monitoring during reactor operations.

DTE also prepared an environmental report that was submitted as Part 3 of the COL application. The report addressed the environmental impacts from constructing, operating, and decommissioning the proposed facility. NRC staff issued the Final Environmental Impact Statement (FEIS) as NUREG–2105. The transportation impacts from unirradiated fuel are discussed in this FEIS.

NRC staff reviewed FSAR Sections 11.4, 11.5, 12.1, 12.2, and 13.1, in addition to FSAR Table 13.4-201. These sections describe the radiation protection and waste management program to be used for the entire facility, which includes the proposed activities that are within the scope of this review. The staff noted that several elements of DTE's environmental protection strategy will be in place before the onsite receipt of fuel or initial fuel loading. These elements include but are not limited to the radiological environmental monitoring program, waste management program, offsite dose calculation manual, and the process and effluent monitoring and sampling program. The staff also noted that the incremental effects related to the fresh fuel assemblies for the first core loading, and the use of fission chamber detectors, do not change DTE's ALARA goals or controls for liquid or air effluents. These goals include an analysis of the total effective dose equivalent to the maximally exposed individual member of the public who would receive the greatest radiation dose. Population dose estimates are also unaffected. DTE's monitoring of liquid and air discharges, including monitoring locations and samples, will not be affected by the proposed activities.

DTE's plant personnel includes those involved in the proposed activities who will be qualified to meet the requirements in American National Standard Institute (ANSI)/American Nuclear Society (ANS) 3.1-1993 "American National Standard for Selection, Qualification, and Training of Personnel for Nuclear Power Plant" as endorsed by RG 1.8, "Qualification and Training of Personnel for Nuclear Power Plants." FSAR Section 13.2 references the NRC-approved NEI guidance NEI 06-13A, "Template for an Industry Training Program Description." The staff recognizes that compliance with these documents is an acceptable method for ensuring that the facility's staff will have adequate education and training to engage in the proposed activities.

NRC staff finds that the quality control procedures related to the collection and analyses of environmental monitoring samples will not be affected by the proposed activities. ALARA reviews and reports to management will not be affected by activities involving the fresh fuel assemblies or the fission chamber detectors. Because the fresh fuel assemblies and fission chamber detectors contain SNM in the form of encapsulated material (i.e., not dispersible), they result in a low risk of environmental releases. DTE's implementation of the Environmental Protection Program as described in the Fermi 3 FSAR provides reasonable assurance that any releases or waste generated during the proposed activities will be adequately handled to protect the public health and safety and the environment.

NRC staff also evaluated the environmental impacts related to the transportation of unirradiated fuel assemblies to and from the Fermi 3 facility using a representative route. Section 6.2 of NUREG–2105 documents the findings in this area. DTE provided dose projections for the maximally exposed individuals under different transportation scenarios, including accident conditions. The staff independently verified the dose projections, which were found to be below the regulatory limits in 10 CFR 51.52. Therefore, the staff has reasonable assurance that the environmental impacts associated with the transportation of unirradiated fuel to the Fermi 3 facility will not pose an undue risk to public health and safety and to the environment. DTE has committed to adequate environmental protection measures including (1) environmental and effluent monitoring, (2) effluent controls to maintain public doses ALARA as part of the Radiation Protection Program, and (3) waste management programs. NRC staff concludes, with reasonable assurance that DTE's conformance to the application and license conditions is adequate to protect the environment and public health and safety and complies with the regulatory requirements imposed by the Commission in 10 CFR Parts 20, 51, and 70. NRC staff finds that DTE's Environmental Protection Program for the proposed activities as described in the COL application and the environment report, adequately addresses the applicable acceptance criteria in Subsection 9.4.3.2 of NUREG–1520, Revision 1, and is therefore acceptable.

Special Nuclear Materials Material Control and Accounting Review

The staff conducted a review of the applicant's MC&A Program description. The purpose of this review was to determine that the applicant had provided a description of an MC&A Program that would be capable of satisfying the regulatory requirements in 10 CFR Part 74, Subpart B.

In accordance with 10 CFR 70.22(b), current applicants requesting a license to possess SNM must submit a full description of their program for the control and accounting of SNM in the applicant's possession and to show compliance with 10 CFR 74.31, 74.33, 74.41, or 74.41, as applicable. Also in accordance with 10 CFR 70.32(c), applicants requesting a license to possess SNM are subject to a license condition to maintain and follow a program for controlling and accounting for source material and SNM. Decreases in the program's effectiveness will be submitted as an amendment pursuant to 10 CFR 70.34. However, the requirements in 10 CFR 70.22(b) and 70.32(c) contain an exclusion for licensees governed by 10 CFR Part 50, "Domestic Licensing of Production and utilization Facilities"; including existing nuclear power plants. Moreover, the DTE Fermi 3 COL application was submitted and accepted as a licensing action for a nuclear power plant under 10 CFR Part 52 instead of 10 CFR Part 50.

The 10 CFR Part 70 and 74 exclusions described above do not include 10 CFR Part 52 applicants, even though for purposes of the requirement, the applicants are the same facility type. For both 10 CFR Parts 50 and 52 applicants, 10 CFR Part 74, Subpart B (excluding 74.17) contains the appropriate MC&A performance requirements. An adequate applicant submittal would describe the licensee program elements that would meet the 10 CFR Part 74 requirements. Additionally, because the primary roles of the MC&A Program are to control and account for SNM, the licensee program elements would have to be developed and implemented before receiving SNM and be maintained as long as any SNM was onsite.

Regulatory Guide 5.29, issued June 2013 (ADAMS Accession No. ML13051A421), provides American National Standard (ANSI) publication, N15.8-2009, as an acceptable approach to the staff for complying with the NRC's regulations regarding material control and accounting requirements in Subpart B of 10 CFR Part 74 at nuclear power plants (Draft Regulatory Guide

DG-5028 was issued May 2012 [ADAMS Accession No. ML113550062]). This approach will result in the MC&A description providing assurance that the implemented program would meet the performance requirements of 10 CFR Part 74, Subpart B (excluding 10 CFR 74.17).

Exemption Requests from 70.22(b), 70.32(c), 74.31, 74.41, and 74.51

In order for the applicant to have the same requirements applied to their SNM MC&A Program as are applied to other reactors licensed under 10 CFR Part 50, the applicant submitted requests for exemption from 10 CFR Parts 70.22(b), 70.32(c), 74.31, 74.41, and 74.51 that are detailed in Part 7 of the application. The staff finds that these exemptions are justified and should be granted. The staff's reviews of these exemption requests are in SER Section 1.4.4.

MC&A Review

In a letter dated June 21, 2011 (ADAMS Accession No. ML111720620), the staff requested the applicant to complete a table of cross-referenced regulations and regulatory guidance in support of the staff's review for the Parts 30, 40, and 70, as it relates to the staff's SNM MC&A review in RAI 01-4.

In a letter dated July 15, 2011 (ADAMS Accession No. ML11200A042), the applicant provided the following items:

- Completed cross-referenced tables.
- An update to FSAR Table 13.4-201 that includes a milestone for implementing the SNM MC&A Program.
- An updated FSAR that includes a new Subsection 13.5.2.2.11 with SNM MC&A Procedures.
- An update that includes a new description of the SNM MC&A Program as Appendix 13CC in FSAR Chapter 13.
- An updated COL application Part 7 that includes a request for exemptions from 10 CFR 70.22(b), 70.32 (c), 74.31, 74.41, and 74.51.

The staff finds the following responses acceptable:

- The complete cross-referenced tables provided the staff with a useful guide to portions of the application that pertained to Parts 30, 40, and 70.
- The SNM MC&A Program will be implemented as an operational program before the receipt of SNM; and the program and its implementation will be fully described in the updated application in Appendix 13CC, which is included as an operational program and commitment in Table 13.4-201.
- The applicant has proposed an update to FSAR Subsection 13.5.2.2.11 that will include STD SUP 13.5-41 (missing from 13 SER), which will briefly describe the procedures detailed in the applicant's SNM MC&A Program and will serve as a pointer to Appendix 13CC.

As stated above, the staff finds this information acceptable. Therefore, RAI 01-4 is resolved.

In order for the staff to continue the review of the MC&A plans, the staff issued RAI 01-7 as discussed above in Subsection 1.4.5.5, Parts 30, 40, and 70 Materials and Use Clarifications, per 70.22 (a)(4). The applicant's response dated December 7, 2011 (ADAMS Accession No. ML11343A014) describes the other types of non-fuel SNM typically required of ESBWR units and identifies them as fission chambers and neutron source wires. In addition to this information, the applicant submitted a supplemental response to RAI 01-7 dated February 1, 2012 (ADAMS Accession No. ML12034A064) that specifies definitions per 10 CFR 70.4 and further clarifies that the SNM in the form of new reactor fuel for Fermi 3 is a Category III SNM of low strategic significance. In addition, this response clarifies that the new reactor fuel will not exceed the U-235 isotope enrichment of 10 percent. With this information, the applicant adequately addresses the requirements in 70.23(a)(4). Therefore, RAI 01-07 is resolved.

The review of the applicant's proposed SNM MC&A Program in Appendix 13CC encompassed requirements in 70.22(a)(4); 74.11, "Reports of loss or theft or attempted theft or unauthorized production of special nuclear material"; 74.13, "Material status reports"; 74.15, "Nuclear material transaction reports"; and 74.19, "Recordkeeping." The staff concludes the programs as described are acceptable and meet the regulatory requirements for:

- notification
- material balance and inventory listing reports
- nuclear material transaction reports
- records retention
- established procedures
- conducting a physical inventory and maintaining associated records

The staff finds that the applicant's changes to the application acceptable in that the MC&A Program will be an operation program, and the development of MC&A procedures is formally annotated in FSAR Appendix 13CC. The staff proposes the following license condition as it relates to the MC&A requirements in Part 74:

> **License Condition** – Prior to initial receipt of special nuclear materials (SNM) onsite, the licensee shall implement the SNM Material Control and Accounting program. No later than 12 months after issuance of the COL, the licensee shall submit to the Director of Office of New Reactors (NRO) a schedule that supports planning for and conduct of NRC inspections of the SNM Material Control and Accounting program. The schedule shall be update every 6 months until 12 months before scheduled fuel loading, and every month thereafter until the SNM Material Control and Accounting program has been fully implemented.

This license condition is included in the Subsection 1.4.5.6, Parts 30, 40, and 70 License Conditions, above.

<u>Fixed Site and Transportation Security for SNM in Regards to the 10 CFR 73.67 Review</u>

This portion of the Part 70 materials review pertains to 10 CFR 73.67, "Licensee fixed site and in-transit requirements for the physical protection of special nuclear material of moderate and low strategic significance."

In Item 15 of FSAR Table 13.4-201, the applicant states that the protected area will be established before the onsite fuel delivery. Therefore, the staff finds that a Special Nuclear

Material Physical Protection Plan (SNMPPP) that describes how the fixed site requirements of 10 CFR 73.67 will be met would not be required. In order to complete the review, the staff issued RAI 01-6 on August 2, 2011 (ADAMS Accession No. ML112140062), requesting the applicant to provide a transportation security plan that addresses the security requirements for shipping and receiving SNM (new fuel) in accordance with 10 CFR 73.67(g). On August 15, 2011, the applicant submitted the response to RAI 01-6 (ADAMS Accession No. ML11229A165) that included a description of the New Fuel Shipping Plan as Appendix 13DD in FSAR Chapter 13. In addition, the applicant updated FSAR Subsection 13.5.2.2.8 to address the addition of the new fuel shipping plan as part of the security procedures. The staff verified that the applicant incorporated the FSAR markups identified in the RAI response into Revision 7 of the application.

NRC staff also reviewed the applicant's New Fuel Shipping Plan for SNM low strategic significant (SNM-LSS) shipments originating from or arriving at the facility. The plan states that the reactor licensee will not develop its own transportation security plan and will make arrangements with an SNM-qualified licensee for transport under its own transportation security plan. These arrangements carried out in this manner for in-transit physical protection are acceptable per 10 CFR Part 73.67(g)(1)(v). The approaches and procedures as outlined in the New Fuel Shipping Plan satisfy the requirements specified in 10 CFR 73.67(a), 73.67(f) and (g)(1)-(3), and 73.71. NRC staff concludes that the facility New Shipping Plan is acceptable and provides reasonable assurance that the requirements for the physical protection of SNM-LSS in transit will be met.

<u>Physical Protection Program in FSAR Section 13.6 in Regards to the 10 CFR 73.55 Review</u>

Part 8 of the application contains the Fermi 3 security plan that is referenced in Part 2, FSAR Chapter 13, Section 13.6. This information includes the Physical Security Plan that contains safeguards information as defined by 10 CFR 73.21; its disclosure to unauthorized individuals is prohibited in Section 147 of the AEA. The staff's safety review of this information under 10 CFR Part 52 for the licensing and operation of Fermi 3 is in SER Chapter 13, Subsection 13.6. Those persons with the correct access authorization and a need to know basis may view the safeguards information version of the Fermi COL application, SER Section 13.6.

Per 10 CFR 73.55, "Requirements for physical security protection of licensed activities in nuclear power reactors against radiological sabotage," the staff reviewed the applicant's proposed security plan in Part 2 of FSAR Chapter 13, Subsection 13.6 and Part 8 of the application. The staff finds that the applicant has satisfied the regulatory requirements and provided the required information relating to physical security. The staff concludes that the applicant has provided the necessary programmatic elements in the physical security plan, the training and qualification plan, and the safeguards contingency plan, which provide a high assurance that activities involving SNM are not inimical to common defense and security and do not constitute an unreasonable risk to public health and safety.

1.4.5.9 Parts 30 and 40 License Staff Review

In order to satisfy NRC regulations and requirements for the receipt, possession, and use of byproduct and/or source materials, the applicant needed to address the following main areas for review per the guidance in NUREG–1556, Volume 7, Section 8:

- General Information – License action type, legal identities, address, points of contact.
- Materials to be possessed and used.
- Financial assurance and recordkeeping.
- Individuals responsible for the radiation safety program and training and experience, etc.
- Training for workers in restricted areas.
- Facilities and equipment.
- Radiation Safety Program.
- Waste management.
- Physical security.
- Emergency preparedness.

General Information

The Part 30 and 40 licenses requested by the applicant are described above in Subsection 1.4.5.3, Parts 30, 40 and 70 License Request Clarifications, and in Subsection 1.4.5.6, Parts 30, 40, and 70 License Conditions. The legal identities, addresses, and points of contact are described in Part 1 of Section 2(a-d). The staff finds that the applicant has adequately addressed this information.

Materials To Be Possessed and Used

The possession and proposed uses of Parts 30 and 40 materials are described above in the Subsection 1.4.5.5, Parts 30, 40, and 70 Materials and Use Clarifications; in addition to the Subsection on 1.4.5.3, Parts 30, 40, and 70 License Request Clarifications. The staff finds that the applicant has adequately identified the possession and proposed uses of materials.

Financial Assurance and Recordkeeping for Decommissioning

The applicant describes this information in the Decommissioning Funding Report in Part 1, Section 2(f), including Appendix C. This information is discussed and reviewed in Section 1.4.1 of this SER. In addition, the QAPD in FSAR Appendix 17AA describes the decommissioning record keeping processes. The QAPD is reviewed in SER Chapter 17. The staff finds that the applicant has adequately addressed these items.

Individuals Responsible for the Radiation Safety Program: Qualifications, Training, and Experience

The RP Program for Fermi 3 is described in FSAR Section 12.5, Appendices 12AA and 12BB. In SER Chapter 12, the staff finds the applicant's programs acceptable. In regards to radiation protection managers, supervisors, and technicians, FSAR Section 13.1 describes the job and function for these positions. In addition, qualifications and training for these positions are described in FSAR Sections 13.1 and 13.2. The staff reviewed this information in SER Chapter 13 and finds it acceptable.

Training for Workers in Restricted Areas

The RP Program for Fermi 3 is described in FSAR Section 12.5, Appendices 12AA and 12BB. In SER Chapter 12, the staff finds the applicant's programs acceptable. The training criteria for workers in restricted areas are described in FSAR Section 13.2. The staff reviewed this information in SER Chapter 13 and finds it acceptable.

Facilities and Equipment

The physical arrangement and design features for radiation protection is described in FSAR Section 12.3. In addition, in FSAR Sections 12.5, Appendices 12AA and 12BB describe the facilities, instrumentation, and equipment provided to support the implementation of the radiation protection program. The staff reviewed this information in SER Chapter 12 and finds it acceptable.

Radiation Safety Program

The applicant describes the RP Program in FSAR Section 12.5. The staff finds the applicant's RP Program acceptable in SER Chapter 12. Qualifications, training, and experience for managers, supervisors, and technicians are described in FSAR Sections 13.1 and 13.2. The staff reviewed this information in SER Chapter 13. Radiation control procedures and the maintenance of radiation records will be established by the applicant's QAPD, as presented in FSAR Appendix 17AA. The QAPD is reviewed in SER Chapter 17. In addition, FSAR Table 13.4-201 provides the applicant's commitments to implement the radiation protection programs. The staff reviewed this information in SER Chapters 12 and 13 and finds it acceptable. The staff finds that the applicant has adequately addressed these items.

Waste Management

The radioactive waste management system includes the liquid waste management system (LWMS, Section 11.2); gaseous waste management system (GWMS, Section 11.3); solid waste management system (SWMS, Section 11.4); and process effluent radiation monitoring and sampling systems (PERMS, Section 11.5) as described in the FSAR. The staff evaluated these systems and associated programs and information supplied by the applicant. The staff concludes that the information pertaining to the applicant's waste management systems and programs in Chapter 11 are acceptable.

Physical Security

The applicant's physical security program is described in FSAR Section 13.6. The staff reviewed the Physical Security Program in SER Section 13.6 and finds it acceptable.

Emergency Preparedness

The staff's evaluation of the application for emergency planning with respect to Parts 30, 40, and 70 licenses is in Section 13.3B.9 of the staff's SER. In this review, the staff finds that the applicant has met the requirements of 10 CFR 30.32(i) and 40.31(j).

The applicant states that no byproduct material in an unsealed form on foils or plated sources, or sealed in glass, in excess of the quantities in Schedule C of 10 CFR 30.72, would be received, possessed, or used at the Fermi 3 site. Because the quantities do not exceed Schedule C, an emergency plan that meets the requirements of 10 CFR 30.32(i)(3) is not required. Therefore, the implementation of the emergency plan before the receipt of byproduct material has been removed from FSAR Table 13.4-201.

The applicant states that the Part 40 license will not involve authorization to receive, possess, or use uranium hexafluoride in excess of 50 kilograms in a single container or 1,000 kilograms total. Because these quantities will not exceed the values listed above, an emergency plan for responding to radiological hazards from an accidental release of source material and to any associated chemical hazards related to the material is not required. Therefore, the implementation of the emergency plan before the receipt of source material has been removed from FSAR Table 13.4-201. Chapter 12 of the FSAR includes a requirement addressing these limitations during the period before the implementation of the emergency plan—before the initial fuel loading following the finding that the acceptance criteria in the COL have been met as provided in 10 CFR 52.103(g).

The applicant acknowledges that these limitations on Parts 30 and 40 materials, with respect to the period before the implementation of the emergency plan and in preparation for the initial fuel loading following a 10 CFR 52.103(g) finding, will be addressed in a revision to Subsection 12.2.1.5 of the FSAR. However, as discussed above, the staff notes that in response to RAI 01-7, the applicant further clarifies that no 10 CFR Part 40 specifically licensed material including natural uranium, depleted uranium, and uranium hexafluoride will be received, possessed, or used during the period between the issuance of the COL and the 10 CFR 52.103(g) finding. This limitation is addressed in Subsection 1.4.5.6, Parts 30, 40, and 70 License Conditions, above.

Therefore, based on the above, the staff finds that the applicant has met the requirements of 10 CFR 30.32(i) and 40.31(j).

1.4.5.10 Part 37 Staff Review

On March 19, 2013, a new 10 CFR Part 37 rule was published in the FR. The NRC amended its regulations to establish security requirements for the use and transport of Category 1 and Category 2 quantities of radioactive material. The NRC considers these quantities to be risk significant and, therefore, to warrant additional protection. Category 1 and Category 2 thresholds are based on the quantities established by the International Atomic Energy Agency (IAEA) in its Code of Conduct on the Safety and Security of Radioactive Sources, which the NRC endorses. The objective of the 10 CFR Part 37, "Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material," rule is to provide reasonable assurance of preventing the theft or diversion of Category 1 and Category 2 quantities of radioactive material. The regulations also include security requirements for the transportation of irradiated reactor fuel that weighs 100 grams or less in net weight of irradiated fuel. The 10 CFR Part 37 rule affects any licensee that possesses an aggregated Category 1 or Category 2 quantity of radioactive material, any licensee that transports these materials using ground transportation, and any licensee that transports small quantities of irradiated reactor fuel. The 10 CFR Part 37 rule compliance date was March 19, 2014.

By letter dated January 16, 2014 (ADAMS Accession No. ML14022A165), the NRC issued RAI 89 for the Fermi 3 COL application. RAI 89 requested the applicant to provide descriptions in the FSAR, (e.g. Chapter 13), to address how the applicant, prior to taking possession of an aggregated Category 1 or Category 2 quantity of radioactive material will implement the requirements of 10 CFR Part 37, by establishing, implementing, and maintaining a security program for Fermi 3. By letter dated February 12, 2014 (ADAMS Accession No. ML14051A707), the applicant provided a response to RAI 89.

Upon further review by the staff, it was determined that the regulations of 10 CFR Part 37 do not require COL applicants to address 10 CFR Part 37. After COL issuance, a COL licensee becomes subject to the requirements of this regulation upon taking possession of an aggregated Category 1 or Category 2 quantity of radioactive material. Therefore, the NRC withdrew RAI 89 as stated in letter dated April 24, 2014 (ADAMS Accession No. ML14097A323). By letter dated April 30, 2014 (ADAMS Accession No. ML14121A371), the applicant withdrew its response to RAI 89. Since the RAI response resulted in changes that were incorporated into Revision 7 of the Fermi 3 COLA, the applicant included a proposed FSAR change to remove this information. The staff will track the applicant's revision to this FSAR section as Confirmatory Item 01-3. The staff verified that FSAR Revision 7 does not include the response to RAI 89. Therefore, Confirmatory Item 01-3 is resolved.

Conclusion

Based on the reviews discussed above, the staff finds that the applicant has used a combination of the information in the referenced ESBWR DCD and the information in the COL application, including supplemental COL information, in order to demonstrate compliance with the requirements of 10 CFR Part 52. The applicant's compliance with 10 CFR Part 52 licensing encompasses the necessary requirements to support granting 10 CFR Parts 30, 40, and 70 licenses consistent with operating licenses for nuclear power plants licensed in accordance with 10 CFR Part 50. The staff used the guidance in NUREG–0800, NUREG–1520, and NUREG-1566.

The privileges to be granted under the 10 CFR Parts 30, 40, and 70 licenses are detailed by the staff in the proposed License Conditions specified above. Therefore, the applicant for the Fermi 3 COL will also be authorized to receive, possess, and use source, byproduct, and special nuclear material in accordance with the Commission's regulations in 10 CFR Parts 30, 40, and 70; including 10 CFR Sections 30.33, 40.32, 70.23, and 70.31. The applicant complies with all applicable regulations of 10 CFR Parts 30, 40, and 70; as well as the regulations in 10 CFR Parts 20, 50, and 52.

2.0 SITE CHARACTERISTICS

This chapter of the Fermi 3 Combined Operating License (COL) Final Safety Analysis Report (FSAR) addresses the geological, seismological, hydrological, and meteorological characteristics of the site and vicinity, in conjunction with present and projected population distribution and land use, and site activities and controls.

2.0.1 Introduction

The site characteristics are reviewed by the U.S. Nuclear Regulatory Commission (NRC) staff to determine whether the applicant has accurately described the site characteristics and site parameters together with site-related design parameters and design characteristics in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, “Licenses, certifications, and approvals for nuclear power plants.” The review is focused on the site characteristics and site-related design characteristics needed to enable the NRC staff to reach a conclusion on all safety matters related to siting of Fermi 3. Because this combined license application (COLA) references the Economic Simplified Boiling-Water Reactor (ESBWR) Design Control Document (DCD), Revision 10, this section focuses on the applicant’s demonstration that the characteristics of the site fall within the site parameters specified in the design certification (DC) rule or, if outside the site parameters, that the design satisfies the requirements imposed by the specific site characteristics and conforms to the design commitments and acceptance criteria described in the ESBWR DCD.

2.0.2 Summary of Application

Section 2.0 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 2.0 of the ESBWR DCD, Revision 10. In addition, the applicant provides the following:

<u>*COL Items*</u>

- EF3 COL 2.0-1-A DCD Site Parameter Values

  Table 2.0-201 of the Fermi 3 COL FSAR identifies each DCD site parameter value and the corresponding Fermi 3 site characteristic values, and evaluates, as applicable, whether the Fermi 3 site characteristic values fall within the DCD values.

- EF3 COL 2.0-2-A through
  EF3 COL 2.0-30-A Site Characteristics

  Information in Sections 2.1 through 2.5 of the Fermi 3 COL FSAR identifies site characteristics and addresses NRC guidance in NUREG-0800.

<u>*Supplemental Information*</u>

- EF3 SUP 2.0-1 Site Specific Input Values

  Appendix 2A provides site specific input values used in the analysis of on-site atmospheric dispersion factors (χ/Q values).

2.0.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1966, "Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling Water Reactor." In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the site characteristics, and the associated acceptance criteria, are given in Section 2.0 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)," the Standard Review Plan (SRP).

The applicable regulatory requirements for site characteristics are as follows:

- 10 CFR 52.79(a)(1)(i) - (vi) provides the site-related contents of the application.
- 10 CFR 52.79(d)(1), as it relates to information sufficient to demonstrate that the characteristics of the site fall within the site parameters specified in the DC.
- 10 CFR Part 100, "Reactor Site Criteria," as it relates to the siting factors and criteria for determining an acceptable site.
- The acceptance criteria associated with specific site characteristics/parameters and site-related design characteristics/parameters are addressed in the related Chapter 2 or other referenced sections of NUREG-0800.

2.0.4 Technical Evaluation

As documented in NUREG–1966, the NRC staff reviewed and approved Section 2.0 of the certified ESBWR DCD. The staff reviewed Section 2.0 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the Fermi 3 COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information contained in the application and the information incorporated by reference address the relevant information related to this section.

The staff reviewed the information in the Fermi 3 COL FSAR as follows:

<u>*COL Items*</u>

- EF3 COL 2.0-1-A

  DCD site parameter values for the ESBWR standard plant are identified in DCD Tier 2, Table 2.0-1 and DCD Tier 1, Table 5.1-1.

- EF3 COL 2.0-2-A through EF3 COL 2.0-30-A

  Information on Fermi 3 site characteristics is provided in Section 2.1 through Section 2.5. This information addresses NRC guidance in NUREG-0800 as identified in Table 2.0-2R. In the "COL Information" column, the COL item from

[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

the DCD is replaced with information responding to the COL item and identifying the FSAR section which addresses the SRP section invoked by the COL item.

The NRC staff reviewed the COL information in Fermi 3 COL FSAR Section 2.0, "Site Characteristics", describing the characteristics and site-related design parameters for the Fermi site. The appropriateness of the site characteristic values presented by the applicant for the Fermi 3 site is reviewed by the staff in Section 2.1 through 2.5 of this SER. The applicant compared its site specific characteristics to the DCD site parameters from DCD Tier 2, Table 2.0-1 and DCD Tier 1, Table 5.1-1 in Fermi 3 COL FSAR Table 2.0-2R and Table 2.0-201.

In Fermi 3 FSAR, Revision 2, Table 2.0-201, the applicant listed Fermi 3 long term dispersion estimate site characteristic values that do not fall within the corresponding ESBWR DCD site parameter values. The staff issued RAI 02-1 and requested the applicant justify why this is not listed as a departure in Part 7 of the Fermi 3 COLA. In a letter dated September 2, 2010 (Agency wide Documents Access and Management System (ADAMS) Accession No. ML102570700) the applicant provided the response discussed below.

The applicant stated that the Fermi 3 long term atmospheric dispersion estimates are not referenced as a departure from the ESBWR DCD for the following reasons:

- The departure definition of Regulatory Guide (RG) 1.206 is not applicable to the Fermi 3 long term atmospheric dispersion estimates presented in FSAR Chapter 2 because the site specific atmospheric dispersion estimates do not constitute a deviation from DCD design information. The χ/Q and D/Q estimates presented in the DCD are not utilized as bounding analysis to determine or demonstrate site suitability, as each COL applicant is responsible to perform site specific analysis.

- The departure definitions of current DC rules are not applicable to ESBWR DCD long term atmospheric dispersion estimates. Although the GEH ESBWR DC rule had not yet been finalized, a previous DC rule has stated that a departure from a method of evaluation described in the plant-specific DCD used in establishing the design bases or in the safety analyses means (1) changing any of the elements of the method described in the plant-specific DCD unless the results of the analysis are conservative or essentially the same, or (2) changing from one method described in the plant-specific DCD to another method unless that method has been approved by the NRC for the intended application. The applicant contends that the Fermi 3 COLA has not changed the method of evaluation described in the DCD; instead, it presents the required site specific atmospheric dispersion estimates and associated dose analysis utilizing methods specified in the DCD.

- The 10 CFR 52.79(d)(1) and NUREG-0800 discussions of DC site parameters that must be met by COL applicants are not applicable to ESBWR DCD long term atmospheric dispersion estimates. According to NUREG-0800, site parameters used in bounding evaluations of the certified design define the requirements for the design that must be met by a site. The ESBWR DCD χ/Q and D/Q estimates are not utilized in any bounding evaluations of the certified design, as each COL applicant is required to present a site specific evaluation.

- Footnote 12 of the ESBWR DCD, Tier 2, Table 2.0-1 requires the Fermi 3 analysis of site parameters associated with long term atmospheric dispersion estimates to be extended to the dose analysis of Chapter 12. In other words, the Fermi 3 COLA demonstrates that the estimated atmospheric dispersion site characteristics fall within the site parameters specified in the DCD by presenting a site specific dose analysis as required in Chapter 12 of the Fermi 3 FSAR.

The staff evaluated the applicant's response to Request for Additional Information (RAI) 02-1 (ADAMS Accession No. ML102570700) and finds the response to be acceptable because the ESBWR DCD long term χ/Q and D/Q estimates are not utilized in any bounding evaluations of the certified design as each COL applicant is required to present a site specific evaluation.

The NRC staff reviewed the applicant's comparison of site specific characteristics against the ESBWR DCD site parameters and finds the comparison to be acceptable. The staff review confirms that the DCD values enveloped site specific values, except for the long term atmospheric dispersion estimates discussed above.

Supplemental Information

- EF3 SUP 2.0-1 Site Specific Input Values

  Appendix 2A provides site specific input values used in ARCON96 analysis of on-site χ/Q values.

The site specific input to the ARCON96 analysis which is provided in Appendix 2A is reviewed in SER Subsection 2.3.4 of this SER.

The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

2.0.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.0.6 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference are resolved.

In addition, the staff compared the additional COL information in the application, and the applicant's response to RAI 02-1 (ADAMS Accession No. ML102570700) to the relevant NRC regulations, the guidance in Section 2.0 of NUREG–0800, and other NRC RGs. The staff's safety evaluation (SE) of Fermi 3 COL FSAR, Section 2.0 is provided in Section 2.0 of this SER, and concluded that Fermi 3 COL FSAR Section 2.0 is acceptable and meets NRC regulatory requirements in 10 CFR 52.79(a)(1)(i) - (vi), 10 CFR 52.79(d)(1), 10 CFR Part 100 and Section 2.0 of NUREG-0800.

2.1 Geography and Demography

Section 2.1 of the Fermi 3 FSAR, Revision 7, discusses the site characteristics that could affect the safe design and siting of the plant and includes information about the site boundaries and location of the site with respect to prominent natural and man-made features.

The descriptions of the site area and reactor location are used to assess the acceptability of the reactor site. The review covers the following specific areas: (1) specification of reactor location with respect to latitude and longitude, political subdivisions; and prominent natural and manmade features of the area, (2) site area map to determine the distance from the reactor to the boundary lines of the exclusion area, including consideration of the location, distance, and orientation of plant structures with respect to highways, railroads, and waterways that traverse or lie adjacent to the exclusion area, and (3) any additional information requirements prescribed within the "Contents of Application" sections of the applicable Subparts to 10 CFR Part 52. The purpose of the review is to ascertain the accuracy of the applicant's description for use in independent evaluations of the exclusion area authority and control, the surrounding population, and nearby manmade hazards.

2.1.1 Introduction

Section 2.1, "Geography and Demography" of the Fermi 3 COL FSAR addresses site-specific information related to the site location and description, exclusion area authority and control, and population distribution.

2.1.2 Summary of Application

Section 2.1 of the Fermi 3 COL FSAR describes the geography and demography of the Fermi 3 site. In addition, the applicant provides the following:

COL Items

- EF3 COL 2.0-2-A Site Location and Description

  The proposed location for Fermi 3 is on the same site as Fermi 2. The Fermi 3 FSAR specifies the latitude, longitude and coordinates for the Fermi 3 site.

- EF3 COL 2.0-3-A Exclusion Area Authority and Control

  The Fermi 3 Exclusion Area Boundary (EAB) is designated as the area encompassed by an 892.45 m (2928 ft) radius circle around the reactor center.

- EF3 COL 2.0-4-A Population Distribution

  The permanent population data presented in this section are primarily derived from the 2000 U.S. Census.

2.1.3 Regulatory Basis

The acceptance criteria associated with the relevant requirements of the Commission regulations for the site characteristics are given in Section 2.0 of NUREG-0800.

The applicable regulatory requirements for site characteristics are as follows:

10 CFR Parts 50 and 52, as they relate to the inclusion in the SAR of a detailed description and safety assessment of the site on which the facility is to be located, with appropriate attention to features affecting facility design 10 CFR 52.79(a)(1).

10 CFR Part 100, as it relates to the following: (1) defining an exclusion area and setting forth requirements regarding activities in that area (10 CFR 100.3); (2) addressing and evaluating factors that are used in determining the acceptability of the site as identified in 10 CFR100.20(a) and 10 CFR100.20(b); (3) determining an exclusion area such that certain dose limits would not be exceeded in the event of a postulated fission product release as identified in 10 CFR 52.79(a)(1) as it relates to site evaluation factors identified in 10 CFR Part 100; and (4) requiring that the site location and the engineered features included as safeguards against the hazardous consequences of an accident, should one occur, should ensure a low risk of public exposure.

10 CFR 100.20(a) and 10 CFR 100.20(b) as they relate to population densities.

The related acceptance criteria are:

Specification of Location: The information submitted by the applicant is adequate and meets the requirements of 10 CFR 52.79(a)(1) if it describes highways, railroads, and waterways that traverse the exclusion area in sufficient detail to allow the reviewer to determine that the applicant has met the requirements in 10 CFR 100.3.

2.1.4 Technical Evaluation

As documented in NUREG–1966, the NRC staff reviewed and approved Section 2.1 of the certified ESBWR DCD. The staff reviewed Section 2.1 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the Fermi 3 COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1]

The staff's review confirmed that the information contained in the application address the relevant information related to this section.

The staff reviewed the information in the Fermi 3 COL FSAR as follows:

COL Items

- EF3 COL 2.0-2-A Site Location and Description

[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

COL Items

- EF3 COL 2.0-2-A Site Location and Description

  The proposed reactor is designated as Fermi 3. It is located on the same site as Fermi 2. The location of each reactor at the Fermi site is specified by latitude, longitude and Universal Transverse Mercator (UTM) coordinates.

- EF3 COL 2.0-3-A Exclusion Area Authority and Control

  As shown in Figure 2.1-204, the Fermi 3 Exclusion Area Boundary (EAB) is designated as the area encompassed by an 892.45 m (2928 ft) radius circle around the reactor center. The Fermi 2 and Fermi 3 exclusion areas overlap a significant amount of the same area and are entirely within the 509.9 hectares (1260 acres) owned by Detroit Edison with the exception of a few small areas in Lake Erie to the east. Detroit Edison owns a 16.2 hectare (40 acre) parcel of submerged land in Lake Erie expressly for protection and maintenance of the intake channel. Detroit Edison has fee simple absolute ownership of all the land within the Fermi site property boundary, and therefore the applicant has the authority to determine all activities, including exclusion and removal of personnel and property from the EAB, as specified by 10 CFR 100.21(a). All points of personnel and vehicle access to the site are strictly controlled utilizing methods such as searches, escorts for visitors, and ensuring individuals are evacuated in the event of an emergency.

- EF3 COL 2.0-4-A Population Distribution

  The permanent population data presented in this section are primarily derived from the 2000 U.S. Census information contained in LandView® 6. This software is a flexible tool capable of identifying economic and demographic information in a selected geographic area. Sources for population data and projections, as well as information on seasonal variations (transient) population in the area around the Fermi site are identified and referenced in this section, as appropriate. The population data and general descriptions of human activity and seasonal variations are provided to comply with RG 1.206. In general, the Fermi 3 Environmental Report was the basis for the information included in this section. This information was updated with data obtained by research, as cited.

The NRC staff reviewed the resolution to the site-specific items related to the site location and description included under Section 2.1 of the Fermi 3 COL and independently estimated and verified the site latitude and longitude coordinates, and the UTM coordinate system coordinates provided by the applicant in the Fermi 3 COLA.

Using maps readily available in most libraries and the internet, the NRC verified the political subdivisions and prominent manmade features of the area provided by the applicant.

The NRC staff verified that the site area map, Figure 2.1-1 provided by the applicant, showed the distance from the reactor to the boundary lines of the Fermi 3 exclusion area. The NRC staff verified that no public roads, commercial railroads, or commercial waterways cross or lieadjacent to the exclusion area. The exclusion area does extend into Lake Erie to the east of

Fermi 3. Lake Erie is too shallow for commercial shipping in this area. The nearest commercial shipping channel is 4.5 miles east of Fermi 3.

The site area map submitted by the applicant is adequate and meets the requirements of 10 CFR 52.79(a)(1) if it describes the site location, including the exclusion area and the location of the plant within the area, in sufficient detail to enable the reviewer to evaluate the applicant's analysis of a postulated fission product release, thereby allowing the reviewer to determine (in SRP Sections 2.1.2 and 2.1.3 and Chapter 15) that the applicant has met the requirements of 10 CFR Part 100.

On the basis of the NRC staff's review of the information addressed in the Fermi 3 COL, and also the NRC staff's confirmatory review of pertinent information generally available in literature and on the internet, the information provided by the applicant with regard to the site location and description is considered adequate and acceptable.

The NRC staff reviewed the resolution to the Fermi 3 COLA related to the exclusion area authority and control including size of the area, and activities that may be permitted within the designated exclusion area included under Section 2.1 of the COL using the review procedures described in Section 2.1.2 of NUREG-0800.

The applicant provided the information concerning the following:

- Complete legal authority to regulate access and activity within the exclusion area boundary (EAB).

- Identification of any facilities within the EAB that have activities unrelated to plant operation being controlled and considered for emergency planning (EP).

The NRC staff verified the applicant's ownership of all property within the EAB, including mineral rights, absolute ownership of all lands within the exclusion area, including mineral rights, is considered to carry with it the required authority to determine all activities on this land and is acceptable to meet the requirements of 10 CFR Part 100. The NRC staff verified the applicant's description of the exclusion area as well as the authority under which all activities within the exclusion area can be controlled. The NRC staff also verified, for consistency, that the EAB is the same as that being considered for the radiological consequences in Chapters 15 and 13.3 of the FSAR by the applicant. The staff concludes that the applicant has acquired authority to control all activities within the designated exclusion area.

The property is clearly posted and includes actions to be taken in the event of emergency conditions at the plant. The Fermi 3 EAB is greater than 0.5 mile from the potential release points.

The NRC staff reviewed the resolution to the COL specific items related to the population distribution around the site environs included under Section 2.1.3 of the Fermi 3 COL.

The staff reviewed the data on the population in the site environs, as presented in the applicant's FSAR, to determine whether the exclusion area, Low Population Zone (LPZ), and population center distance for the proposed site comply with the requirements of 10 CFR Part 100. The staff also evaluated whether, consistent with Regulatory Position C.4 of RG 4.7, the applicant should consider alternative sites with lower population densities.

The staff also reviewed whether appropriate protective measures could be taken on behalf of the enclosed populace within the emergency planning zone, which encompasses the LPZ, in the event of a serious accident.

The staff compared and verified the applicant's population data estimates against U.S. Census Bureau Internet data. The staff reviewed the projected population data provided by the applicant, including the weighted transient population for 2013, 2018, 2020, 2030, 2040, 2050, and 2060. Based on the comparison of the applicant's data to Census Bureau data, the staff finds that the applicant's estimate of the population, including transients, is reasonable.

The staff verified that the distances to the nearest population centers are well in excess of the minimum population center distance of 4 miles (1 1/3 times the distance from center point to the outer boundary of the LPZ). The Fermi 3 LPZ is defined as a circle with a 3 mile radius from the Unit 3 site center point. The nearest population center, as defined by 10 CFR 100.3, is Monroe, Michigan. The distance to Monroe's urban boundary, as defined by US Census files, is 5.5 miles from the Unit 3 center point. This distance is approximately 1 mile greater than the calculated minimum distance of 4 miles to population center as required by 10 CFR Part 100, and satisfies the acceptance criteria of NUREG-0800 and the guidance provided in RG 4.7. Therefore, the NRC staff concludes that the proposed site meets the population center distance requirement set forth in 10 CFR Part 100, Subpart B.

The NRC staff evaluated the site population density against the criterion in Regulatory Position C.4 of RG 4.7, Revision 2, regarding whether it is necessary to consider alternative sites with lower population densities. The NRC staff's evaluation confirmed the applicant's conclusion that the population densities at the time of initial site approval (assumed 2013), and 5 years thereafter, would not exceed the criteria of 500 persons per square mile averaged over any radial distance out to 20 miles (cumulative population within a distance of up to 20 miles divided by the area of the same radius circle), and thus is acceptable.

The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Therefore, the NRC staff concludes that the applicant's Fermi 3 site density estimates conform with Regulatory Position C.4 of RG 4.7, Revision 2, as well as the requirements in 10 CFR Part 100, Subpart B, and 10 CFR 50.34(a)(1)(ii)(D)(1).

2.1.5 Post Combined License Activities

There are no post COL activities related to this section.

2.1.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference has been resolved.

In addition, the staff compared the additional COL information in the application to the relevant NRC regulations; guidance in Section 2.1 of NUREG–0800, and to the regulatory requirements in 10 CFR 52.79(a)(1), 10 CFR 100.3 and 10 CFR 100.20(b).

As set forth above, the applicant has presented and substantiated information to establish the site location and description. The staff has reviewed the information provided and, for the reasons given above, concludes that it is sufficient for the staff to evaluate compliance with the siting evaluation factors in 10 CFR Part 100.3, as well as with the radiological consequence evaluation factors in 10 CFR 52.79(a)(1).

The staff further concludes that the applicant provided sufficient details about the site location and site description to allow the staff to evaluate, as documented in Sections 2.1.2, 2.1.3, and 13.3 and Chapters 11 and 15 of this SER, whether the applicant has met the relevant requirements of 10 CFR 52.79(a)(1) and 10 CFR Part 100 with respect to determining the acceptability of the site. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR Parts 50, 52, and 100.

As set forth above, the applicant has provided and substantiated information concerning its legal authority and control of all activities within the designated exclusion area.

The staff has reviewed the information provided and, for the reasons given above, concludes that the applicant's exclusion area is acceptable to meet the requirements of 10 CFR 52.79(a)(1), 10 CFR Part 100, and 10 CFR 100.3 with respect to determining the acceptability of the site. This conclusion is based on the applicant having appropriately described the plant exclusion area, the authority under which all activities within the exclusion area can be controlled, and the methods by which access and occupancy of the exclusion area can be controlled during normal operation and in the event of an emergency situation. In addition, the applicant has the required authority to control activities within the designated exclusion area, including the exclusion and removal of persons and property, and has established acceptable methods for control of the designated exclusion area. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR Parts 50, 52, and 100.

As set forth above, the applicant has provided an acceptable description of current and projected population densities in and around the site. The staff has reviewed the information provided and, for the reasons given above, concludes that the population data provided is acceptable to meet the requirements of 10 CFR 52.79(a)(1), 10 CFR 100.20(a), 10 CFR 100.20(b), 10 CFR Part 100, and 10 CFR 100.3. This conclusion is based on the applicant having provided an acceptable description and safety assessment of the site, which contains present and projected population densities that are within the guidelines of Regulatory Position C.4 of RG 4.7, and properly specified the low-population zone and population center distance. In addition, the staff has reviewed and confirmed, by comparison with independently obtained population data, the applicant's estimates of the present and projected populations surrounding the site, including transients. The applicant also has calculated the radiological consequences of design-basis accidents at the outer boundary of the low-population zone (SRP Chapter 15) and has provided reasonable assurance that appropriate protective measures can be taken within the low-population zone to protect the population in the event of a radiological emergency. This addresses COL Section 2.1 specific items. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR Parts 50, 52, and 100.

2.2 Nearby Industrial, Transportation, and Military Facilities

Section 2.2, "Nearby Industrial, Transportation, and Military Facilities" of the Fermi 3 COL FSAR provides information on the site characteristics that could affect the safe design and siting of the plant. The information consists of three subsections: Subsection 2.2.1 provides information on locations and routes; Subsection 2.2.2 describes nearby industrial transportation facilities (airports, airways, roadways, railways, etc.) and military facilities; and Subsection 2.2.3 evaluates potential hazards.

2.2.1 Locations and Routes

The locations of and separation distances from transportation facilities and routes, including airports and airways, roadways, railways, and navigable bodies of water are addressed as information item EF3 COL 2.0-5-A in Fermi 3 FSAR Sections 2.2.1 and 2.2.2. The staff's review of this information is below in Section 2.2.2 of this Safety Evaluation Report (SER).

2.2.2 Descriptions

2.2.2.1 *Introduction*

The description of locations and routes refers to potential external hazards or hazardous materials that are present or may reasonably be expected to be present during the projected lifetime of the proposed plant. The purpose is to evaluate the sufficiency of information concerning the presence and magnitude of potential external hazards so that the reviews and evaluations described in standard review plan Sections 2.2.3, 3.5.1.5, and 3.5.1.6 can be performed. The review covers the following specific areas: (1) the locations of and separation distances to transportation facilities and routes, including airports and airways, roadways, railways, pipelines, and navigable bodies of water; (2) the presence of military and industrial facilities such as fixed manufacturing, processing, and storage facilities; and (3) any additional information requirements prescribed within the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.2.2.2 *Summary of Application*

Subsection 2.2.2 of the FSAR addresses the need for locations and route descriptions and descriptions of nearby industrial and military facilities. The applicant addressed the information as follows:

COL Items

- EF3 COL 2.0-5-A Locations and Routes

  EF3 COL 2.0-5-A resolves DCD COL Item 2.0-5-A by providing information about industrial, military, and transportation facilities and routes to establish the presence and magnitude of potential external hazards. The site-specific information needed to address DCD COL Item 2.0-5-A in the Fermi 3 FSAR is addressed by EF3 COL 2.0-5-A in Fermi 3 FSAR Sections 2.2.1 and 2.2.2 in accordance with RG 1.206 and relevant sections of 10 CFR Parts 52 and 100.

Locations and Routes

The significant manufacturing plants, storage facilities, quarrying operations, and transportation routes within 8 km (5 mi) of Fermi 3 are presented in Fermi 3 COL FSAR, Figure 2.2-201. There are no chemical plants, refineries, mining operations, drilling operations, active oil or gas wells, military bases, or missile sites within the vicinity of Fermi 3. The Fermi 2 reactor is located approximately 0.42 km (0.26 mi) northeast of the Fermi 3 centerline.

The western basin of Lake Erie is adjacent to the eastern property boundary of the Fermi site. The Port of Monroe is the closest waterway shipping facility at the mouth of River Raisin approximately 11.2 km (7 mi) southwest. The West Outer Channel and the East Outer Channel connect in Lake Erie approximately 11.2 km (7 mi) northeast of the plant as shown in Fermi 3 FSAR Figure 2.2-201. The West Outer Channel provides the closest shipping approach in Lake Erie at over 8 km (5 mi) away from Fermi 3.

The nearest major highways are Interstate 75 and Interstate 275. These two highways intersect at 6.6 km (4.1 mi) northwest of Fermi 3. State Route 24 runs parallel to Interstate 75 approximately 9.3 km (5.8 mi) northwest of Fermi 3. Interstate 75 has heavy commercial traffic since it is a major access route to industries in the Detroit area.

Two railroad companies transport freight in the vicinity of Fermi 3 as shown in FSAR Figure 2.2-201. Canadian National Railway operates the closest rail line within 5.6 km (3.5 mi) of Fermi 3, and also provides service to the single spur track onto the site. Norfolk Southern Railway has two parallel rail lines at distances of 5.6 km (3.5 mi) and 6.1 km (3.8 mi) from Fermi 3 and operates the nearest railroad yard in Monroe over 9.6 km (6 mi) away.
Nearby airports and air routes are shown in FSAR Figure 2.2-202.

Industrial Facilities

Industrial facilities which use, store, or transport significant quantities of hazardous materials in the vicinity of 8 km (5 mi) of Fermi 3 are presented in FSAR Table 2.2-201, including primary function, major products, and number of persons employed. No hazardous materials are manufactured within 8 km (5 mi) of Fermi 3.

Hazardous materials identified, including toxic chemicals, flammable materials, explosive substances, and shipment information reported by nearby industrial facilities, are summarized in FSAR Table 2.2-202.

There are two extractive industries within 8 km (5 mi) of Fermi 3. However, explosive materials are not stored overnight. For both Stone Co. of Michigan’s Newport Quarry and Rockwood Quarry LLC, a blasting company truck delivers the required quantity of ammonium nitrate fuel oil only on the days that blasting occurs. The chemicals are mixed with explosive components immediately prior to use for blasting, and unused explosives are removed from the quarries by the end of the day.

Onsite chemical storage for Fermi 3 and Fermi 2 is shown in FSAR Table 2.2-203.

Pipelines

There are no pipelines carrying potential hazardous materials (e.g., propane, chlorine, toxic chemicals) within 8 km (5 mi) of the site. Even though there are local, residential and commercial natural gas distribution pipelines and service lines near the site, there is no large diameter natural gas or oil transmission pipelines in the vicinity of Fermi 3.

Waterways

The station water intake structure at Fermi 3 is located inside the water intake bay (groin area) and does not extend out into Lake Erie. Additional protection for the intake structure is provided by the designation of all waters and adjacent shoreline of Fermi 2 as a security zone as set forth by 33 CFR 165.915. Entry into this zone is prohibited unless authorized by the U.S. Coast Guard. The station intake structure is located over 8 km (5 mi) from the West Outer Channel as shown in FSAR Figure 2.2-201.

The depths of the shipping channels that extend from the Port of Monroe and from the Detroit River range between 6.4 m (21 ft) to 8.8 m (29 ft). The types of ships using Lake Erie in these channels include self-propelled vessels and integrated tug/barge units ranging in length from 116.7 m to 209 m (383 ft to 1014 ft).

Small amounts of fuel are stored and used near the boat docks at Swan Boat Club and Swan Yacht Basin on Swan Creek about 2.4 km (1.5 mi) north of Fermi 3 and at the Brest Bay Marina approximately 4.8 km (3 mi) southwest. The closest maritime facility is the Port of Monroe located approximately 11.3 km (7 mi) southwest of Fermi 3, where the principal imports and exports are asphalt, asphalt flux, coal, equipment, petroleum coke, and armor stone. On Lake Erie in general, and likely to be shipped on the West Outer Channel about 8 km (5 mi) east of the site, are Great Lakes fleet vessels such as dry-bulk carriers, cement carriers, and tankers which transport cargo primarily consisting of iron ore, coal, limestone, cement, salt, sand and gravel, grain, potash, liquid bulk, and general cargo.

Highways

Nearby industries reported receiving shipments of hazardous material primarily by truck. Trucks deliver freight along Interstates 75 and 275 which pass approximately 6.4 km (4 mi) northwest of the plant. Petroleum products are delivered to the site from Dixie Highway via Fermi Drive in transport trucks.

Railroads

Canadian National Railway operates the closest rail line within 5.6 km (3.5 mi) of Fermi 3, and also provides service to the single spur track onto the site. The rail spur is used infrequently and primarily for the transportation of non-hazardous heavy items and large equipment. Norfolk Southern Railway has 2 parallel rail lines at distances of about 5.6 km (3.5 mi) and 6.1 km (3.8 mi) from the plant running in a northeast to southwest direction, basically paralleling Interstate 75.

Airports

Nearby airports, runway descriptions, types of aircraft, number of operations per year, and accident statistics are provided in FSAR Table 2.2-204. The Fermi helipad is located approximately 1.2 km (0.75 mi) southwest of the Fermi 3 reactor and is available for emergency MediVac air ambulance service.

Mills Field (MI53), a private turf runway, is the only operational airport within 8 km (5 mi) of Fermi 3. The National Transportation Safety Board aviation accident database lists no reported accidents/incidents in the last 40 years at Mills Field. Detroit Metropolitan Wayne County Airport located 30.6 km (19 mi) to the northwest is the only airport in the region which has annual flight operations greater than the 1000 D^2 criteria (where D= Statute miles from the site) per RG 1.206. As shown in FSAR Figure 2.2-202, the closest edges of V 383 and V 10 176-188 airways fall within the proximity criteria provided in RG 1.206 and NUREG-0800. Federal airway V 383 passes 8 km (5 statute miles) west of Fermi 3 oriented in a north-south direction. Federal airway V 10-176-188 passes 8 km (5 statute miles) north of Fermi oriented in an east-west direction.

Outside the vicinity, Airway V 133 is located approximately 10.46 km (6.5 mi) to the northeast, Airway V 426 runs about 11.26 km (7 mi) to the southwest, Airway 26 is located approximately 12.1 km (7.5 mi) to the northeast, and Airway V 467 passes over 14.5 km (9 mi) to the west at its closest point.

Projections of Industrial Growth

Very limited long-term growth of industrial facilities is expected in the vicinity, which is predominantly rural, agricultural and residential. According to the Monroe County Industrial Development Corporation, future plans call mainly for prime agricultural uses and open space in the areas surrounding the Fermi site. Most of the anticipated industrial growth for facilities using hazardous materials will take place outside the 8 km (5 mi) vicinity near the Port of Monroe about 11.3 km (7 mi) to the southwest near Interstate 275/Telegraph Road intersection area, or in the city of Monroe. Overall, the region is continuing to experience a decline in manufacturing and industrial processes that are the most likely candidates to use hazardous materials.

2.2.2.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the nearby industrial, transportation, and military facilities, and the associated acceptance criteria are given in Section 2.2.1-2.2-2 of NUREG-0800.

The applicable regulatory requirements for identifying locations and routes are:

- 10 CFR 100.20(b), which requires that the nature and proximity of human-related hazards (e.g., airports, dams, transportation routes, and military and chemical facilities) be evaluated to establish site parameters used to determine whether the plant's design can accommodate commonly occurring hazards, and whether the risk of other hazards is very low.

- 10 CFR 52.79(a)(1)(iv), as it relates to the factors to be considered in the evaluation of sites that require the location and description of industrial, military, or transportation facilities and routes.

- 10 CFR 52.79(a)(1)(vi), as it relates to compliance with 10 CFR Part 100.

The related acceptance criteria are:

- Data in the FSAR adequately describe the locations of and distances from the plant of nearby industrial, military, and transportation facilities; and the data are in agreement with data obtained from other sources, when available.

- Descriptions of the nature and extent of activities conducted at the site and in its vicinity, including the products and materials likely to be processed, stored, used, or transported; and that they are adequate to permit identification of the possible hazards cited in Subsection III of Section 2.2.1-2.2.2 of NUREG-0800.

- Sufficient statistical data with respect to hazardous materials that establish a basis for evaluating the potential hazards to the plant or plants considered at the site.

2.2.2.4 *Technical Evaluation*

The staff reviewed the information in the Fermi 3 COL FSAR as follows:

COL Item

- EF3 COL 2.0-5-A Locations and Routes

  The significant manufacturing plants, storage facilities, quarrying operations, and transportation routes within 8 km (5 mi) of Fermi 3 are presented in Figure 2.2-201. There are no chemical plants, refineries, mining operations, drilling operations, active oil or gas wells, military bases, or missile sites within the vicinity of Fermi 3. The Fermi 2 reactor is located approximately 0.42 km (0.26 mi) northeast of the Fermi 3 centerline. The Davis-Besse Nuclear Power Station is located about 42 km (26 mi) south-southeast of the Fermi site. The nearest military facilities are Camp Perry Military Reservation near Port Clinton, Ohio, approximately 48 km (30 mi) southeast and Selfridge Michigan Air National Guard Base about 80 km (50 mi) northeast of Fermi 3.

The NRC staff reviewed Section 2.2 of the Fermi 3 COL FSAR to ensure that the required information is presented in the COL. The staff's review confirms that the information contained in the application addresses the relevant information related to identification of potential hazards in the vicinity of the site.

The NRC staff reviewed EF3 COL 2.0-5-A as a resolution to DCD COL Item 2.0-5-A related to identification of potential hazards in the vicinity of the site, including nearby industrial, transportation, and military facilities addressed in summary of application in Subsection 2.2.2.2.

As set forth above, the applicant presented and substantiated information that identified potential hazards in the site vicinity. The staff reviewed the information in the FSAR and, for the reasons given above, concludes that the applicant had provided information that identified potential hazards in accordance with the requirements of 10 CFR 52.79(a)(1)(iv) and 10 CFR 52.79(a)(1)(vi) for compliance evaluation.

2.2.2.5 *Post Combined License Activities*

There are no post-COL activities related to this section.

2.2.2.6 *Conclusion*

The NRC staff reviewed the information provided by the applicant in the Fermi 3 COLA Part 2 FSAR. The staff's review confirms that the applicant addressed the relevant information, and there is no outstanding information expected to be addressed in the COL FSAR related to this subsection.

As set forth above, the applicant presented and substantiated information that identified potential hazards in the site vicinity. The staff reviewed the information in the FSAR and, for the reasons given above, concludes that the applicant has provided information that identified potential hazards in accordance with the requirements of 10 CFR 52.79(a)(1)(iv) and 10 CFR 52.79(a)(1)(vi) for compliance evaluation. The nature and extent of activities involving potentially hazardous materials that are conducted at nearby industrial, military, and transportation facilities have been evaluated to identify those activities that have the potential for adversely affecting plant safety-related structures. Based on information in the FSAR, as well as information that the staff independently obtained, the staff concludes that all potentially hazardous activities on the site and in the vicinity of the plant have been identified. The hazards associated with these activities have been reviewed and are discussed in Sections 2.2.3, 3.5.1.5, and 3.5.1.6 of this SER. In conclusion, the applicant has provided sufficient information to satisfy 10 CFR Part 50, 10 CFR 52.79(a)(1)(iv), 10 CFR 52.79(a)(1)(vi),10 CFR 100.20, and 10 CFR 100.21.

2.2.3 Evaluation of Potential Accidents

2.2.3.1 *Introduction*

The evaluation of potential accidents considers the applicant's probability analyses of potential accidents involving hazardous materials or activities on the site and in the vicinity of the proposed site to confirm that appropriate data and analytical models have been used. This review covers the following specific areas: (1) hazards associated with nearby industrial activities such as manufacturing, processing, or storage facilities; (2) hazards associated with nearby military activities such as military bases, training areas, or aircraft flights; and (3) hazards associated with nearby transportation routes (aircraft routes, highways, railways, navigable waters, and pipelines). Each hazard review area includes consideration of the following principal types of hazards: (1) toxic vapors or gases and their potential for incapacitating nuclear plant control room operators; (2) overpressure resulting from explosions or detonations involving materials such as munitions, industrial explosives, or explosive vapor clouds resulting from the atmospheric release of gases (such as propane and natural gas or any other gas) with a potential for ignition and explosion; (3) missile effects attributable to mechanical impacts such as aircraft impacts, explosion debris, and impacts from waterborne items such as barges; and (4) thermal effects attributable to fires.

2.2.3.2 *Summary of Application*

This section of the COL FSAR addresses the need to evaluate potential accidents. The applicant addressed the information as follows:

<u>*COL Item*</u>

- EF3 COL 2.0-6-A Evaluation of Potential Accidents

  EF3 COL 2.0-6-A resolves DCD COL Item 2.0-6-A by addressing the provision for evaluating potential accidents. The site-specific information needed to address DCD COL Item 2.0-6-A in Fermi 3 FSAR is incorporated in Fermi 3 COLA Part 2 FSAR Section 2.2.3.

2.2.3.3 *Regulatory Basis*

The applicable regulatory requirements for identifying and evaluating potential accidents are: 10 CFR 52.79(a)(1)(iv) as it relates to the factors to be considered in the evaluation of sites, which require the location and description of industrial, military, or transportation facilities and routes.

- 10 CFR 52.79(a)(1)(vi) as it relates to compliance with 10 CFR Part 100.

The acceptance criteria presented in the Fermi 3 COLA Part 2 FSAR are based on meeting the relevant requirements of 10 CFR Parts 52 and 100.

The related acceptance criteria are:

- Event Probability: The identification of design-basis events resulting from the presence of hazardous materials or activities in the vicinity of the plant or plants of specified type is acceptable if all postulated types of accidents are included for which the expected rate of occurrence of potential exposures resulting in radiological dose in excess of the 10 CFR 50.34(a)(1) limits, as it relates to the requirements of 10 CFR Part 100, is estimated to exceed the NRC staff objective of an order of magnitude of 10^{-7} per year.

- Design-Basis Events: The effects of design-basis events have been adequately considered, in accordance with 10 CFR 100.20(b), if analyses of the effects of those accidents on the safety-related features of the plant or plants of specified type have been performed and measures have been taken (e.g., hardening, fire protection) to mitigate the consequences of such events.

2.2.3.4 *Technical Evaluation*

The NRC staff reviewed Subsection 2.2.3 of the Fermi 3 COL FSAR and performed independent checks of the information presented. The staff's review confirms that the information contained in the application addresses the relevant information related to the evaluation of potential accidents. Where the information or analyses lack sufficient details, the staff requested additional information from the applicant.

The staff reviewed the information in the Fermi 3 COL FSAR as follows:

<u>*COL Item*</u>

- EF3 COL 2.0-6-A Evaluation of Potential Accidents

The staff's technical evaluation of this application is based on reviewing the information pertaining to COL Item EF3 COL 2.0-6-A, related to the evaluation of potential accidents to be covered under resolving the DCD COL Item 2.0-6-A.

Explosions

The applicant addressed potential explosions from the transportation of explosive materials from Interstates 75 and 275 at a minimum distance of 4 mi, the nearest railway at a minimum distance of 5.6 km (3.5 mi), and the nearest waterway (West Outer Channel) at a minimum distance of 8 km (5 mi) from the Fermi site. According to RG 1.91, Revision 1, "Evaluations of Explosions Postulated to Occur on Transportation Routes Nnear Nuclear Power Plants," the separation distance between the interstate highways, railway and waterway and the Fermi site are within the respective safe distance criteria, and therefore, explosion events from these transportation routes are not considered design basis events.

The applicant listed propane in Fermi 3 FSAR Table 2.2-202, but did not evaluate for the potential as an explosion hazard. The staff requested the applicant for additional information in RAI 2.2.3-1 on the basis for not evaluating this potentially explosive material.

In letter dated September 30, 2009 (ADAMS Accession No. ML092750405), the applicant responded to RAI 2.2.3-1 and provided the following information:

The propane explosion scenario was analyzed using the methodology of RG 1.91. RG 1.91 provides guidance for evaluations of explosions postulated to occur on transportation routes near nuclear power plants. As described in Section B, fifth paragraph, of RG 1.91, a TNT mass equivalence is used to determine the safe separation distance.

For determining the safe stand-off distance for the off-site propane storage, the reasonable upper bound of 240 percent is used.

The applicant included in the response a table, “Determination of Safe Stand-Off Distances For Off-Site Propane Storage Locations”, which lists the quantities, TNT equivalents and safe stand-off distances for the Meijer Distribution facility (4 miles distance), the TWB Company (4.5 miles distance) and the Rockwood Landfill (4.5 miles distance). The applicant stated the propane quantities stored at the three facilities are located much farther away than the calculated minimum safe stand-off distance determined using the guidance in RG 1.91. Based on the staff’s review of the applicant provided information, and confirmatory calculations, the staff considers the information adequate and acceptable, therefore RAI 2.2.3-1 is closed.

The applicant evaluated hydrogen and oxygen from the nearest storage tank farm for potential explosions resulting in blast overpressure using 1 psi overpressure as a criterion for adversely affecting plant operations or preventing the safe shutdown of the plant. The applicant determined the safe separation distance of 229 ft between the hydrogen and oxygen storage area and the nearest safety-related structures. The applicant did not provide sufficient details for determining this safe separation distance. Therefore, the staff requested the applicant for additional information (RAI 2.2.3-2).

In letter dated September 30, 2009 (ADAMS Accession No. ML092750405), the applicant responded to RAI 2.2.3-2 and provided the following information:

> In Fermi FSAR Section 2.2.3.1.1, the safe separation distance between the hydrogen and oxygen storage area and nearest safety-related structure is calculated using methods based on EPRI Document No. NP-5283-SR-A, “Guidelines for Permanent BWR Hydrogen Water Chemistry Installations - 1987 Revision”. Appendix B of the guidelines in EPRI Document No. NP-5283-SR-A provides an evaluation report recommending separation distances based on stored quantities and building design factors.
>
> The method in EPRI Document No. NP-5283-SR-A is based on a reinforced concrete wall at least 18 inches thick; a tensile steel factor between 0.12 ksi and 0.3 ksi, and the minimum static lateral load capacities for the tornado region the plant is located in per RG 1.76.
>
> The ESBWR DCD shows that the outer walls for the ESBWR safety-related structures are at least 18 inches thick. The analysis assumes a tensile steel factor of 0.12 ksi (lower end of range in EPRI Document No. NP-5283-SR-A). The lower value for the tensile steel factor results in a larger safe separation distance. RG 1.76, “Design -Basis Tornado and Tornado Missiles for Nuclear Power Plants,” Revision 1, Figure 1, indicates that the Fermi site is located within Tornado Intensity Region I. NUREG/CR-2642, “Capacity of Nuclear Power Plant Structures to Resist Blast Loadings,” dated September 1983, Section 6, states:

"A conservative static capacity can be based upon the required design pressure drop for the tornado zone in which the plant is sited."

For Tornado Region I, the design pressure drop is 3.0 psi. Therefore, a static capacity of 3.0 psi is used in the analysis.

Based on these input values, the minimum safe separation distance for the hydrogen and oxygen storage area is 229 m (750.ft) from the nearest safety-related structure.

The staff reviewed the applicant provided information and the reference material. Based on independent determination, staff considers the applicant response reasonable, adequate and acceptable as it satisfies the NRC provided guidance, therefore, RAI 2.2.3-2 is closed.

It is shown in Fermi 3 FSAR Table 2.2-202, that the nearest storage location of flammable liquids, diesel fuel and gasoline, is 3.4 mi away from the site. The applicant stated that the potential formation and detonation of a flammable vapor is not a design basis event due to the size and distance of the tanks.

The staff noted that Fermi 3 FSAR Table 2.2-203 lists two 8,000 gallon underground gasoline storage tanks adjacent to the southeast corner of building 24. The staff requested additional information from the applicant (RAI 2.2.3-3) to address potential explosion hazard of tanker truck for onsite delivery of gasoline to these tanks.

In letter dated September 30, 2009 (ADAMS Accession No. ML092750405), the applicant responded to RAI 2.2.3-3 and provided the following information:

The Fermi 3 FSAR Table 2.2-203 indicates that there are two 8,000 gallon gasoline underground storage tanks. In further review there is only one 8,000 gallon underground gasoline storage tank, with two dispensing islands (gas pumps). The underground storage tank is currently located adjacent to the holding pond, one dispensing island is located adjacent to the south of the underground storage tank, and the second dispensing island is located adjacent to southeast corner of Fermi 2 Building No. 24. Fermi 3 FSAR Table 2.2-203 will be revised to reflect the single tank and its location.

Fermi 3 FSAR Section 2.2.2.5 Description of Highways states:

"Petroleum products are delivered to the site from Dixie Highway via Fermi Drive in transport trucks."

The current location of the gasoline storage tank will be moved when Fermi 3 is constructed because the current location creates interference with Fermi 3 construction activities. The gasoline storage tank and tanker truck access will be relocated to a safe distance from Fermi 3. The safe separation distance for the gasoline storage tank and tanker truck access is determined using the methodology of RG 1.91 for explosions postulated to occur on transportation routes near nuclear power plants. RG 1.91 uses a TNT mass to determine the safe separation distance.

The minimum safe separation distance is determined by assuming a 10,000 gallon gasoline tanker truck delivering to underground storage tank. The underground gasoline storage tank will be located such that the tank and the gasoline tanker truck access are a minimum of 721.4 m (2367 ft) from the nearest Fermi 3 safety related structure.

The NRC staff considers the applicant's response reasonable and the conclusion acceptable because it meets the requirements in 10 CFR 52.79(a)(1)(i) - (vi), 10 CFR 52.79(d)(1), and 10 CFR Part 100 and the guidance in Section 2.0 of NUREG-0800, therefore RAI 2.2.3-3 is closed.

Aircraft Hazards

The applicant addressed the potential risks due to aircraft hazards associated with airports and airways. The safety evaluation of these impact analyses are performed as a part of the NRC staff's review in SER Section 3.5.1.6 based on the guidance provided in RG 1.206 and NUREG-0800.

Toxic Chemicals

The applicant identified the onsite storage of chemicals for Unit 3 and Unit 2 in Fermi 3 FSAR Table 2.2-203 and the toxic chemicals considered for the potential impact for the control room habitability are identified in Fermi 3 FSAR Table 2.2-205. However, there is no detailed information on the methodology for screening out chemicals or the analyses demonstrating that determined concentrations of chemicals are lower than their respective limiting concentrations. The staff requested the applicant for additional information (RAI 02.02.03-4) to provide its toxic chemicals analyses. The applicant also identified toxic chemicals from offsite stationary sources in Fermi 3 FSAR Table 2.2-202. The applicant stated that the chemicals were evaluated and screened out using criteria in RG 1.78. But no details were provided. Therefore, the staff requested the applicant for additional information (RAI 02.02.03-5) to provide the rationale and methodology used for the toxic chemical analyses. The applicant provided the response for these RAIs with adequate information. The NRC staff reviewed the applicant's response dated September 30, 2009 (ADAMS Accession No. ML092750405), and concluded that the information is reasonable and acceptable because the applicant provided the details and results of analyses except for on-site storage of propane. The applicant stated in the response that the current onsite location of propane will be relocated prior to the operation of Fermi 3. The NRC staff has developed License Condition 2.2.3-1 that will require the applicant to use tanks with a maximum capacity of 1000 gallons for the on-site storage of propane and ensure that no more than 1000 gallons of propane will be stored in any single location, and no storage location will be located closer than the minimum safe distance of 854 meters (2800 ft) from any Fermi 3 safety-related structure and the Main Control Room (MCR). In addition, the applicant proposed revision to Fermi 3 FSAR Sections 2.2.3.1.4.1 and 2.2.3.1.4.2. In the Fermi 3 FSAR Section 2.2.3.1.4.3, the applicant stated that the transportation of toxic chemicals in the vicinity is not a concern for the Fermi 3 control room habitability analysis. There is no discussion to support this statement. Therefore, the staff requested the applicant for additional information (RAI 02.02.03-6) to provide the rationale and methodology applied for making this statement. The applicant provided the response with adequate information. The NRC staff reviewed the applicant's responses dated September 30, 2009 (ADAMS Accession No. ML092750405), for RAIs 02.02.03-4, 02.02.03-5 and 02.02.03-6 and concludes that the information is reasonable and acceptable.

The staff evaluated the information pertaining to toxic chemicals from onsite and offsite stationary and mobile sources identified by the applicant in Fermi 3 FSAR Section 2.2.1-2.2.2 and addressed in Section 2.2.3, for the applicant's analysis of control room habitability in Section 6.4.

The staff reviewed the applicant's inventory of chemicals from the above sources, and screening out of toxic chemicals that do not pose a threat to control room habitability. Based on evaluation of the information presented in above sections of the application, confirmatory analyses, and review of the responses to the RAIs dated September 30, 2009 (ADAMS Accession No. ML092750405), the staff accepts the applicant's identified toxic chemicals, liquid nitrogen and carbon dioxide, for the control room habitability analysis. The staff concludes that these two applicant listed chemicals should be further evaluated in Section 6.4 for control room habitability.

Potential fires due to accidents from the transportation routes do not jeopardize the safe operation of Fermi 3 due to the separation distance of potential fires from Fermi 3. A detailed description of the fire protection system is addressed in FSAR Section 9.5.1. The NRC staff considers the applicant's response reasonable and the conclusion acceptable because it meets the requirements in 10 CFR 52.79(a)(1)(i) - (vi), 10 CFR 52.79(d)(1), 10 CFR Part 100 and Section 2.0 of NUREG-0800.

Collision with Unit 3 Intake Structure

The Fermi 3 intake structure is adjacent to the Fermi 2 intake structure, located on the Lake Erie shoreline within the intake bay. This bay is protected by two rock groins that extend into the lake. The water in the vicinity of the intake structure is very shallow, and therefore, a large ship would not easily reach the intake structure. In addition, the Fermi 3 intake structure is not a safety-related structure, and therefore, any such collision, although unlikely, would not affect the safe operation or shutdown of Fermi 3. Based on the review of the information, the staff considers the applicant's conclusion acceptable.

Liquid Spills near the Intake Structure

No liquid hazardous materials are stored at, delivered to or transported through the intake bay, and an accidental liquid spill in the intake bay is considered very unlikely. No shipping lanes pass within 5 mi of Fermi 3; therefore waterway traffic unrelated to the plant is not likely to cause a spill near the intake bay. The staff considers that the liquid spills would not affect the safe operation of Fermi 3.

2.2.3.5 *Post Combined License Activities*

The staff identified the following license condition for the safe storage of an onsite propane tank:

License Condition 2.2.3-1: The applicant shall use tanks with a maximum capacity of 1000 gallons for the on-site storage of propane. No more than 1000 gallons of propane will be stored in any single location, and no storage location will be located closer than the minimum safe distance of 854 meters (2800 ft) from any Fermi 3 safety-related structure and the MCR.

2.2.3.6 *Conclusion*

As set forth above, the applicant has identified potential accidents related to the presence of hazardous materials or activities in the site vicinity that could affect a nuclear power plant or plants of the specified type that might be constructed on the proposed site, has appropriately determined those that should be considered as design-basis events, and has demonstrated that the plant is adequately protected and can be operated with an acceptable degree of safety with regard to the design-basis accidents. The staff has reviewed the information provided in Fermi 3 FSAR and, for the reasons given above, concludes that the applicant has established that the construction and operation of a nuclear Unit 3 of the specified type on the proposed site location is acceptable to meet the requirements of 10 CFR 52.79(a)(1)(iv) and 10 CFR 52.79(a)(1)(vi) for compliance with respect to determining the acceptability of the site. This addresses EF3 COL Information Item 2.0.6-A. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR 50.34(a)(1), 10 CFR 52.79(a)(1)(iv), 10 CFR 52.79(a)(1)(vi), 10 CFR 100.20, and 10 CFR 100.21.

2.3 Meteorology and Air Quality

To ensure that a nuclear power plant or plants can be designed, constructed, and operated on an applicant's proposed site in compliance with the Commission's regulations, the NRC staff evaluates regional and local climatological information, including climate extremes and severe weather occurrences that may affect the design and siting of a nuclear plant. The staff also reviews the applicant's onsite meteorological monitoring program and information on the atmospheric dispersion characteristics of a nuclear power plant site to determine whether the radioactive effluents from postulated accidental releases, as well as routine operational releases, are within Commission guidelines.

The staff has prepared Subsections 2.3.1 through 2.3.5 of this SER in accordance with the review procedures described in NUREG-0800, using information presented in Sections 2.0 and 2.3 of the Fermi 3 COL FSAR, Revision 7, which references ESBWR DCD, Revision 10, responses to staff RAIs, and applicable sections of NUREG-0800.

2.3.1 General Regional Climate

2.3.1.1 Introduction

Subsection 2.3.1, "General Regional Climate," of the Fermi Unit 3 COLA addresses observed averages and measured and probabilistic extremes of climatic conditions and regional meteorological phenomena that could affect the safe design and siting of the plant, including information describing the general climate of the region, seasonal and annual frequencies of severe weather phenomena, and other meteorological conditions to be used for design- and operating-basis considerations.

2.3.1.2 Summary of Application

Section 2.3 of the Fermi 3 COL FSAR, Revision 7, addresses characteristics of the regional climate considered by the applicant to be reasonably representative of conditions that may be expected to occur at the Fermi Unit 3 site. In addition, in FSAR Section 2.3.1, the applicant provides the following:

COL Item

- EF3 COL 2.0-7-A Regional Climatology

  The meteorological data presented were published by the National Oceanic and Atmospheric Administration (NOAA), and included in industry standards and RGs.

2.3.1.3 Regulatory Basis

The relevant requirements of the Commission regulations for the regional climatology, and the acceptance criteria are given in Section 2.3.1 of NUREG-0800.

The acceptance criteria for identifying regional climatological characteristics are based on meeting the relevant requirements of 10 CFR Parts 52 and 100. The staff considered the following regulatory requirements in reviewing the applicant's discussion of the regional climatology:

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated.

- 10 CFR 100.20(c)(2) and 10 CFR 100.21(d), with respect to the consideration given to the regional meteorological characteristics of the site.

NUREG-0800, Section 2.3.1, specifies that an application meets the above requirements, if the application satisfies the following criteria:

- The description of the general climate of the region should be based on standard climatic summaries compiled by the National Oceanic and Atmospheric Administration (NOAA). Consideration of the relationships between regional synoptic-scale atmospheric processes and local (site) meteorological conditions should be based on appropriate meteorological data.

- Data on severe weather phenomena should be based on standard meteorological records from nearby representative National Weather Service (NWS), military, or other stations recognized as standard installations that have long periods of data on record. The applicability of these data to represent site conditions during the expected period of reactor operation should be substantiated.

- The tornado parameters should be based on RG 1.76; alternatively, an applicant may specify any tornado parameters that are appropriately justified, provided that a technical evaluation of site-specific data is conducted.

- The extreme (straight-line) 100-year return period 3-second gust wind speed site characteristics should be based on appropriate standards, with suitable corrections for local conditions.

- Ultimate Heat Sink (UHS) meteorological data, as stated in RG 1.27, “Ultimate Heat Sink for Nuclear Power Plants,” should be based on long-period regional records which represent site conditions.

- The 100-year ground-level snowpack or snowfall, whichever is greater, should be based on data recorded at nearby representative climatic stations or obtained from appropriate standards with suitable corrections for local conditions. The 48-hour probable maximum winter precipitation (PMWP) should be determined in accordance with reports published by NOAA’s Hydrometeorological Design Studies Center.

- Ambient temperature and humidity statistics should be derived from data recorded at nearby representative climatic stations or obtained from appropriate standards with suitable corrections for local conditions.

- High air pollution potential information should be based on U.S. Environmental Protection Agency (EPA) studies.

- All other meteorological and air quality conditions identified by the applicant as design and operating bases should be documented and substantiated.

Generally, the information should be presented and substantiated in accordance with acceptable practice and data as promulgated by the NOAA, industry standards, and RGs.

Subsequent to the publication of SRP Section 2.3.1, the staff issued interim staff guidance document DC/COL-ISG-7, “Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures,” (74 FR 31470) (ADAMS Accession No. ML091490565) to clarify the staff’s position on identifying winter precipitation events as site characteristics and site parameters for determining normal and extreme winter precipitation loads on the roofs of seismic Category I structures.

To the extent that the data are applicable to the acceptance criteria outlined above, the applicant has applied the following NRC-endorsed meteorological information selection methodologies and techniques:

- RG 1.23, “Meteorological Monitoring Programs for Nuclear Power Plants,” which provides criteria for an acceptable onsite meteorological measurements program, which can be used to monitor regional meteorology site characteristics.

- RG 1.76, which provides criteria for selecting the design-basis tornado parameters.

- RG 1.206, “Combined License Applications for Nuclear Power Plants,” which describes the type of regional meteorological data that should be presented in FSAR Section 2.3.1.

- RG 1.221, “Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants,” which provides criteria for selecting the design basis hurricane parameters.

When independently assessing the acceptability of the information presented by the applicant in FSAR Chapter 2.3.1, the NRC staff applied the same methodologies and techniques cited above.

2.3.1.4 Technical Evaluation

The NRC staff reviewed the application and the applicant's responses to RAIs to verify the accuracy, completeness, and sufficiency of the information regarding regional climate. The staff followed the procedures in Section 2.3.1 of NUREG–0800 as part of this review.

The staff reviewed the information in the Fermi 3 COL FSAR as follows:

<u>*COL Item*</u>

- EF3 COL 2.0-7-A Regional Climatology

  This COL information item requires that the COL applicant supply site-specific information in accordance with SRP Section 2.3.1; that is, the COL applicant should describe averages and extremes of climatic conditions and regional meteorological phenomena that could affect the safe design and siting of the plant.

In response to this COL information item, the applicant describes (1) data sources used to characterize the regional climatological conditions pertinent to the proposed site, (2) the general climate of the region with respect to types of air masses, synoptic features (high- and low-pressure systems), general airflow patterns (wind direction and speed), temperature and atmospheric moisture, and precipitation (rain, snow, and ice), (3) the frequencies of severe weather phenomena that have affected the proposed site, including thunderstorms and lightning, extreme wind, tornadoes and waterspouts, hail, drought, dust (sand) storms, freezing rain, and winter precipitation (snow and ice), (4) design-basis dry- and wet-bulb temperatures for the proposed site, and (5) regional air quality and the potentiality for restrictive air dispersion conditions and high air pollution at the proposed site.

The NRC staff reviewed the applicant's resolution to EF3 COL 2.0-7-A related to averages and extremes of climatic conditions and regional meteorological phenomena that could affect the safe design and siting of the plant and finds the information to be acceptable and to meet the regulatory requirements.

General Climate

In Subsection 2.3.1.1 of the FSAR, the applicant characterizes the regional climatology of the proposed Fermi Unit 3 site using data from the National Climatic Data Center (NCDC), including the first-order NWS stations at Detroit Metropolitan Airport; Toledo, Ohio; and Flint, Michigan, as well as four NWS Cooperative Observation Program (COOP) stations located within 80 km (50 mi) of the Fermi site (Monroe, Michigan; Windsor, Ontario; Ann Arbor, Michigan; and Adrian, Michigan). The regional climatic observation stations used by the applicant are included in the list presented in FSAR Table 2.3-201.

The applicant addresses relevant information related to regional climatology. The applicant states that the meteorological data obtained for the climatology were collected and processed by the NOAA Midwestern Regional Climate Center and the NCDC. The applicant states that the meteorological stations it chose have long-term data (30 years or greater) that are representative of the short- and long-term climate characteristics of the region surrounding the Fermi site.

The applicant describes the general climate of the Fermi site and the surrounding region as humid continental, characterized by warm and humid summers and severe winters. Lake Erie adjacent to the Fermi site has a large influence on temperature, wind, and precipitation patterns at the site and surrounding region. The thermal capacity of the lake moderates the daily temperature extremes from those found farther inland. Lake and land breezes are common during the late spring through late fall. During late December, ice typically forms on the lake, decreasing the lake's influence on the climate in the coastal areas; the ice cover usually thaws by the middle of March, prolonging cooler temperatures into early spring. Annually, the region experiences approximately six days below –17.8 degrees C (0 degrees F) and twelve days above 32.2 degrees C (90 degrees F).

The applicant states that monthly values of precipitation vary slightly throughout the year in the region surrounding the Fermi site. The meteorological conditions in the Fermi region are also affected by the mean storm track, which brings a high frequency of storm systems and cloudiness to the region. During the late spring and summer, the storm track migrates north of the region, and the Fermi region experiences increased sunshine and warmer temperatures. Monthly rainfall is highest in summer due to frequent thunderstorms that occur about six days per month, higher than other months throughout the year. During the winter, the storm track is situated near the Fermi region, and storm systems come from the southwest, west, and northwest, which could bring wintery precipitation, including rain, freezing rain, sleet, and snow, into the region. Heavy snowfalls are possible throughout the winter and can cause significant accumulations.

The staff verified that the applicant's description of the general climate of the region in FSAR Subsection 2.3.1.1 is consistent with the NCDC narrative, "2006 Local Climatological Data, Annual Summary with Comparative Data for Detroit, Michigan (KDTW)."

Normal, Mean, and Extreme Climatological Conditions

In Subsection 2.3.1.2 of the FSAR, the applicant states that the monthly prevailing winds at the nearest first-order NWS station, Detroit Metropolitan Airport, are generally from the southwest, except during spring when the prevailing wind is from the northwest. Annual prevailing wind directions at two other first-order NWS stations (Toledo, Ohio, and Flint, Michigan) are also from the southwest, but there are differences in monthly prevailing winds among the three stations in late winter and spring months which can be attributable to the relative position of the storm track and general weakening of the jet stream. The annual mean wind speed at the Detroit Metropolitan Airport is 15.9 km/hr (9.9 mph), with the highest speeds occurring during the winter and spring months and the lowest during summer months. Wind speed patterns at two other first-order NWS stations are almost the same, but wind speeds are generally lower than those at Detroit because of the relative position of the storm track near the Fermi region.

The applicant states that stations that are closer to Lake Erie, such as Monroe, Michigan and Windsor, Ontario, have slightly higher daily minimum and lower daily maximum temperatures than other stations located farther inland due to the heat content of the Lake. One exception is that daily minimum temperature at Detroit Metropolitan Airport is slightly higher than Monroe or Windsor due to the heat island effect caused by the Detroit metropolitan area.

During the summer months of June through August, the daily mean maximum and minimum temperatures average 27.2 degrees C (81 degrees F) and 15.5 degrees C (60 degrees F), respectively. The highest daily maximum temperature recorded at Detroit Metropolitan Airport was 40 degrees C (104 degrees F) in June 1988; a higher temperature, 40.5 degrees C

(105 degrees F), was recorded in July 1934 at nearby Detroit City Airport. The highest temperature around the Fermi site was 42.2 degrees C (108 degrees F), recorded at the Adrian 2 NNE COOP station in July 1934.

Mean daily maximum and minimum temperatures at the Detroit Metropolitan Airport during the winter months of December through February are 1.1 degrees C (34 degrees F) and –6.7 degrees C (20 degrees F), respectively. The lowest daily minimum temperature recorded at Detroit Metropolitan Airport was –29.4 degrees C (–21 degrees F) in January 1984. The lowest temperature recorded around the Fermi site was –32.2 degrees C (–26 degrees F) at the Adrian 2 NNE COOP station in January 1892. During the winter, arctic air masses pass over Lake Michigan, which provides heat and moisture to the air masses. The region experiences increasing cloudiness and moderation of extreme arctic temperatures due to the lake effect caused by the Great Lakes.

The applicant states that mean annual relative humidity values at the three first-order NWS stations range from about 71 to 73 percent, with the highest relative humidity occurring around early morning (7 a.m.) and the lowest relative humidity occurring around early and mid-afternoon. The highest nighttime relative humidity occurs during late summer and early fall, while the highest daytime relative humidity occurs during late fall and winter.

The applicant states that the mean annual wet-bulb temperature at Detroit Metropolitan Airport is 7.2 degrees C (45.0 degrees F), with the highest monthly average of 18.8 degrees C (65.9 degrees F) in July and the lowest monthly average of –4.6 degrees C (23.7 degrees F) in January. Because they are closer to Lake Erie, Detroit and Toledo have somewhat higher mean annual wet-bulb temperatures than Flint.

The applicant states that the mean annual dew-point temperature at Detroit Metropolitan Airport is 4.6 degrees C (40.3 degrees F), with the highest dew-point temperatures in July and the lowest dew-point temperatures in January when the mean monthly temperature is the lowest. Dew point temperatures at Detroit Metropolitan Airport are higher than those at Flint but lower than those at Toledo, Ohio. It appears that atmospheric moisture content could be directly correlated to the latitude of the station and, to lesser extent, its distance to Lake Erie.

The applicant states that annual precipitation, which ranges from 80.3 cm (31.6 in.) in Flint, Michigan, to 91.9 cm (36.2 in.) in Winsor, Ontario, is uniformly distributed across the region and fairly consistent throughout the year. Annual precipitation at the Detroit Metropolitan Airport averaged about 83.5 cm (32.89 in.), with the highest monthly average of 9.0 cm (3.55 in.) occurring in June and the lowest monthly average of 4.8 cm (1.88 in.) occurring in February. The highest 24-hour and monthly precipitation values occurred at the Flint station, with a maximum 24-hour precipitation of 15.3 cm (6.04 in.) in September 1950, and a maximum monthly precipitation of 28.0 cm (11.04 in.) in August 1975. Although the frequency of weather systems decreases in summer, the highest precipitation is recorded during the summer months due to the intensity of precipitation associated with thunderstorms. The annual snowfall amount at the Detroit Metropolitan Airport is about 111.8 cm (44.0 in.), falling mostly during winter months. The highest snowfall amount in a 24-hour period was 62.2 cm (24.5 in.) near what is now the Detroit City Airport in April 1886, while the highest monthly snowfall 148.6 cm (58.5 in.) at the Ann Arbor COOP station in February 1923.

The staff compared the applicant's statements about the normal, mean, and extreme climatological conditions in the region surrounding the Fermi site in FSAR Section 2.3.1.2, and verified those statements, based on the NCDC narrative, "2006 Local Climatological Data, Annual Summary with Comparative Data," for three first-order meteorological stations (Detroit and Flint, Michigan, and Toledo, Ohio), "Climatology of the United States No. 20 1971-2000" and "DS 3200-Surface Summary of the Day for Monroe, Ann Arbor (University of Michigan), and Adrian (2 NNE)-1880-2007," and Environment Canada publication "Canadian Climate Normals 1971-2000" for a COOP station in Windsor, Ontario.

The NRC staff issued RAI 02.03.01-1 requesting the applicant to be more specific when using the term "storm" because "storm" could be interpreted as a thunderstorm, tropical depression, tropical storm, or hurricane. The applicant's response to RAI 02.03.01-1, dated February 8, 2010 (ADAMS Accession No. ML093570220), states that "storm" will be replaced with "surface low pressure systems." The applicant has incorporated this into the Fermi 3 FSAR, Revision 2, and thus RAI 02.03.01-1 is considered resolved.

Regional Meteorological Conditions for Design and Operating Bases

a. Severe Weather Phenomena

i. Thunderstorms and Lightning

Subsection 2.3.1.3.1.1 of the FSAR provides a discussion of severe weather phenomena, thunderstorms and lighting.

The following discussion on thunderstorms and lightning is intended to provide a general climatic understanding of the severe weather phenomena in the site region. However, the discussion does not generate site characteristics for use as design or operating bases.

The applicant states that, on average, thunderstorms occur 33 days of the year at the Detroit Metropolitan Airport. About 54 percent of these thunderstorm days occur between June and August, reaching a maximum of 6.3 days in July. Thunderstorm days are least frequent during the late fall and winter, reaching a minimum of 0.2 days in January. The applicant calculated the average number of lightning strikes as 10 per square mile per year or nearly four strikes per square kilometer per year for the Fermi region. Further, the applicant estimates that 1.13 lightning strikes per year occur near the planned location of the Fermi Unit 3 reactor (within 305 m [1000 ft]).

The staff confirmed that the statistics provided by the applicant for thunderstorms are correct based on the NCDC narrative, "2006 Local Climatological Data, Annual Summary with Comparative Data for Detroit, Michigan (KDTW)." The staff finds the applicant's estimate of the frequency of lightning strikes acceptable because "Vaisala's National Lightning Detection Network (NLDN) Cloud-to-Ground Lightning Incidence in the Continental U.S. (1997-2007)" (http://www.lightningsafety.noaa.gov/stats/08_Vaisala_NLDN_Poster.pdf, accessed July 8, 2010) shows that the annual average flash density around the Fermi site is 3 to 4 flashes per square kilometer.

ii. Extreme Winds and High Wind Events

FSAR Subsection 2.3.1.3.1.2 states that the Fermi 3 site characteristic value for the 3-second gust 50-year return period wind speed is 144.8 km/hr (90 mph). The applicant derived this site characteristic value from engineering weather data statistics published by NCDC for the Detroit City Airport. The applicant applied a multiplier of 1.07 to convert the 50-year return period wind speed value to its 100-year return period wind speed site characteristic value of 155 km/hr (96.3 mph). The applicant obtained the 1.07 conversion factor from the American Society of Civil Engineers (ASCE) Standard ASCE/SEI 7-05.

The staff reviewed the basic wind speed map in ASCE/SEI 7-05 (which is a plot of 50-year return period 3-second gust wind speeds) for the portion of the United States that includes the Fermi Unit 3 site and obtained the same 144.8 km/hr (90 mph) 3-second gust wind speed value. Because the applicant's extreme wind site characteristic values are consistent with ASCE/SEI 7-05, the staff finds the applicant's extreme wind site characteristic values to be acceptable.

The applicant states in Revision 1 of FSAR Subsection 2.3.1.3.1.2 that 770 high wind events (50 knots [92.6 km/hr or 57.5 mph] or greater) were reported in the 5-county area surrounding the Fermi Unit 3 site (Lenawee, Monroe, Washtenaw, and Wayne counties in Michigan; Lucas county in Ohio) between January 1, 1955, and December 31, 2007, based on the NCDC online storm database. The highest wind speed was 83 knots (153.7 km/hr or 95.5 mph) in Monroe County on May 21, 2004. The highest wind speeds for the surrounding counties were 90 knots (166.7 km/hr or 103.6 mph), occurring in Wayne and Lucas Counties on July 22, 1960, and July 4, 1969, respectively. For comparison, a maximum 2-minute wind speed of 98.2 km/hr (61 mph) and a corresponding 125.5 km/hr (78 mph) 5-second wind gust were recorded at the Detroit Metropolitan Airport in May of 2004.

The applicant states that local and regional records of maximum wind speeds occurring from thunderstorms and other high wind events present values higher than the 100-year site characteristic extreme wind speed of 155.0 km/hr (96.3 mph) for seismic Category I, II, and radwaste building (RWB) structures. However, these reported maximum wind speed values are below the ESBWR seismic Category I and II structures extreme wind site parameter value of 242 km/hr (150 mph) for a 3-second gust wind speed, and therefore do not represent a threat to these structures.

The NRC staff issued RAI 02.03.01-2 requesting that the applicant (1) revise its incorrect counting of the number of high wind events and (2) address the possibility of underestimating high wind events, considering that the first year reported in the NCDC online storm database is later than 1955.

The staff counted 816 high wind (50 knots [92.6 km/hr or 57.5 mph] or greater) event reports for the 5-county area in the NCDC online storm database, not 770 as reported in Revision 1 to FSAR Section 2.3.1.3.1.2. The number of high wind events may be under-reported in the FSAR or it may be that only 770 unique high wind events occurred, as some of the events counted by the staff may have occurred concurrently in several of the five counties. In response to RAI 02.03.01-2, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant found a counting error and revised the number of high wind events to 816 in Revision 2 of the Fermi 3 COL FSAR.

The FSAR states that the NCDC online storm database does not cover the entire 1955–2007 period, but in Revision 1 to Section 2.3.1.3.1.2, "Extreme Winds and High Wind Events," the FSAR does not estimate the increase in the number of high wind events that would result from a complete record. The number of high wind events is probably underestimated by virtue of the reporting periods of some of the stations used having begun much later than 1955. Therefore, the number of reported high wind events during the 53-year period considered may be underestimated. In response to RAI 02.03.01-2, the applicant analyzed the storm database on a decade-by-decade basis and concluded that annual-average high wind events in five counties do not show a significant deviation over the first four decades, as compared with the two most recent decades. Lower high wind events reported during the first four decades might be attributable to the sparseness and precision of instrumentation. The applicant has incorporated the results of its analysis into Revision 2 of the FSAR, and thus RAI 02.03.01-2 is considered resolved.

Revision 1 of FSAR Table 2.0-201, Sheet 1 of 28, stated under the evaluation for extreme wind exposure category that "the Fermi 3 site characteristic is Exposure Category C as this value cannot be exceeded." The NRC staff requested that the applicant explain this statement in RAI 02.03.01-3. In its response to RAI 02.03.01-3, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant identified the Fermi region as being classified as Exposure Category C in accordance with ASCE/SEI 7-05 and agreed that the statement "as the value cannot be exceeded" is incorrect. The applicant removed this statement from Revision 2 of the FSAR. Thus, RAI 02.03.01-3 is considered resolved.

Because the applicant's extreme wind site characteristic values are consistent with ASCE/SEI 7-05, the staff finds the applicant's extreme wind site characteristic values to be acceptable.

iii. Tornadoes and Waterspouts

Subsection 2.3.1.3.1.3 of the FSAR discusses tornadoes and waterspouts. The applicant's report of the number of waterspouts and tornadoes in Revision 1 of FSAR Subsections 2.3.1.3.1.2 and 2.3.1.3.1.3 was based on the NCDC online storm database. Revision 1 to the FSAR stated that eight waterspouts were reported to have occurred off the shoreline of Lucas and Monroe Counties between 1993 and 2007, while 92 tornadoes were reported to have occurred in the 5-county area during the 53-year period January 1, 1955, through December 31, 2007. However, the staff counted 110 tornado reports in the NCDC online storm database for the same 53 year period. The NCDC online database indicated that several tornadoes and a waterspout have occurred in the vicinity of the Fermi site.

The staff issued RAI 02.03.01-4 to clarify the following two issues. First, some of the tornadoes counted by the staff may have spanned multiple counties, so the number of unique tornadoes in the 5-county area may have been 92, as reported by the applicant. If so, the FSAR should state that there were 92 unique tornadoes and that some of the 110 tornadoes counted by the staff spanned multiple counties. However, if the 110 tornadoes counted by the staff are unique, the statistics on tornadoes per year and strike probabilities presented in the FSAR should be revised. Second, the first year of tornado reports for each of the five counties began later than 1955. The applicant should therefore assess whether the number of tornado events that occurred during the 53-year reporting period (January 1, 1955, through December 31, 2007) could be underestimated.

In response to RAI 02.03.01-4, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant stated it combined tornado occurrences if the tornado reports indicated that the tornado tracked in a traceable direction between different counties or within the same county during a narrow time period and occurred within 45 minutes of one another. Therefore, the applicant concluded that the 92 tornadoes reported in Revision 1 to FSAR Section 2.3.1.3.1.2 is a valid count of tornadoes within the 5-county area between January 1, 1950, and December 31, 2007. The applicant also stated it analyzed the storm data on a decade-by-decade basis and concluded that the annual-average high wind events in five counties do not show a significant deviation over the first four decades. The staff reviewed the response to RAI 02.03.01-4 and determined that the question is closed but that two issues remained unresolved. To address these issues, the staff issued follow-up question RAI 02.03.01-15.

The staff issued RAI 02.03.01-15 to clarify the following two issues. First, contrary to the information provided in response to RAI 02.03.01-4, in which the applicant stated 92 tornadoes are a valid count in the 5-county area between January 1, 1950, and December 31, 2007, Revision 2 to FSAR Section 2.3.1.3.1.2 states that 92 tornadoes were reported between January 1, 1955, and December 31, 2007. The staff requested the applicant to clarify this apparent discrepancy in the reporting period and revise the FSAR accordingly. Second, two tornadoes occurring in different counties at almost the same time cannot necessarily be counted as one tornado. The staff requested the applicant provide a list of the tornadoes occurring within the 5-county area indicating which tornado reports were considered unique and which tornado reports were combined.

In response to RAI 02.03.01-15, dated September 2, 2010 (ADAMS Accession No. ML102570700), the applicant stated that the tornado reporting period begins in January 1, 1950, and revised the reporting period accordingly in Revision 4 of the FSAR. The applicant also performed an updated tornado evaluation for the 5-county area and the 2-degree latitude/longitude box around the Fermi 3 site, where the applicant combined tornadoes with matching coordinates or tornadoes within 8 km (5 mi) of one another over a time period of 30 minutes or less. The applicant concluded that 110 tornadoes out of 117 reported tornado occurrences in the 5-county area for the period between January 1, 1950, and December 31, 2007 were unique. The applicant's updated analysis resulted in an increase in the overall number of separate tornadoes, tornado area, and strike probability. The applicant revised Revision 4 of the FSAR accordingly. The staff reviewed the applicant's response and finds the revised tornado analysis to be reasonable. Therefore, RAI 02.03.01-15 is considered to be resolved.

The staff conducted an independent analysis to determine whether any tornadoes are unique, based on begin/end times, direction of tornado path, length/width, and relative locations (plotted on the map). Although some tornadoes are uncertain as to a determination of uniqueness, the staff arrived at a conclusion that was similar to the applicant's analysis.

Around 2:33 a.m. on June 6, 2010, a tornado hit the Fermi site and Unit 2 sustained damage due to this severe storm. The tornado touched down in Detroit Beach, Michigan, traveled about 10.5 km (6.5 mi) northeast, and entered Lake Erie at Estral Beach six minutes later. Based on the extent of damage, NOAA classified the tornado as an EF1 on the enhanced Fujita scale (i.e., 3-second gusts between 38.4 m/s [86 mph] and 49.2 m/s [110 mph]). Fermi Unit 2, which was along the tornado's path, automatically shut down when offsite power was lost. Although the reactor building (RB) was undamaged, the storm tore a 6-m (20-ft) by 9-m (30-ft) hole in the roof of the building housing the steam turbines, blew off siding from the auxiliary building, and damaged the cooling fins at the twin NDCTs. The Fermi Unit 2 reactor was safely shut down and kept in standby for more than a week as repairs to associated facilities were made.

The applicant calculated the probability of a tornado striking a point structure on the Fermi site by evaluating the frequency of occurrence of tornadoes in the counties that are either fully or partially inside a 2-degree latitude by 2-degree longitude box centered on the Fermi site. The applicant determined a strike probability of 3.87×10^{-4} per year or a recurrence interval of once every 2584 years. The staff performed a similar, independent analysis and derived a tornado strike probability of 4.94×10^{-4} per year or a recurrence interval of 2032 years. The difference between the applicant's and staff's tornado strike probabilities and recurrence intervals may be due, in part, to the fact that the staff identified a slightly different set of counties that were within the 2-degree box.

NUREG/CR–4461 Revision 2, "Tornado Climatology of the Contiguous United States," provides the basis for the design-basis tornado wind speed in Revision 1 to RG 1.76. Appendix A to NUREG/CR-4461 contains estimates of strike probabilities by 2-degree latitude and longitude boxes. The Fermi site is located about N 42.0 degree latitude and W 83.3 degree longitude, near the center of the 2-degree box bounded by 41-degree and 43-degree North latitude and 82-degree and 84-degree West longitude. The expected strike probability per year in this 2-degree box for a structure with a characteristic dimension of 61 m (200 ft) is 5.37×10^{-4}, which corresponds to a mean recurrence interval of approximately once every 1860 years. The staff accepts the applicant's tornado strike probability as it is reasonably close to the staff's estimates.

The applicant chose the tornado site characteristics based on Revision 1 to RG 1.76. RG 1.76 provides design-basis tornado characteristics for three tornado intensity regions throughout the United States, each with a 10^{-7} per year probability of occurrence. The proposed Fermi Unit 3 site is located in tornado-intensity Region I where the most severe tornadoes frequently occur and corresponds to the most severe design-basis tornado characteristics. The applicant has chosen to use the design-basis tornado characteristics from Region I and, correspondingly, proposes the following tornado site characteristics:

- A maximum wind speed of 230 mi/h (103 m/s)
- A translational speed of 46 mi/h (21 m/s)
- A maximum rotational speed of 184 mi/h (82 m/s)
- The radius of a maximum rotational speed of 150 ft (45.7 m)
- A pressure drop of 1.2 pounds per square inch (psi) (83 mb)
- A rate of pressure drop of 0.5 psi per second (37 mb/s)

Because the applicant's design-basis tornado site characteristics are based on RG 1.76, the staff concludes that the applicant has chosen acceptable tornado site characteristics.

Revision 1 of RG 1.76 reduced the design-basis tornado criteria as compared to previous guidance documents. Therefore, it was no longer clear that the design-basis tornado winds and missiles in Revision 1 of RG 1.76 would bound design-basis hurricane wind and missiles in all areas of the United States. As a result, the NRC issued RG 1.221 in October 2011. RG 1.221 provides the design-basis hurricane wind speeds that correspond to an exceedance frequency of 10^{-7} per year, which is similar to the exceedance frequency for the design-basis tornado wind speeds. The staff issued RAI 02.03.01-20 asking the applicant to include new site characteristics in the FSAR called "hurricane wind speed" and "hurricane missile spectra" or provide a justification as to why the FSAR should not be updated to include these new site characteristics.

In response to RAI 02.03.01-20, dated April 3, 2012 (ADAMS Accession No. ML12095A283), the applicant stated that the Fermi 3 site is located well inland from the hurricane wind speed profiles shown in RG 1.221. Therefore, the applicant concluded that the current Fermi 3 tornado site characteristic values remain valid and are inclusive of all winds associated with an annual exceedance frequency of 10^{-7}. The staff found that the applicant's assessment is acceptable because the Fermi 3 site is located well inland from areas impacted by hurricanes. The staff has confirmed that the applicant incorporated this information into the Fermi 3 FSAR.

iv. Hail

Subsection 2.3.2.3.1.4 of the FSAR provides a discussion on hail and is intended to provide a general climatic understanding of the severe weather phenomena in the site region. However, the discussion does not generate site characteristics for use as design or operating bases.

The online NWS Glossary defines hail as showery precipitation in the form of irregular pellets or balls of ice more than 5 millimeters (mm) in diameter, falling from a cumulonimbus or thunderstorm cloud. Hail generally occurs during the spring and can be a major weather hazard, causing significant damage to crops and property.

The applicant used the NCDC online storm database to find that in the 5-county area surrounding the Fermi site 571 severe hail events were reported over the 53-year period of January 1, 1955, through December 31, 2007, producing an average of 10.8 occurrences of severe hail per year. Eighty-seven of these hail events involved large hail (defined as diameter equal to or greater than 4.4 cm [1.75 in.]). The largest hail diameter reported was 10.2 cm (4.00 in.) in Wayne County on November 13, 1955, and in Monroe County on March 27, 1991. During the 53-year period, there were no reports of hail during the winter months of December and January.

In Revision 1 of FSAR Subsection 2.3.1.3.1.4, “Hail,” the staff finds the reporting of hail events to be generally consistent with the NCDC online storm database, although the staff counted 576 hail events using the same online database. Some of the hail events probably spanned multiple counties, so the number of hail events may actually have been fewer. However, hail reports may have begun later than 1955 in four of the counties. Therefore, the number of hail events during the period considered may be underestimated. If the number of hail events reported in the NCDC online storm database reflect unique events, hail events per year for the 5-county area is likely greater than stated by the FSAR, although the number of events per year in Monroe County itself is very small. If the hail events in the NCDC online storm database are not unique, but span multiple counties, this should be stated by the FSAR as a justification for the smaller number of hail event reports. Consequently, the staff issued RAI 02.03.01-5 asking the applicant to clarify its reporting of hail events.

In response to RAI 02.03.01-5, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant stated it recounted the same number of hail events. In addition, the applicant demonstrated that, in comparison with hail events reporting during the 1960–1969 and 1970–1979 periods, the limited number of hail events reported between 1955 and 1959 is representative of the 1955–1959 period. The staff finds the applicant’s analysis acceptable, and thus RAI 02.03.01-5 is considered resolved.

v. Drought

Subsection 2.3.1.3.1.5 of the FSAR is a discussion on drought that is intended to provide a general climatic understanding of the severe weather phenomena in the site region. However, the discussion does not generate site characteristics for use as design or operating bases.

The applicant states that periodic extreme drought can occur from time to time in the vicinity of the Fermi site. Based on hourly precipitation data at the Detroit Metropolitan Airport during

1961–2007, the longest period with no measurable precipitation occurred for 644 hours (26.8 days) from June 17 through July 13, 1963. According to an analysis performed by the NCDC, 10 extreme droughts (Palmer Drought Index ≤ –4) have occurred in Michigan between 1900 and February 2008.

The staff examined the same databases (Solar and Meteorological Surface Observational Network (SAMSON) data for 1961–1990, Hourly U.S. Weather Observations (HUSWO) data for 1991–1995, and Integrated Surface Hourly Data (ISHD) for 1996–2007) and has verified the longest drought stretch in the summer of 1963 and the number of drought periods reported by the applicant in FSAR Subsection 2.3.1.3.1.5.

b. Probable Maximum Annual Frequency of Occurrence and Duration of Dust (Sand) Storms

Subsection 2.3.1.3.2 of the FSAR is a discussion on dust and sand storms that is intended to provide a general climatic understanding of the severe weather phenomena in the site region. However, the discussion does not generate site characteristics for use as design or operating bases.

The applicant states that prolonged dry periods are infrequent and the occurrence of dust, blowing dust, blowing sand, and dust storms are rare in the vicinity of the Fermi site. Dust storms are most likely when dry conditions and high winds occur in the southern plains States and/or the upper Midwest, with synoptic systems carrying the dust northeastward. FSAR Table 2.3-207 presents the annual number of hours that dust was reported for each year during the period 1961–1995 at the Detroit Metropolitan Airport using the SAMSON and HUSWO databases. Dust was reported for very few years, and the majority of dust events lasted four hours or less, with a maximum of seven hours. The applicant determined the probable maximum annual frequency of occurrence as 0.09 percent of hours annually (8 hours), corresponding with the year that contained the highest number of hours of reported dust. The applicant also determined the probable maximum duration of dust events as seven hours, based on the longest duration during the same period.

The staff has verified the applicant’s statements in FSAR Subsection 2.3.1.3.2 concerning dust (sand) storm occurrence in the region surrounding the Fermi site using the same database and found one dust event in July 4, 1974, that was missing. RAI 02.03.01-6 was issued asking the applicant to confirm the missing 1974 dust event. In its response (ML093570220, dated February 8, 2010) to RAI 02.03.01-6, the applicant again reviewed the database and found the one missing event and revised the text in Revision 2 of the FSAR accordingly. Thus RAI 02.03.01-6 is considered resolved.

c. Probable Maximum Annual Frequency of Occurrence, Duration, and Historical Amounts of Freezing Rain

Subsection 2.3.1.3.3 of the FSAR is a discussion on freezing rain that is intended to provide a general climatic understanding of the severe weather phenomena in the site region. However, the discussion does not generate site characteristics for use as design or operating bases.

The applicant reported that freezing rain and ice pellet events have occurred from November through April, but mostly from December through March for the Fermi region for the 1976–1990 period. In addition, freezing rain occurred about four to five days per year around the Fermi site, while ice pellets occurred about four days per year. A total of 24 ice events were reported in the

5-county area surrounding the Fermi site during the period 1993–2007. The frequency of freezing rain events during this 15-year period was calculated at 1.6 events per year by the applicant. The applicant stated that a severe winter storm lasting nearly 24 hours during January 1967 produced ice accumulations of up to 7.6 cm (3 in) across northwest Ohio and parts of southern Michigan. The staff has verified these values using the NCDC storm database and storm data reports.

In Revision 1 to FSAR Subsection 2.3.1.3.3, “Probable Maximum Annual Frequency of Occurrence and Duration of Freezing Rain,” the applicant uses the terms “freezing rain” and “ice pellets” interchangeably to refer to ice events. However, these two phenomena are different. Freezing rain is rain that falls in liquid form and freezing upon impact to form a coating of glaze upon the ground and exposed objects, whereas ice pellets are a type of precipitation consisting of pellets of ice. It is sometimes confusing within the FSAR as to whether the two types of ice events are being spoken of separately, as a group, or interchangeably. The NCDC ice storm reports include freezing rain only. The FSAR also refers to a “sub-freezing air mass near the surface,” which more accurately should be called a “sub-freezing air layer.” The staff issued RAI 02.03.01-7 requesting that the applicant clarify these issues.

In response to RAI 02.03.01-7, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant revised the text in FSAR Revision 2 as suggested by the staff to indicate that ice events mean freezing rain events. Thus RAI 02.03.01-7 is considered resolved.

d. Roof Loads of Winter Precipitation Events on Fermi Structures

Subsection 2.3.1.3.4 of the FSAR is a discussion on roof loads of winter precipitation events.

DC/COL-ISG-7, “Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures,” (ADAMS Accession No. ML091490565) states that normal and extreme winter precipitation events should be identified in SRP Section 2.3.1 as a COL site characteristic for use in SRP Section 3.8.4 to determine the normal and extreme winter precipitation loads on the roofs of seismic Category I structures.

ISG-7 states that the normal winter precipitation roof load should be a function of the normal winter precipitation event. The extreme winter precipitation roof loads should be based on the weight of the antecedent snowpack resulting from the normal winter precipitation event plus the larger resultant weight from either (1) the extreme frozen winter precipitation event or (2) the extreme liquid winter precipitation event. The extreme frozen winter precipitation event is assumed to accumulate on the roof on top of the antecedent normal winter precipitation event, whereas the extreme liquid winter precipitation event may or may not accumulate on the roof, depending on the geometry of the roof and the type of drainage provided.

Appropriate methodologies for determining the normal and extreme winter precipitation events are discussed in ISG-7. For example, ISG-7 states that the extreme liquid winter precipitation event should be determined in accordance with the Hydrometeorological Reports (HMRs) published by NOAA’s Hydrometeorological Design Studies Center.

The staff issued RAI 02.03.01-9 requesting the applicant evaluate the winter precipitation roof loadings in FSAR Revision 1, Section 2.3.1.3.4 using the criteria presented in ISG-7 or justify an alternative methodology. The staff also stated in the RAI that FSAR Revision 1, Subsection 2.3.1.3.4, assumes that scuppers and drains on the roof of the ESBWER are designed to limit water accumulation to no more than 10.2 cm (4 in.) of water. This assumption conflicts with the ESBWR DCD, Tier 2, Table 3G.1-2 which assumes water accumulation on the roof could reach 0.61 meter (2.0 feet), which is the height of the parapets, during the extreme winter precipitation event when the roof scuppers and drains are assumed to be clogged.

The applicant's response to RAI 02.03.01-9, dated February 8, 2010 (ADAMS Accession No. ML093570220), presented an evaluation of the winter precipitation roof loads based on ISG-7. The staff reviewed the response to RAI 02.03.01-9 and has determined that, for the reasons cited below, the question is closed but there were two issues that remained unresolved. To address these issues, the staff issued follow-up questions RAI 02.03.01-16 and RAI 02.03.01-18.

i. Maximum Ground-Level Weight of the Normal Winter Precipitation Event

Guidance from ISG-7 defines the normal winter precipitation event as the highest ground-level weight (lb_f/ft^2) among (1) the 100-year return period snowpack, (2) the historical maximum snowpack, (3) the 100-year return period two-day snowfall event, or (4) the historical maximum two-day snowfall event in the site region. In its evaluation of the ground-level weight of the normal winter precipitation event, the applicant developed the following:

- Weight of the 100-year return period snowpack: 1403 Pa (29.3 lb_f/ft^2)

  The applicant stated in its response ADAMS Accession No. (ML093570220) to RAI 02.03.01-9 that ASCE/SEI 7-05 identifies the Fermi Unit 3 site as being located in a ground snow load zone of 1149 Pa (24 lb_f/ft^2) based on a 50-year return period and used a conversion factor of 1.22 (derived from Table C7-3 of ASCE/SEI 7-05) to convert to a 100-year return period ground snow load of 1403 Pa (29.3 lb_f/ft^2). The staff reviewed the ground snow load map (Figure 7-1) in ASCE/SEI 7-05 and concludes that the applicant appropriately assigned the Fermi Unit 3 site as being located in a 100-year return period ground snow load zone of 1403 Pa (29.3 lb_f/ft). The applicant included this information in Revision 2 to FSAR Section 2.3.1.3.4.

- Weight of the historical maximum snowpack: 1551 Pa (32.4 lb_f/ft^2)

  The applicant stated in its response to RAI 02.03.01-9 that the maximum snow depth measurement obtained for stations surrounding the Fermi site was 60.96 cm (24 in.) occurring at the Detroit Metropolitan Airport in January 1999. The applicant used Equation 1 from ISG-7 to convert this maximum snow depth to a maximum snowpack event weight of 1005 Pa (21 lb_f/ft^2).

  The staff issued RAI 02.03.01-16 asking the applicant to reevaluate the historical maximum snowpack event, as the staff found a higher snowpack record than that used by the applicant. The staff found an extreme daily snow cover value of 83.82 cm (33.0 in.) for the Willis 5 SSW COOP station (located approximately 32 km [20 mi] northwest of the Fermi 3 site in Washtenaw County) using the NCDC Snow Climatology database. Using Equation 1 from ISG-7, the staff converted the 83.82 cm (33.0-in.) snow cover to a snowpack weight of 1551 Pa (32.4 lb_f/ft^2).

  In response to RAI 02.03.01-16, dated September 2, 2010 (ADAMS Accession No. ML102570700), the applicant confirmed the historical maximum snowpack weight for the

Fermi vicinity is 1551 Pa (32.4 lb_f/ft^2), based on 83.82 cm (33 in.) snow cover that was recorded at the Willis 5 SSW COOP station. The applicant revised the weight of the historical maximum snowpack from 21 lb_f/ft^2 (1005 Pa) to 1551 Pa (32.4 lb_f/ft^2) in Revision 4 of FSAR Subsection 2.3.1.3.4.1. Therefore, RAI 02.03.01-16 is considered to be resolved.

- Weight of the 100-year return period two-day snowfall event: 685 Pa (14.3 lb_f/ft^2)

  The applicant stated in its response to RAI 02.03.01-9 (ADAMS Accession No. ML093570220) that maximum 100-year return period snowfall for the Fermi region is 46.48 cm (18.3 in.) based on data from the NCDC Snow Climatology database. The applicant used the assumptions presented in Equation 2 from ISG-7 to convert this maximum snowfall to a snow load weight of 685 Pa (14.3 lb_f/ft^2). Therefore, the staff finds the applicant's weight of the 100-year return period two-day snowfall event to be acceptable. The applicant included this information in Revision 2 to FSAR Subsection 2.3.1.3.4.

- Weight of the historical maximum two-day snowfall event: 915 Pa (19.1 lb_f/ft^2)

  Revision 1 to FSAR Subsection 2.3.1.3.4.2 stated that the highest 24-hour snowfall was 62.2 cm (24.5 in.) during April of 1886 in the vicinity of what is now the Detroit City Airport whereas the highest 2- and 3-day snowfalls occurred at the Flint recording station where 57.7 cm (22.7 in.) was reported for both snowfalls. The reported maximum 2- and 3-day snowfalls at Flint were inconsistent with (i.e., lower than) the maximum 24-hour snowfall at the Detroit City Airport. The staff issued RAI 02.03.01-8 to clarify this apparent discrepancy in snowfall statistics.

  In response to RAI 02.03.01-8, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant stated that the maximum 2- and 3-day snowfall data were obtained from the NCDC snow climatology database and that this database has a shorter period-of-record than the database used to obtain the maximum 24-hour snowfall data. Therefore, the applicant stated that it is appropriate that the maximum 24-hour snowfall value of 62.2 cm (24.5 in.) also be used to represent the maximum 2- and 3-day snowfall values for the Fermi site. The staff finds this assessment acceptable because it results in a higher maximum 2-day snowfall than that indicated by the NCDC snow climatology database which is referenced in ISG-7. The applicant revised the text in Revision 2 to FSAR Subsections 2.3.1.3.4.1 and 2.3.2.1.3 accordingly, and thus RAI 02.03.01-8 is considered resolved.

The applicant used the assumptions presented in Equation 2 from ISG-7 to convert the 62.2 cm (24.5 in.) snowfall to a snow load weight of 915 Pa (19.1 lb_f/ft^2). Therefore, the staff finds the applicant's weight of the historical maximum two-day snowfall event to be acceptable. The applicant included this information in Revision 2 to FSAR Subsection 2.3.1.3.4.

As part of its response (ML102570700) to RAI 02.03.01-16, the applicant identified the weight of the historical maximum snowpack (1551 Pa [32.4 lb_f/ft^2]) as providing the maximum ground-level weight for the normal winter precipitation event. This estimate is bounded by the corresponding ESBWR standard plant site parameter value of 2394 Pa (50 lb_f/ft^2). The staff finds the applicant's ground-level weight for the normal winter precipitation event to be acceptable because it is based on guidance provided in ISG-7.

ii. Maximum Ground-Level Weight of the Extreme Winter Precipitation Event

ISG-7 states that the extreme frozen winter precipitation event should be the higher ground-level weight (lb_f/ft^2) between (1) the 100-year return period two-day snowfall event (i.e., 685 Pa [14.3 lb_f/ft^2]) and (2) the historical maximum two-day snowfall event in the site region (i.e., 915 Pa [19.1 lb_f/ft^2]). Therefore, the extreme frozen winter precipitation event results in a ground-level weight of 915 Pa (19.1 lb_f/ft^2).

ISG-7 states that the extreme liquid winter precipitation event is defined as the theoretically greatest depth of precipitation (in inches of water) for a 48-hour period that is physically possible over a 25.9-square-kilometer (10-square-mile) area at a particular geographical location during those months with the historically highest snowpacks. The applicant estimated that the extreme liquid winter precipitation event is 49 cm (19.3 in.) in accordance with HMR-53 (NUREG/CR-1486). This is equivalent to a weight of 4805 Pa (100.4 lb_f/ft^2). The staff independently used HMR-53 to calculate a slight lower value for the extreme liquid precipitation event. Therefore, the staff finds the applicant's extreme liquid winter precipitation event of 49 cm (19.3 in.) to be acceptable.

iii. Maximum Roof Load

Guidance from ISG-7 defines the extreme winter precipitation roof load as the weight of the antecedent snowpack resulting from the normal winter precipitation event (i.e., 1551 Pa [32.4 lb_f/ft^2]) plus the larger resultant weight from either (1) the extreme frozen winter precipitation event or (2) the extreme liquid winter precipitation event.

Revision 2 to FSAR Subsection 2.3.1.3.4 calculated the maximum roof load for the Fermi site for the following three scenarios:

- the extreme liquid winter precipitation event (e.g., the 48-hour PMWP) on top of the 100-year return ice accretion
- historical maximum snowfall on top of the 100-year return period snowpack
- the extreme liquid winter precipitation event on top of the 100-year return period snowpack with a 5 lb_f/ft^2 rain-on-snow surcharge

Because the applicant calculated a revised historical maximum snowpack weight of 1551 Pa (32.4 lb_f/ft^2) in its response to RAI 02.03.01-16 which is higher than the 100-year return period snowpack weight of 1403 Pa (29.3 lb_f/ft^2), the applicant revised the last two scenarios listed above and provided maximum roof load calculations for the following three scenarios as part of its response to RAI 02.03.01-16:

- the extreme liquid winter precipitation event (e.g., the 48-hour PMWP) on top of the 100-year return ice accretion
- historical maximum snowfall on top of the historical maximum snowpack
- the extreme liquid winter precipitation event on top of the historical maximum snowpack with a 5 lb_f/ft^2 rain-on-snow surcharge

The applicant found the last scenario listed above resulted in the most severe roof load, 7407 Pa (154.7 lb_f/ft^2), and stated this roof load was bounded by the ESBWR maximum roof load resulting from the normal and extreme winter precipitation events (7828 Pa [163.5 lb_f/ft^2]).

The FSAR derived the 7828 Pa [163.5 lb_f/ft^2] ESBWR maximum roof load value by summing the roof load resulting from the normal winter precipitation event (1843 Pa [38.5 lb_f/ft^2]) and the extreme winter precipitation event (5985 Pa [125 lb_f/ft^2]) maximum roof snow load values that are listed in ESBWR DCD, Tier 2, Table 3G.1-2. This summation conflicts with the GEH response to RAI 2.3-4 S05 dated May 11, 2009 (ADAMS Accession No. ML091320434) which states that the 5985 Pa (125 lb_f/ft^2) extreme live load for roofs includes the contribution of 1843 Pa (38.5 lb_f/ft^2) from the normal winter precipitation event. Similarly, footnote 5 to ESBWR DCD, Tier 2, Table 2.0.1, states the corresponding maximum ground snow load for the extreme winter precipitation event (7757 Pa [162.5 lb_f/ft^2]) includes the contribution from the normal winter precipitation event (2394 Pa [50 lb_f/ft^2]). The staff issued RAI 02.03.01-18 asking the applicant to address this apparent contradiction in defining the ESBWR extreme winter precipitation event roof load.

In its response to RAI 02.03.01-18, dated January 10, 2011 (ADAMS Accession No. ML110110550), the applicant agreed that the methodology it used to derive the maximum roof load in Revision 2 to FSAR Section 2.3.1.3.4 as modified as part of its response to RAI 02.03.01-16 is not consistent with the ESBWR DCD. Instead, the applicant stated the extreme frozen winter precipitation event is considered to be the higher ground-level weight between the 100-year return period snowfall event (685 Pa [14.3 lb_f/ft^2]) and the historical maximum snowfall event (915 Pa [19.1 lb_f/ft^2]). Adding this value (915 Pa [19.1 lb_f/ft^2]) to the maximum ground snow load for the winter precipitation event (1551 Pa [32.4 lb_f/ft^2]) results in a total maximum ground snow load for both the normal and extreme frozen winter precipitation events of 2466 Pa (51.5 lb_f/ft^2). This ground snow load value is bounded by the ESBWR maximum ground snow load for extreme winter precipitation event site parameter value of 7757 Pa (162 lb_f/ft^2).

The applicant also notes in its response to RAI 02.03.01-18, dated January 10, 2011 (ADAMS Accession No. ML110110550), that the parapets on the roof of the ESBWR could allow water to accumulate up to 60.96 cm (24 in.) during an extreme winter precipitation event when the roof scuppers and drains are assumed to be clogged. The ESBWR extreme live load roof design of 5985 Pa (125 lb_f/ft^2) is based on 60.96 cm (24 in.) of standing water on the roof. Therefore, the staff notes that the Fermi 3 extreme liquid winter precipitation event of 49 cm (19.3 in.) of water does not challenge the integrity of the ESBWR extreme live load roof design.

The staff finds the applicant's response to RAI 02.03.01-18 acceptable because the applicant derived its extreme winter precipitation event roof load following the description of the ESBWR roof design as described in the DCD. The applicant incorporated the information provided in response to RAI 02.03.01-18 into Revision 4 of the FSAR. Therefore, RAI 02.03.01-18 is considered to be resolved.

e. Design Basis Ambient Temperature and Humidity Statistics

In Subsection 2.3.1.3.5 of the FSAR, the applicant presented ambient temperature and humidity statistics for the Detroit Metropolitan Airport in Table 2.3-210 of the FSAR Revision 1 (dated March 2009). The Detroit Metropolitan Airport is the closest first-order NWS climatic observation station to the Fermi Unit 3 site (located approximately 17 mi [27 km] to the north-northwest) which has a long-term history of recording hourly temperature and humidity data. The staff expects that the temperature and humidity data recorded at the Detroit Metropolitan Airport should be generally representative of Fermi 3 site conditions. In order to confirm this hypothesis, the staff generated 2001-2007 Detroit Metropolitan Airport dry-bulb (DB) statistics from the NCDC ISHD database and compared them with similar statistics generated from the applicant's 2001-2007 onsite meteorological database. Table 2.3-1 provides the results of this comparison.

Table 2.3-1 Comparison of Detroit Metropolitan Airport and Fermi 3 Site Dry- Bulb Statistics for 2001–2007

Dry-Bulb Statistic	2001–2007	
	Detroit Metropolitan Airport	Fermi 3 Site
Maximum	37.2 °C	34.6 °C
1 Percent Exceedance	31.0 °C	29.4 °C
Median	10.0 °C	10.5 °C
99 Percent Exceedance	-12.2 °C	-12.6 °C
Minimum	-20.6 °C	-19.9 °C
Unit in the table is in degrees Celsius (C). To convert to degrees Fahrenheit (F), use the formula: F = 1.8 C + 32.		

This comparison shows that the maximum and the 1 percent exceedance Detroit Metropolitan Airport DB statistics tend to be higher (more conservative) than the Fermi 3 site statistics, probably due to the Fermi 3 site location being closer to Lake Erie and the lake's moderating effects on temperature during the summer (more detail is provided in SER Subsection 2.3.2 of this SER). The 99 percent exceedance and minimum Detroit Metropolitan Airport DB statistics are generally representative of (e.g., within 1 degree C) of the Fermi 3 data.

The staff also compiled and compared, in Table 2.3-2, the Detroit Metropolitan Airport dew point statistics with the onsite dew point data provided by the applicant.

Table 2.3-2 Comparison of Detroit Metropolitan Airport and Fermi 3 Site Dew-Point Statistics for 2001–2007

Dew Point Statistic	2001–2007	
	Detroit Metropolitan Airport	Fermi 3 Site
Maximum	26.0 °C	23.7 °C
1 Percent Exceedance	22.2 °C	20.2 °C
Median	5.0 °C	3.2 °C
Unit in the table is in degrees Celsius (C). To convert to degrees Fahrenheit (F), use the formula: F = 1.8 C + 32.		

This comparison shows that the Detroit Metropolitan Airport dew point statistics tend to be higher (more conservative) than the Fermi 3 site statistics. This may be due, in part, to the differences in instrumentation between the Detroit Metropolitan Airport station and the Fermi 3 station.

American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) climatic design data are available for the Detroit Metropolitan Airport. Based on 1972–2001 period of record in the 2005 ASHRAE Handbook, the applicant identified the maximum 2.0 and 1.0 percent annual DB cooling exceedance temperatures with the corresponding mean coincident wet-bulb (MCWB) temperatures, the maximum 2.0 and 1.0 percent annual non-coincident WB cooling exceedance temperatures, and the minimum 99.0 and 99.6 percent annual DB heating exceedance temperatures. The staff compared the applicant’s 2.0 and 1.0 percent exceedance DB and coincident and non-coincident WB temperatures and 99-and 99.6 percent exceedance DB temperature with the Detroit Metropolitan Airport data statistics published by ASHRAE. The staff has confirmed that the statistics provided by the applicant are correct.

In addition, the applicant calculated zero percent exceedance (i.e., historic) values of maximum DB temperature with the corresponding MCWB temperature, maximum non-coincident WB temperature, and minimum DB temperature for the 1961 to 2007 period of Detroit Metropolitan Airport data. The applicant also estimated values of the 100-year maximum and minimum DB temperatures and 100-year maximum non-coincident WB temperature based on the same 1961–2007 database.

10 CFR 52.79(a)(iii) states, in part, that the COL FSAR shall include the meteorological characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated. In order to be compliant with 10 CFR 52.79(a)(1)(iii), the ambient design temperature site characteristics should be based on the more extreme of either historic or 100-year return period values. Temperatures based on a 100-year return period are considered to provide a sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated as required by regulation.

The zero percent exceedance ambient design temperature Fermi Unit 3 site characteristic values presented in Revision 1 to FSAR Table 2.0-201 (Sheet 6 of 28) are based on historic extreme values. The NRC staff issued RAI 02.03.01-10 requesting that the applicant justify why these site characteristic values are not based on the more extreme of either the historic or

100-year return values. Note that FSAR Section 2.3.1.3.5 already states that the more extreme 100-year temperature values are considered representative of the Fermi site for design purposes. The staff further requested a revision of FSAR Revision 1, Table 2.0-201 (Sheet 6 of 28) to identify the Fermi Unit 3 maximum and minimum zero percent exceedance ambient design temperature site characteristic values as the more extreme of either the historic recorded values or the 100-year return values.

In the response to RAI 02.03.01-10, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant estimated a 100-year return period MCWB temperature by using the 2009 ASHRAE's Weather Data Viewer Version 4.0 (WDView 4.0) to extrapolate a MCWB temperature value from a joint frequency matrix of 1982-2006 Detroit Metropolitan Airport DB and WB values. The NRC staff also compiled and compared maximum DB with MCWB, maximum non-coincident WB, and minimum DB temperatures as shown in the Table 2.3-3 below.

Table 2.3-3 Maximum DB with MCWB, Maximum Non-coincident WB, and Minimum DB Temperatures[a]

Parameter		DCD Zero percent Exceedance Values	Fermi 3 Values					
			DTE		LCD	NRC		
			Historic	100-yr	Historic	Historic	100-yr	
Max	DB	47.2	40.0[b]	40.1[c]	40.0[b]	39.4[d]	40.8[e]	40.3[f]
	MCWB	26.7	24.8[c]	23.3[f]	-[g]	23.3[d]	23.8[e]	23.2[f]
	WB	31.1	29.4[c]	30.0[c]	-	29.4[d]	30.1[d]	-
Min	DB	–40.0	–29.4[b]	–34.9[c]	–29.4[b]	–28.9[d]	–33.8[e]	–33.2[f]

(a) Unit in the table is in degrees Celsius. To convert to degrees Fahrenheit, use the formula: F = 1.8 C + 32.
(b) Based on the 1959–2006 data (source: 2007 LCD).
(c) Based on the 1961–2007 data (source: SAMSON/HUSWO/ISHD).
(d) Based on the 1961–2009 data (source: SAMSON/HUSWO/ISHD).
(e) Based on the 1972–2001 data (source: 2005 ASHRAE Handbook).
(f) Based on the 1982–2006 data (source: 2009 ASHRAE Handbook).
(g) Not available.

DB=dry bulb; DCD= design certification document; ISHD= Integrated Surface Hourly Data; HUSWO= Hourly U.S. Weather Observations; LCD= Local Climatological Data; MCWB= mean coincident wet bulb; WB= wet bulb

- <u>Maximum Dry Bulb Temperature:</u> The applicant determined the Fermi 3 site characteristic value of 40.1 degrees C (104.2 degrees F) based on a 100-year value derived from a review of the 1961–2007 Detroit Metropolitan Airport annual maximum DB temperature values using a Gumbel distribution. The staff performed an independent evaluation of the 100-year site characteristic value using Equation 1 from Chapter 14 of the *2009 ASHRAE Handbook – Fundamentals*. Using the Detroit Metropolitan Airport 1972–2001 mean and standard deviation of annual extreme maximum DB temperature data provided in the *2005 ASHRAE Handbook*, the staff derived a value of 40.8 degrees C (105.4 degrees F); using the 1982–2006 mean and standard deviation data provided in the *2009 ASHRAE Handbook*, a value of 40.3 degrees C (104.5 degrees F) was derived. The staff calculated maximum DB temperature values that were slightly higher than the applicant's values; however, given that the corresponding ESBWR site parameter value, 47.2 degrees C (117 degrees F), is significantly higher than either the applicant's or staff's maximum DB temperature values, the applicant's site characteristic value is considered acceptable.

- Mean Coincident Wet Bulb Temperature: The applicant determined the Fermi 3 site characteristic value of 23.3 degrees C (73.9 degrees F) based on its review of Detroit Metropolitan Airport 1982–2006 MCWB temperature values (from the 2009 ASHRAE database, WDView 4.0) extrapolated to a DB temperature value of 40.1 degrees C (104.2 degrees F). Using the 2005 ASHRAE database WDView 3.0, the staff extrapolated a MCWB temperature of 23.8 degrees C (74.8 degrees F) for a DB temperature of 40.8 degrees C (105.4 degrees F). Using the 2009 ASHRAE database WDView 4.0, the staff extrapolated a MCWB temperature of 23.2 degrees C (73.8 degrees F) for a DB temperature of 40.3 degrees C (104.5 degrees F). Although the staff calculated slightly higher values, the applicant's site characteristic value of 23.3 degrees C (73.9 degrees F) is considered acceptable, given that the corresponding ESBWR site parameter value of 26.7 degrees C (80 degrees F) is significantly higher than either the applicant's or staff's MCWB temperature values.

- Maximum Wet Bulb Temperature: The applicant determined the Fermi 3 site characteristic value of 30.0 degrees C (86.0 degrees F) based on a 100-year value derived from a review of Detroit Metropolitan Airport 1961–2007 mean and standard deviation of annual maximum WB temperatures using a Gumbel distribution. Using the 1961–2009 mean and standard deviation of annual maximum WB temperatures with a Gumbel distribution, the staff derived a maximum WB temperature of 30.1 degrees C (86.2 degrees F). Because the staff's value is only slightly higher than the applicant's site characteristic value, the applicant's value is considered acceptable.

- Minimum Dry Bulb: The applicant determined the Fermi 3 site characteristic value of –34.9 degrees C (–30.8 degrees F) based on a 100-yr value derived from a review of the Detroit Metropolitan Airport 1961–2007 mean and standard deviation of annual minimal DB temperatures using a Gumbel distribution. Using the 1972–2001 mean and standard deviation of annual extreme minimum DB temperatures provided in the 2005 ASHRAE Handbook, the staff derived a value of –33.8 degrees C (–28.8 degrees F); using the 1982–2006 mean and standard deviation data provided in the 2009 ASHRAE Handbook, a value of –33.2 degrees C (–27.8 degrees F) was derived. On this basis, the staff concludes that the applicant's site characteristic value of –34.9 degrees C (-30.8 degrees F) is conservative.

The applicant revised the zero percent exceedance ambient design temperature site characteristic values presented in FSAR Table 2.0-1 to be the more extreme of either the historic or 100-year return values. For this reason, RAI 02.03.01-10 is considered resolved.

GEH added three new site parameters related to ESBWR control room habitability area (CRHA) transient room temperature analysis in Revision 8 to DCD Tier 2, Table 2.0-1. The applicant submitted proposed changes to the Fermi 3 COL FSAR in response to ESBWR DCD Revision 8 in a letter dated November 9, 2010. These three new site parameters, along with the corresponding Fermi 3 site characteristic values developed by the applicant, are as follows:

- Maximum average dry bulb temperature for zero-percent exceedance maximum temperature day

  This ESBWR site parameter value, 39.7 degrees C (103.5 degrees F), is used to evaluate maximum temperature conditions for the CRHA transient room temperature analysis. The corresponding site characteristic value is defined as the average of the zero percent exceedance maximum dry bulb temperature and the dry bulb temperature resulting from a daily temperature range, where the daily temperature range is defined as the dry bulb temperature difference between the zero percent exceedance maximum dry bulb temperature and the dry bulb temperature that corresponds to the higher of the two lows occurring within 24 hours before and after that maximum.

  The applicant reported that the historic maximum dry bulb temperature value reported for the Detroit Metropolitan Airport during the period 1961-2007 was 40.0 degrees C (104.0 degrees F) which occurred on June 25, 1988. The applicant stated that the higher of the two lows occurring within 24 hours before and after the historic maximum dry bulb temperature was 18.9 degrees C (66.0 degrees F). Because the 100-year return maximum dry bulb temperature (40.05 degrees C [104.1 degrees F]) is higher than the historic maximum dry bulb temperature, the applicant used the higher 100-year value in calculating a Fermi 3 maximum average dry bulb temperature for zero-percent exceedance maximum temperature day site characteristic value of 29.48 degrees C (85.1 degrees F). The resulting Fermi 3 site characteristic value is bounded by the corresponding ESBWR site parameter value.

- Minimum average dry bulb temperature for zero-percent exceedance minimum temperature day

  This ESBWR site parameter value, −32.5 degrees C (−26.5 degrees F), is used to evaluate minimum temperature conditions for the CRHA transient room temperature analysis. The corresponding site characteristic value is defined as the average of the zero percent exceedance minimum dry bulb temperature and the dry bulb temperature resulting from a daily temperature range, where the daily temperature range is defined as the dry bulb temperature difference between the zero percent exceedance minimum dry bulb temperature and the dry bulb temperature that corresponds to the lower of the two highs occurring within 24 hours before and after that minimum.

  The applicant reported that the historic minimum dry bulb temperature value reported for the Detroit Metropolitan Airport during the period 1961-2007 was −29.44 degrees C (−21.0 degrees F) which occurred on January 21, 1984. The applicant stated that the lower of the two highs occurring within 24 hours before and after the historic maximum dry bulb temperature was −17.8 degrees C (−0.04 degrees F). Because the 100-year return minimum dry bulb temperature (−34.89 degrees C [−30.8 degrees F]) is lower than the historic minimum dry bulb temperature, the applicant used the lower 100-year value in calculating a Fermi 3 minimum average dry bulb temperature for zero-percent exceedance minimum temperature day site characteristic value of −26.35 degrees C (−15.4 degrees F). The resulting Fermi 3 site characteristic value is bounded by the corresponding ESBWR site parameter value.

- Maximum high humidity average web bulb globe temperature index for zero-percent exceedance maximum wet bulb temperature day

  This ESBWR site parameter value, 30.3 degrees C (86.6 degrees F), is used to evaluate high humidity conditions for the CRHA transient room temperature analysis. It is defined as the average of the wet bulb globe temperature (WBGT) index values for the zero-percent exceedance maximum wet bulb temperature and the highest of the six low wet bulb temperatures that occurs in each of the three 24-hour periods before and after the zero-percent exceedance wet bulb temperature. The WBGT index value is defined as the dry bulb temperature multiplied by 0.3 plus the wet bulb temperature multiplied by 0.7.

  The applicant reported that the historic maximum wet bulb temperature value reported for the Detroit Metropolitan Airport during the period 1961-2007 was 29.44 degrees C (85.0 degrees F) which occurred on July 14, 1995. The coincident dry bulb temperature was 36.7 degrees C (98.1 degrees F). Because the 100-year return maximum wet bulb temperature (30.0 degrees C [86.0 degrees F]) is higher than the historic maximum wet bulb temperature, the applicant used the higher 100-year value in calculating a WBGT index of 32.01 degrees C (89.62 degrees F).

  The applicant stated that the highest of the six low wet bulb temperatures that occurred in each of the 24-hour periods before and after the historic maximum wet bulb temperature was 24.1 degrees C (75.4 degrees F). The coincident dry bulb temperature was 28.9 degrees C (84.0 degrees F), resulting in a WBGT index of 25.54 degrees C (77.97 degrees F).

  The average of the WBGT index values for the zero-percent exceedance maximum wet bulb temperature and the highest of the six low wet bulb temperatures that occurs in each of the three 24-hour periods before and after the zero-percent exceedance wet bulb temperature is 28.78 degrees C (83.80 degrees F). This value represents the site characteristic value for the Fermi 3 maximum high humidity average web bulb globe temperature index for zero-percent exceedance maximum wet bulb temperature day. The resulting Fermi 3 site characteristic value is bounded by the corresponding ESBWR site parameter value.

The staff reviewed meteorological data from the Detroit Metropolitan Airport for the period 1961-2009 and identified the same dates and times as the applicant regarding the occurrence of the historic maximum and minimum dry bulb temperatures and the historic maximum wet bulb temperature. The staff also found that its historic temperature values were the same or bounded by the applicant's values. The staff also concluded that the applicant used the correct methodology in developing the three CRHA transient room temperature analysis site parameter values by following the definitions presented in ESBWR DCD, Tier 2, Appendix 3H, Section 3H.3.2.1. Therefore, the staff finds the applicant's three CRHA transient room temperature analysis site parameter values to be acceptable.

The staff issued RAI 02.03.01-19 requesting that the applicant address the following in its proposed revision to the FSAR that develops the CRHA transient room temperature analysis site characteristic values: (1) change the use of the term "Fermi site parameters" to "Fermi site characteristics" in order to be consistent with the terms defined in 10 CFR 52.1(a), and (2) more precisely describe the methodology used in determining the CRHA site characteristic values in accordance with Revision 8 to ESBWR DCD, Tier 2, Appendix 3H, Section 3H.3.2.1.

In its response to RAI 02.03.01-19, dated January 10, 2011 (ADAMS Accession No. ML110110550), the applicant agreed to revise the FSAR to change the term "Fermi site parameters" to "Fermi site characteristics" when referring to the site-specific CRHA transient room temperature analysis values. The applicant also agreed to update the FSAR to more precisely describe the methodology used in determining the CRHA transient room temperature analysis site characteristic values in accordance to the definitions in the ESBWR DCD. The staff reviewed the applicant response to RAI 02.03.01-19 and finds the response acceptable because the applicant agreed to revise the FSAR to address the staff's concerns.

The applicant incorporated the three CRHA transient room temperature analysis site characteristic values into Revision 4 of the Fermi 3 FSAR, including the changes indentified in the applicant's response to RAI 02.03.01-19. Therefore, RAI 02.03.01-19 is considered to be resolved.

f. Ultimate Heat Sink

Subsection 2.3.1.3.7 of the FSAR discusses the ultimate heat sink (UHS) function for the ESBWR design that is provided by safety systems integral and interior to the reactor plant. DCD Tier 2, Subsection 3.1.4.15, states that the ESBWR UHS is the isolation condenser/passive containment cooling system (IC/PCCS) pool. In the event of a design-basis accident, heat is transferred to the IC/PCCS pool(s) through the isolation condenser system and the PCCS. The water in the IC/PCCS pool(s) is allowed to boil, and the resulting steam is vented to the environment.

Because the UHS for the Fermi Unit 3 ESBWR design does not require an external source of safety-related cooling water and there are no cooling towers, basins, or cooling water intake/discharge structures external to the reactor plant, specialized meteorological data for evaluating the UHS are not required.

g. Regional Air Quality

i. Background Air Quality

In Revision 1 of FSAR Subsection 2.3.1.3.8, the applicant states that air quality at the Fermi site is heavily influenced by the Detroit and Toledo Metropolitan areas and surrounding emission sources. The Michigan Department of Environmental Quality (MDEQ) evaluates the air quality in the Detroit metropolitan area with a network of monitors mostly located in Wayne County, north of the Fermi site. The MDEQ routinely monitors the EPA criteria pollutants of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter equal to or smaller than 2.5 micrometers in diameter ($PM_{2.5}$), particulate matter equal to or smaller than 10 micrometers in diameter (PM_{10}), and ozone (O_3). The applicant identified that Monroe County is designated a nonattainment area for EPA's annual $PM_{2.5}$ standard (i.e., the three-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors exceeded 15.0 $\mu g/m^3$) and 8-hour O_3 standard (i.e., the three-year average of the fourth-highest daily maximum 8-hour average O_3 concentrations measured at each monitor within an area over each year exceeded 0.075 ppm). Maximum concentrations for the annual average of $PM_{2.5}$ and 8-hour O_3 pollutants were obtained from monitors in Monroe and Wayne Counties. The applicant reports that the highest annual $PM_{2.5}$ concentration reported between 1999 and 2006 is 20.1 $\mu g/m^3$, occurring at the Dearborn monitor located west of downtown

Detroit. During the same period, the highest 8-hour O_3 concentration recorded was 0.104 ppm, measured at the East Seven Mile monitor located in northeastern Wayne County.

The NRC staff verified the statements and values determined by the applicant using the EPA's *Green Book* and *Air Data* database, and MDEQ' *2006 Annual Air Quality Report*.

In Revision 1 of FSAR Subsection 2.3.1.3.8.1, "Background Air Quality," the applicant stated that Monroe County is a member of the Air Quality Control Region (AQCR) that included the counties of the Detroit metropolitan area. However, per 40 CFR 81.43, Monroe County is in Metropolitan Toledo Interstate Air Quality Control Region (AQCR 124), and the nonattainment status for $PM_{2.5}$ and O_3 is reported as a part of the Detroit-Ann Arbor designated area as in 40 CFR 81.243. The NRC staff issued RAI 02.03.01-11 asking the applicant to clarify the jurisdiction for air quality control management at the Fermi Unit 3 site.

The applicant's response to RAI 02.03.01-11, dated February 8, 2010 (ADAMS Accession No. ML093570220), revised Revision 2 of FSAR to state that Monroe County is a member of the Metropolitan Interstate Toledo AQCR and is also included in the Detroit-Ann Arbor air quality designation area. The applicant also updated the FSAR to indicate that the Detroit-Ann Arbor air quality designation area is reclassified as a maintenance area for 8-hour O_3 standard on June 29, 2009. The NRC staff has confirmed this information, and thus RAI 02.03.01-11 is considered resolved.

In Revision 1 of FSAR Subsection 2.3.1.3.8.1, "Background Air Quality," the FSAR states that only annual-average $PM_{2.5}$ concentrations exceeded the ambient air quality standards. However, 24-hour average $PM_{2.5}$ concentrations at monitoring stations around the Fermi site frequently exceeded the respective 35 $\mu g/m^3$ standard as well. The NRC staff issued RAI 02.03.01-12 asking the applicant to discuss exceedances of 24-hour $PM_{2.5}$ concentrations around Fermi site and to revise the $PM_{2.5}$ units used in this section from mg/m^3 to $\mu g/m^3$.

In its response to RAI 02.03.01-12, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant agreed to revise the FSAR to include the latest $PM_{2.5}$ nonattainment area designations for Monroe County and nearby monitor concentrations for 24-hour $PM_{2.5}$. The applicant also corrected the units associated with the $PM_{2.5}$ standard. Consequently, RAI 02.03.01-12 is considered resolved.

Section C.I.2.3.1.2 of RG 1.206 and Section III.3.e of SRP Section 2.3.2 state that regional air quality conditions that should be considered in the evaluation of the design and operation of the facility should be identified. Revision 1 of FSAR Section 2.3.1.3.7.1 states that Monroe County is a member of an Air Quality Control Region (AQCR) that has been classified as nonattainment for $PM_{2.5}$ and O_3 national ambient air quality standards (NAAQS). NAAQS are promulgated to protect public health and welfare. The NRC staff issued RAI 02.03.01-13 requesting the applicant to discuss the impact on plant design and operation due to the Fermi site being located in a $PM_{2.5}$ and O_3 nonattainment area.

The applicant response to RAI 02.03.01-13, dated February 8, 2010 (ADAMS Accession No. ML093570220), states that the Detroit-Ann Arbor designation area including Monroe County is redesignated as a maintenance area for the 8-hour O_3 standard, and thus is currently a nonattainment area for $PM_{2.5}$ only. The applicant states that the construction and operation of Fermi Unit 3 would meet the MDEQ regulations and programs and that only few infrequently operated sources of criteria pollutants exist at a new nuclear unit. The applicant concluded that the operation of Fermi Unit 3 will have neither a negative impact on the current air quality nor impede the State's plans for attaining the NAAQS, and thus will not adversely impact public health and welfare via air quality. In addition, the applicant mentioned the need for a conformity analysis for construction and operation at the Fermi Unit 3 site because the project is subject to a Federal action (i.e., NRC's approval for construction and operation) and the area is classified as a maintenance and nonattainment area for 8-hour O_3 and $PM_{2.5}$ standards, respectively.

The NRC staff reviewed the applicant's response to RAI 02.03.01-13 and accepts portions of the applicant's statement. The NRC staff has concluded that the conformity analysis will be addressed separately from this SER. However, the NRC staff found the response to RAI 02.03.01-13 incomplete. The NRC staff closed RAI 02.03.01-13 and issued a follow-up question, RAI 02.03.01-17, to address the unresolved issues.

The staff issued RAI 02.03.01-17 asking the applicant to address the impact on plant design and operation due to the Fermi site being located in a $PM_{2.5}$ nonattainment area. For example, the applicant should discuss whether the increased particulate loading associated with a $PM_{2.5}$ nonattainment area would adversely impact dust loading on HVAC filter systems.

The applicant's response to RAI 02.03.01-17, dated September 2, 2010 (ADAMS Accession No. ML102570700), states that Monroe County is below the NAAQS for $PM_{2.5}$ based on recent (2006-2008) monitoring data. The applicant further states that, per a letter from MDEQ to U.S. EPA, dated March 4, 2009, only one monitor in Southeast Michigan, in Wayne County, shows nonattainment of the standard. All other monitors in Southeast Michigan, including the eight other monitors in Wayne County, are meeting the 24-hour $PM_{2.5}$ standard. The applicant further states that, given that the entire state of Michigan will be in attainment with the $PM_{2.5}$ NAAQS prior to construction and operation of Fermi 3, there is no impact on plant design and operation. The staff has confirmed that there are two exceedances among the monitors in the current nonattainment area of Southeast Michigan, including Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne Counties, based on 2006-2008 monitoring data (U.S. EPA's *AirData* database, available at http://www.epa.gov/air/data/, accessed October 29, 2010). One exceedance occurred in Dearborn, Wayne County, which is located about 25 miles north of the Fermi site. The other exceedance occurred in Port Huron, St. Clair County, which is located about 82 miles north-northeast of the Fermi site. The 2000-2008 monitoring data show a general decreasing trend of 24-hour and annual $PM_{2.5}$ concentrations in Monroe County, except for peaks in 2002 and 2005. The staff also notes that in July 2011, the MDEQ submitted a request asking the EPA to redesignate southeast Michigan as being in attainment with the $PM_{2.5}$ NAAQS. This request would be based, in part, on air quality monitoring data collected in the 2007-2010 period showing all seven counties in southeast Michigan in attainment for the $PM_{2.5}$ NAAQS.

Considering all of these findings, the staff accepts the applicant's conclusion that $PM_{2.5}$ concentrations in Monroe County would be likely to comply with NAAQS during construction and operation of Femi 3 and are not likely to adversely impact dust loading on HVAC filter systems. Therefore, RAI 02.03.01-17 is considered resolved.

ii. Air Stagnation

In Revision 1 to FSAR Subsection 2.3.1.3.8.3 "Air Stagnation," the applicant estimates that high-pressure stagnation conditions, usually accompanied by light and variable wind conditions, can be expected at the proposed Fermi Unit 3 site. These conditions would occur about 10 days per year or in about two cases per year, with a mean duration of about three to four days for each case. This estimation is based on findings by Wang and Angell (NOAA/Air Resources Laboratory ATLAS No. 1, "Air Stagnation Climatology for the United States (1948-1998)," April 1999). Stagnation conditions primarily occur from May through October, with the highest incidences recorded between July and September. This 3-month period also coincides with the lowest monthly mean wind speeds during the year, as reported by the LCD summary for Detroit Metropolitan Airport.

The staff has confirmed that the information presented by the applicant regarding restrictive dispersion conditions is correct. Section 2.3.1 of this SER discusses the proposed Fermi Unit 3 site air quality conditions for design and operating considerations. Sections 2.3.4 and 2.3.5 of this SER discuss atmospheric dispersion site characteristics used to evaluate short-term, post-accident airborne releases and long-term routine airborne releases, respectively.

Potential Changes in Climate

As specified in NUREG–0800, the applicability of data used to discuss severe weather phenomena that may impact the proposed COL site during the expected period of reactor operation should be substantiated. Long-term environmental changes and changes to the region resulting from human or natural causes may affect the applicability of the historical data to describe the site's climate characteristics. The staff believes current climate trends should be analyzed for potential ongoing environmental changes.

The applicant did not address potential impacts associated with climate changes in Revision 1 of the FSAR. SRP Section 2.3.1 states that the applicability of the data on severe weather phenomena that is used to represent site conditions during the expected period of reactor operation should be substantiated. SRP Section 2.3.1 further states that current literature on possible changes in the weather in the site region should also be reviewed to be confident that the methods used to predict weather extremes are reasonable. RAI 02.03.01-14 was issued requesting that the applicant evaluate the trends in severe weather phenomena and extremes in the proposed site vicinity and discuss whether such trends may be indicative of climate change.

The applicant's response to RAI 02.03.01-14, dated February 8, 2010 (ADAMS Accession No. ML093570220), states the applicant analyzed normal temperature and rainfall trends during a 70-year period for successive 30-year intervals by decade for the climate division in which the Fermi site is located. The applicant states that normal (i.e., 30-year average) temperatures have not changed between the beginning period of 1931–1960 and the latest period of 1971–2000, but the normal rainfall has trended upward from 78.0 cm (30.72 in.) per year for the 1931–1960 period to 83.5 cm (32.86 in.) per year for the 1971–2000 period. The applicant also showed that a change in annual-average temperature between the 1920–1940 period and 1980–2000 period for the Detroit Metropolitan Airport has no trend, but annual-average temperature for the 2000–2009 period increased about 0.5 degrees C (0.9 degrees F) compared to the 1980–2000 period. The annual-average precipitation generally shows upward trends: from 77.2 cm (30.4 in.) for the 1920–1940 period to 86.1 cm (33.9 in.) for the 1980–2000 period and 86.6 cm (34.1 in.) for the 2000–2009 period.

The U.S. Global Change Research Program (GCRP) released a report to the President and Members of Congress in June 2009 titled, *Global Climate Change Impacts in the United States*. This report was produced by an advisory committee chartered under the Federal Advisory Committee Act. The report summarizes the science of climate change and the impacts of climate change on the United States.

The GCRP report found that the average annual temperature of the Midwest (which includes the State of Michigan where the Fermi Unit 3 site is located) did not change significantly during the past century as a whole, but the annual average temperature has risen about 1–2 degrees F since 1961. Climate models predict continued warming across the Midwest and an increase in the rate of warming throughout the end of the 21st century. Under a low heat-trapping gas emission scenario, average temperatures around the Fermi site are projected to rise by about 5–6 degrees F by the 2080s, while a higher emissions scenario yields about a 9 degrees F increase in average warming.

The GCRP report also states that there is a 15 to 20 percent increase in observed annual average precipitation from 1958 to 2008 in the region in the proposed location of Fermi 3. Future changes in total precipitation are more difficult to project than changes in temperature. Model projections of future precipitation generally indicate that northern areas of the United States will become wetter due to more northward incursions of storm tracks, with about a 15 to 20 percent increase in winter and spring, a 5 to 10 percent decrease in summer, and a zero to 5 percent increase in fall around the Fermi site.

The applicant stated that there are no discernable trends in extreme weather events, considering that extreme temperatures and precipitation events around the Fermi site occurred more than 30 years ago and increasing trends of severe weather events are primarily due to a simple increase in communication techniques in more recent years. The applicant concluded that the data for extreme weather events presented in the FSAR remain bounded by the design values, as this type of return period goes beyond the design life of the proposed new unit.

The GCRP reports that the distribution by intensity of the strongest 10 percent of hail and wind reports has changed little, and there is no evidence of an observed increase in the severity of such events. Climate models project future increases in the frequency of environmental conditions favorable to severe thunderstorms. But the inability to adequately model the small-scale conditions involved in thunderstorm development remains a limiting factor in projecting the future character of severe thunderstorms and other small-scale weather phenomena.

The staff has verified that, except for a couple of incorrect temperatures, the data and related discussion presented in the response to RAI 02.03.01-14 are reasonable and thus RAI 02.03.01-14 is considered resolved.

The NRC staff acknowledges that long-term climatic change resulting from human or natural causes may introduce changes into the most severe natural phenomena reported for the site. However, no conclusive evidence or consensus of opinion is available on the rapidity or nature of such changes. There is uncertainty in projecting future conditions because the assumptions regarding the future level of emissions of heat-trapping gases depends on projections of population, economic activity, and choice of energy technologies. The GCRP report states that climate will be continually changing toward more extreme weather events. However, there is considerable margin between many of the ESBWR climatic site parameters and the corresponding Fermi 3 site characteristic values as shown in FSAR Table 2.0-201. If it becomes evident that long-term climatic change is influencing the most severe natural phenomena reported at the site, the COL holders have a continuing obligation to ensure that their plants stay within the licensing basis.

The NRC staff has reviewed the application and finds that the applicant has presented and substantiated information to establish the regional meteorological characteristics.

2.3.1.5 *Post Combined License Activities*

There are no post-COL activities associated with this section.

2.3.1.6 *Conclusion*

The NRC staff has reviewed the application and checked the referenced DCD. The NRC staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

The NRC staff reviewed the application and finds that the applicant has presented and substantiated information to establish the regional meteorological characteristics. The staff's review confirms that the applicant has established the meteorological characteristics at the site and in the surrounding area acceptable to meet the requirements of 10 CFR 100.20(c)(2) and 100.21(d) with respect to determining the acceptability of the site.

The staff finds that the applicant has considered the most severe natural phenomena historically reported for the site and surrounding area in establishing its site characteristics. Specifically, the staff accepts the methodologies used to analyze these natural phenomena and to determine the severity of the weather phenomena reflected in these site characteristics. Because the applicant has correctly implemented these methodologies, as described above, the staff has determined that the applicant has considered these historical phenomena with margin sufficient for the limited accuracy, quantity, and period of time in which the data have been accumulated. The staff concludes that the identified site characteristics meet the requirements of 10 CFR 52.79(a)(1)(iii) with respect to identifying the most severe of the natural phenomena historically reported for the site and surrounding area and with a sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated.

In addition, the staff compared the information in the COL application to the relevant NRC regulations, the guidance in Section 2.3.1 of NUREG–0800, and the applicable NRC regulatory guides. The staff's review confirms that the applicant has adequately addressed the COL license information item in accordance with Section 2.3.1 of NUREG–0800.

2.3.2 Local Meteorology

Measurements from the Fermi onsite meteorological tower, located approximately one-quarter mile from the Fermi 3 RB, will be used in this section to characterize the local meteorology conditions at the Fermi site.

2.3.2.1 *Introduction*

Subsection 2.3.2, "Local Meteorology," of the Fermi 3 COL FSAR, Revision 7, addresses the local (site) meteorological characteristics, the assessment of the potential influence of the proposed plant and its facilities on local meteorological conditions and the impact of these modifications on plant design and operations, and provides a topographical description of the site and its environs.

2.3.2.2 *Summary of Application*

Subsection 2.3.2 of the Fermi 3 COL FSAR, Revision 7, discusses the local meteorology at the Fermi 3 site. In addition, in FSAR Section 2.3.2, the applicant provides the following:

<u>COL Item</u>

- EF3 COL 2.0-8-A Local Meteorology

  The onsite meteorological tower (the details of which are contained in Subsection 2.3.3) collects wind speed, wind direction, and ambient temperature at the 10-m (33-ft) and 60-m (197-ft) levels, dew-point temperature at 10-m (33-ft) level, and vertical air temperature difference (ΔT) between the 60-m (197-ft) and 10-m (33-ft) levels. In addition, precipitation is collected at ground level near the base of the tower.

2.3.2.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the local meteorology, and the associated acceptance criteria, are in Section 2.3.2 of NUREG–0800. The acceptance criteria for identifying regional climatology are based on meeting the relevant requirements of 10 CFR Parts 52 and 100. The staff considered the following regulatory requirements in reviewing the applicant's discussion of site location and description:

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated.

- 10 CFR 100.20(c)(2), and 100.21(d) with respect to the consideration that has been given to the local meteorological and air quality characteristics of the site and other physical characteristics of the site that can influence the local meteorology.

NUREG-0800, Section 2.3.2, specifies that an application meets the above requirements, if the application satisfies the following criteria:

- local summaries of meteorological data based on onsite measurements are provided in accordance with RG 1.23 and NWS station summaries or other standard installation summaries from appropriate nearby locations (e.g., within 80 km [50 miles]) are presented as specified RG 1.206, Section 2.3.2.1

- a complete topographical description of the site and environs out to a distance of 80 km (50 mi) from the plant, as described in RG 1.206, Section 2.3.2.2, is provided

- a discussion and evaluation of the influence of the plant and its facilities on the local meteorological and air quality conditions are provided and the applicant identifies potential changes in the normal and extreme values resulting from plant construction and operation

- a description of local site airflow that includes wind roses and annual joint frequency distributions (JFDs) of wind speed and wind direction by atmospheric stability for all measurement levels is provided using the criteria provided in RG 1.23

When independently assessing the acceptability of the information presented by the applicant in FSAR Section 2.3.2, the NRC staff applied the same methodologies and techniques cited above.

2.3.2.4 *Technical Evaluation*

The NRC staff reviewed the application and the applicant's responses to RAIs to verify the accuracy, completeness, and sufficiency of the information regarding local meteorology. The staff followed the procedures in Section 2.3.2 of NUREG–0800 as part of this review.

COL Item

- EF3 COL 2.0-8-A Local Meteorology

This COL information item requires that the COL applicant supply site-specific information in accordance with SRP Section 2.3.2; that is, the COL applicant should provide summaries of the local (site) meteorological characteristics, an assessment of the potential influence of the proposed plant and its facilities on local meteorological conditions, the impact of these modifications on plant design and operation, and a topographical description of the site and its environs.

In response to this COL information item, the applicant provides the following:

- Summaries of the local (site) meteorology in terms of temperature, atmospheric moisture, precipitation, fog and smog, wind direction and wind speeds, wind persistence, mixing heights, and atmospheric stability and inversions.

- An assessment of the construction and operation impacts of the plant and its facilities on the local meteorological parameters listed above. These impacts include the effects of plant structures, terrain modification, and heat and moisture sources due to plant operation.

- A topographical description of the site and its environs, as modified by the plant structures.

The NRC staff reviewed the applicant's resolution to EF3 COL 2.0-8-A related to supplying site-specific information in accordance with SRP Section 2.3.2. The staff's review of the applicant's summaries of the local (site) meteorological characteristics, an assessment of the potential influence of the proposed plant and its facilities on local meteorological conditions, the impact of these modifications on plant design and operation, and a topographical description of the site and its environs is described below.

Normal, Mean, and Extreme Values

In Subsection 2.3.2.1 of the FSAR, the applicant uses measurements made at the Fermi onsite meteorological tower, located approximately one-quarter mile from the Fermi 3 RB, to characterize the local meteorology conditions at the Fermi site. The onsite meteorological tower collects wind speed, wind direction, and ambient temperature at the 10-m (33-ft) and 60 m (197-ft) levels, dew-point temperature at 10-m (33-ft) level, and vertical air temperature difference (ΔT) between the 60-m (197-ft) and 10-m (33-ft) levels. In addition, precipitation is collected at ground level near the base of the tower. The vertical temperature difference (ΔT) between the 60-meter (197-foot) and 10-meter (33-foot) levels is used to compute atmospheric stability in accordance with the guidance provided in RG 1.23. Hourly data from a recent 5-year period (2003 through 2007) were used by the applicant in the analysis of the local meteorology of the Fermi site. The data recovery rate for all the meteorological parameters during this period exceeded 94 percent. Wet-bulb temperature, relative humidity, and the occurrence of fog and visibility are not collected at the Fermi onsite meteorological station; subsequently, the applicant presents data from the nearby Detroit Metropolitan Airport to supplement Fermi site data. The applicant also presents data from the next two closest first-order NWS stations, Toledo, Ohio, and Flint, Michigan. The applicant also obtained extreme values of temperature, rainfall, and snowfall for four NWS COOP stations located within 80 km (50 mi) of the Fermi site (Monroe, Michigan; Windsor, Ontario; Ann Arbor, Michigan; and Adrian, Michigan), since those parameters are also representative from a regional perspective.

a. Temperature

In Subsection 2.3.2.1.1 of the FSAR, the applicant presents monthly and annual temperature data for 10-meter (33-foot) and 60-meter (197-foot) levels at the Fermi site and for the 10-meter (33-foot) level at the Detroit Metropolitan Airport for the 5-year period 2003–2007 in FSAR Section 2.3.2.1.1. While mean annual temperatures at the 10-meter (33-foot) level at the Fermi site and the Detroit Metropolitan Airport are comparable, the mean monthly values are somewhat different. Due to its proximity to Lake Erie, the Fermi site experiences moderating effects of the water's high heat content by onshore and offshore breezes throughout the year except for winter. During winter months, Lake Erie is generally covered with ice, which inhibits the moderating effects of Lake Erie, and thus temperatures between the two sites are nearly identical. During the spring, ice over the lake melts but the water temperature is still cold, which results in cooler temperatures at the Fermi site than those at the Detroit Metropolitan Airport, which is farther inland. As the lake water warms up during the late spring, the lake exerts moderating effects on temperature, and the temperature contrast along the coast creates onshore and offshore breezes. As a result, temperatures at the Fermi site are a little cooler than those at the Detroit Metropolitan Airport. During the fall season, lake water remains warm, and thus temperatures at the Fermi site are warmer than at the Detroit Metropolitan Airport. Due to the moderating effects of lake water, the Fermi site experiences lower maximum and higher minimum temperatures than the Detroit Metropolitan Airport. The applicant states that, in consequence, annual mean temperatures of the Detroit Metropolitan Airport are representative of the Fermi site from a longer climatological standpoint.

The staff evaluated the applicant's statements in FSAR Subsection 2.3.2.1.1 regarding mean, maximum, and minimum temperatures using the 2003–2007 meteorological data from the Fermi site and from the Detroit Metropolitan Airport.

The applicant originally submitted its 2001-2007 onsite meteorological database in response to environmental RAI AQ2.7-3, dated October 30, 2009 (ADAMS Accession No. ML093090165).

The applicant subsequently reviewed its onsite database to confirm the validity of the data as described in the supplemental response to RAI 02.03.04-3, dated March 30, 2010 (ADAMS Accession No. ML100960472), and provided a revised 2001-2007 onsite database in a supplemental response to environmental RAI AQ2.7-3, dated March 30, 2010 (ADAMS Accession No. ML093090165). The staff performed a precursory review of the revised database and determined that the database still contained errors. The staff subsequently issued RAI 02.03.02-7 asking the applicant to review the revised 2001-2007 onsite meteorological database for mislabeled hours and for DB and dew-point temperature data that were out of range and drastically different from the surrounding data and revise the database accordingly.

In response to RAI 02.03.02-7, dated September 2, 2010 (ADAMS Accession No. ML102570700), the applicant states that it conducted a comprehensive review of the onsite meteorological database to identify instances where the hourly DB and dew-point temperature data may be out of range. The applicant flagged for further analysis those hours with a temperature change of ±3 degrees C from the previous hour. The applicant reviewed the validity of the flagged data by considering frontal passages, precipitation events, sea/land breezes, or instrument malfunctions, and also by comparisons with hourly observations at the Detroit Metropolitan Airport. The applicant subsequently identified 25 hours in the 2001-2007 database that contained questionable DB or dew-point temperature values as compared with their surrounding hourly values. The 25 hours amount to about 0.04 percent of the over 60,000 observations contained in the 2001-2007 onsite meteorological database. The applicant further states that no additional hours were found where wind speed, wind direction, or stability class data were considered questionable. The applicant stated that these problematic data have no or minor impact on the SACTI cooling tower plume modeling analysis and the JFD tables of wind speed, wind direction, and atmospheric stability presented in the FSAR. In addition, the applicant revised the monthly and annual onsite dew-point temperature summary presented in FSAR Table 2.3-212. The applicant provided a revised 2001-2007 onsite database in its response to RAI 02.03.02-7 which corrected the mislabeled hours and the questionable DB and dew-point temperature data.

The staff examined the applicant's revised onsite database for mislabeled hours and large hour-to-hour changes in parameter values by performing time-series plotting and found no discontinuities in time labels or out-of-range data. The staff also compiled its own monthly and annual dew-point temperature statistics, which it compared with the revised summary table (FSAR Table 2.3-212) presented by the applicant. The staff found the two sets of dew-point temperature data statistics to be consistent (within 0.056 degree C [0.1 degree F]). Accordingly, the RAI 02.03.02-7 is considered resolved.

The staff issued RAI 02.03.02-8 asking the applicant to confirm the extreme monthly DB temperature values presented in Revision 2 to FSAR Table 2.3-211 for the Detroit Metropolitan Airport. The applicant derived the values presented in FSAR Table 2.3-211 using the NCDC's ISHD. The staff also compiled extreme monthly DB temperature values from the ISHD and found discrepancies between the applicant's values and the staff's values.

In response to RAI 02.03.02-8, dated September 2, 2010 (ADAMS Accession No. ML102570700), the applicant confirmed that it also found data discrepancies that occurred through the use of different versions of the ISHD database; i.e., a full ISHD format used by the staff versus an abridged ISHD format used by the applicant. The applicant reported the apparent data discrepancies to the NCDC. The NCDC acknowledged that its application that is used to generate the abridged ISHD format contained an error and began working to resolve the issue. The applicant reanalyzed the DB temperature data using the full ISHD format and revised the Detroit Metropolitan Airport extreme monthly DB temperature values reported in FSAR Table 2.3-211 accordingly. The applicant incorporated the revised Table 2.3-211 into Revision 3 of the FSAR. Therefore, RAI 02.03.02-8 is considered resolved.

The staff compiled its own monthly DB temperature statistics from the onsite and Detroit Metropolitan Airport data and compared its statistics with the revised DB statistics in the applicant's proposed revision to FSAR Table 2.3-211. In general, the discrepancies between the two are within an acceptable range, but a couple of monthly values are different by more than one degree F: For example, the staff compiled a mean January temperature for the Detroit Metropolitan Airport of –3.3 degree C (26.1 degree F) as compared to the applicant's value of –2.6 degree C (27.4 degree F); similarly, the staff compiled a 60-meter onsite minimum September temperature of 5.5 degree C (41.9 degree F) as compared to the applicant's value of 2.9 degree C (37.3 degrees F). These few temperature discrepancies do not affect the staff's determination that the applicant has adequately described the temperature conditions at the Fermi 3 site.

b. Atmospheric Moisture

In FSAR Subsection 2.3.2.1.2, the applicant compares long-term atmospheric moisture parameters (relative humidity, wet-bulb temperature, and dew-point temperature) among the three first-order NWS stations in the region surrounding the Fermi site. In FSAR Section 2.3.2.1.2, the applicant states that the atmospheric moisture content for stations in the Fermi region is directly related to the latitude of the station and, to a smaller extent, the distance from the Lake Erie shoreline. The applicant indicates that the atmospheric moisture conditions at the Detroit Metropolitan Airport are representative of those at the Fermi site and the atmospheric moisture content at the Fermi site is influenced by Lake Erie and the other Great Lakes.

During the five-year period 2003–2007, the applicant found that the Fermi site meteorological data shows the mean annual dew point temperature for the Fermi site to be 3.1 degree C (37.6 degree F), with the mean monthly dew point temperature highest during July and August (14.5 degree C [58.1 degree F]) and lowest in February (–9.1 degree C [15.7 degree F]). The highest dew point temperature measured was 23.7 degree C (74.7 degree F) while the lowest dew-point temperature measured was –29.9 degree C (–21.8 degree F). Mean monthly diurnal variations in dew point vary the least during summer and early fall when mean dew point temperatures are highest.

The NRC staff has evaluated and confirmed the applicant's statements about monthly and annual, dew point temperature data summaries at the Fermi site in FSAR Subsection 2.3.2.1.2 using 2003–2007 hourly meteorological data from the Fermi station. The staff therefore concludes that the applicant has adequately described the atmospheric moisture conditions at the Fermi 3 site.

c. Precipitation

In FSAR Subsection 2.3.2.1.3, the applicant states that the Fermi onsite meteorological station precipitation sensor malfunctioned several times during the 2003–2007 period, so the applicant used precipitation records for the Detroit Metropolitan Airport to describe the precipitation characteristics of the Fermi site. The applicant characterized the Fermi region as having consistent precipitation amounts during the year and routine wintertime snowfall. The applicant concluded that, when comparing precipitation data from NWS first-order and COOP stations in the Fermi region, precipitation values are reasonably uniform over the region, and therefore are representative of precipitation that would be observed at the Fermi site.

The applicant found that the highest 24-hour precipitation amount measured at the seven stations used to characterize the Fermi Unit 3 site climate was 15.3 cm (6.04 inches) during September 1950 at Flint. The highest monthly precipitation, 28.0 cm (11.04 inches), was also observed at Flint during August 1975. Based on the most recent five years of data from the Detroit Metropolitan Airport (2003–2007), the applicant found precipitation was recorded about 16 percent of the time. January experiences the most frequent hourly precipitation while September has the lowest. The applicant also found that majority of hourly precipitation is of light intensity (less than 0.25 cm [0.1 inches]), and hourly rainfall events greater than 1.27 cm (0.50 inches) occur most frequently with winds from the southwest and south-southwest.

The staff evaluated and confirmed the applicant's statements in FSAR Subsection 2.3.2.1.3 by reviewing NCDC's Local Climatological Data Summary for the three first-order NWS stations (Detroit, Flint, and Toledo) and Climatography for four COOP stations (Adrian 2 NNE, Ann Arbor, Monroe, and Windsor) in the Fermi region and the NCDC's TD-3240 hourly precipitation data at Detroit Metropolitan Airport for the period 2003–2007.

d. Fog and Smog

In FSAR Subsection 2.3.2.1.4, the applicant uses 1961–1995 hourly surface observation data from the Detroit Metropolitan Airport to describe fog and smog conditions at the Fermi site. The applicant stated that the Detroit Metropolitan Airport is the nearest NWS station that monitors visibility and fog. Detroit Metropolitan Airport also has similar elevation and relative proximity to Lake Erie as does the Fermi site, implying that fog conditions would be similar for the two locations. The applicant stated that fog[2] occurred 12.7 percent of the time (1112 hours per year) at Detroit Metropolitan Airport. Fog is most frequent in November and December (14.8 and 17.4 percent, respectively) and least frequent in June and July (9.0 and 9.3 percent, respectively). Heavy fog, defined as a horizontal visibility of 0.4 km (0.25 mi) or less, was found by the applicant to occur about 0.7 percent of the time (60.2 hours per year), most frequently (8 to 11 hours per month) during December through March and least frequently (1 to 2 hours per month) during April through July. The applicant found that smog, defined as a combination of fog and smoke, occurred most frequently during summer and early fall (June through September), and is characterized by warmer air above the surface and lighter winds. This corresponds with the months of weak atmospheric dispersion conditions.

[2] The applicant states that fog is reported by the NWS when horizontal visibility is less than or equal to 9.7 km (6 mi) and the difference between the temperature and dew point is five degrees F or less. However, per SAMSON and HUSWO data format, fog is recorded when visibility is less than 11.3 km (7 mi).

The staff has evaluated and confirmed the applicant's statements in FSAR Subsection 2.3.2.1.4 using 1961–1995 hourly surface observation data for the Detroit Metropolitan Airport (NCDC's SAMSON database for 1961–1990 and HUSWO database for 1991–1995 on CD-ROMs).

e. Wind Direction and Wind Speeds

In Subsection 2.3.2.1.5 of the FSAR, the applicant compares the wind direction and wind speed characteristics of the Fermi site and the Detroit Metropolitan Airport in FSAR Subsection 2.3.2.1.5. The applicant states that the mean annual wind speeds for the 10-meter (33-foot) and 60-meter (197-foot) levels at the Fermi site were 10.6 km/hr (6.57 mph) and 20.5 km/hr (12.74 mph), respectively. The mean annual wind speed at the Detroit Metropolitan Airport is reported as 14.1 km/hr (8.75 mph) at the 10-meter (33-foot) level. The applicant attributes the differences in wind speeds at 10-meter (33-foot) level between the Detroit Metropolitan Airport and the Fermi site to land use characteristics (e.g., Detroit Metropolitan Airport has a flat and suburban location versus the Fermi meteorological tower which is located near a grove of trees that may be reducing the measured wind speed at the 10-meter [33-foot] elevation). Due to frictional effects of the earth's surface, wind speeds at the 60-meter (197-foot) level at the Fermi site are considerably higher than those at the 10-meter (197-foot) level at the Fermi site and the Detroit Metropolitan Airport.

The applicant states that wind directions at the Detroit Metropolitan Airport and at the Fermi site are predominantly from the southwesterly directions and wind directions with a northwesterly component are the second most comment direction. Monthly wind roses for Detroit Metropolitan Airport show definite wind direction patterns by season, depending on the location of the Bermuda High and mean storm track. There is a greater frequency of easterly and southeasterly winds at the Fermi site when compared to the Detroit Metropolitan Airport at the 10-meter (33-foot) level, which the applicant attributes to onshore lake breezes which occur more frequently at the Fermi site.

The staff independently plotted annual and monthly wind roses using 2003–2007 meteorological data from the Fermi site and the Detroit Metropolitan Airport. The staff has confirmed that the applicant's statements in FSAR Subsection 2.3.2.1.5 are correct.

The NRC staff issued RAI 02.03.02-1 requesting the applicant to review and explain the reason for the differences in ratios between 10-meter (33-foot) and 60-meter (197-foot) onsite wind speeds, compared with other meteorological towers. Staff experience indicates 60-meter (197-foot) wind speeds are typically 1.2–1.6 times higher than the 10-meter (33-foot) wind speed during the day and twice as high or higher at night. The Fermi site wind roses appear to show a difference of a factor of about 2 for all hours combined, whereas the staff would expect a factor closer to 1.5 to 1.7. In response to RAI 02.03.02-1, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant stated that the differences between 10-meter (33-foot) and 60-meter (197-foot) wind speeds were possibly due to the presence of the polar jet, the occurrence of offshore winds, and deciduous tree growth to the west of the onsite meteorological tower. The impacts of the apparent increasing frequency of low wind speed observations due to the flow blockage resulting from the trees to the west of the Fermi meteorological tower is discussed further in the applicant's response to RAI 02.03.03-1 in SER Section 2.3.3. RAI 02.03.02-1 is therefore considered resolved.

The NRC staff issued RAI 02.03.02-2 requesting the applicant to address whether the contents of FSAR Figure 2.3-204 changed from a precipitation rose in FSAR Revision 0 to a wind rose in FSAR Revision 1. In response to RAI 02.03.02-2, dated February 8, 2010 (ADAMS Accession

No. ML093570220), the applicant stated that the FSAR Figure 2.3-204 precipitation rose graphic in Revision 0 was correct and revised Figure 2.3-203 in FSAR Revision 2 to once again be a precipitation rose. Thus RAI 02.03.02-2 is considered resolved.

The NRC staff issued RAI 02.03.02-3 requesting the applicant to describe the methodology it used to generate the Detroit Metropolitan Airport wind and precipitation roses presented in FSAR Figures 2.3-204 through 2.3-229. The applicant used wind direction data from the ISHD database to develop these figures and the wind direction data in the ISHD database are reported to the nearest 10 degrees. However, the precipitation and wind rose wind directions plotted from the ISHD database by the applicant are binned into sixteen 22.5 degree sectors, which means the reported wind direction data are typically more concentrated in the four cardinal directions (N, E, S, and W) if wind direction randomization is not applied. In response to RAI 02.03.02-3, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant stated that it randomized the wind directions in order to prevent directional bias for the four cardinal wind directions. Because the applicant used randomized wind direction data to generate the Detroit Metropolitan Airport wind and precipitation roses, RAI 02.03.02-3 is considered resolved.

f. Wind Persistence

In FSAR Subsection 2.3.2.1.6, the applicant presented wind direction persistence summaries based on measurements at the Fermi site for the five-year preoperational period 2003 through 2007. The summaries account for consecutive hours of wind direction at 10-meter (33-foot) and 60-meter (197-foot) levels from the 22½-degree (single) and 67½-degree (three adjoining) wind sectors. The applicant reports in FSAR Section 2.3.2.1.6 that the longest persistence periods for a single sector were 31 hours (in the north and southwest sectors) at the 10-meter level and 36 hours at the 60-meter level (in west-southwest sector). The longest persistence periods for three adjoining sectors occurred 158 hours (west-southwest) at both 10-meter (33-foot) and 60-meter (197-foot) levels.

The staff issued RAI 02.03.02-9 asking that the applicant provide the methodology used to generate the wind direction persistence summaries for the 67½-degree wind sectors. The NRC staff performed an independent analysis of these statistics and found similar distributions of persistence for the 22½-degree wind sectors. However, the staff could not reproduce the applicant's values for the 67½-degree wind sectors.

In response to RAI 02.03.02-9, dated September 2, 2010 (ADAMS Accession No. ML102570700), the applicant provided detailed step-by-step procedures and a schematic diagram describing its methodology for generating the 67½-degree wind sector persistence summaries. The staff processed the onsite meteorological data using the applicant's methodology and compared its results to the applicant's results. There are some discrepancies between the staff's and the applicant's wind persistence summaries, especially for the 67½-degree wind sectors, but the staff does not consider these discrepancies to be significant. Consequently, the staff finds the applicant's wind direction persistence summaries to be acceptable and thus considers RAI 02.03.02-9 to be resolved.

g. Mean Monthly Mixing Heights

In FSAR Subsection 2.3.2.1.7, the applicant noted that from a climatological standpoint, the lowest morning mixing heights occur in the summer and fall and the highest mixing heights occur in the winter. Conversely, afternoon mixing heights reach a seasonal minimum in the winter and a seasonal maximum during the summer, which is expected because of more intense summer heating. The applicant presented on a monthly and annual basis mean morning and afternoon mixing height data calculated by NCDC during 2003–2007 for White Lake, Michigan, which is located about 84 km (52 mi) north-northwest of the Fermi site. The NCDC calculated daily morning and afternoon mixing height data based on vertical temperature and wind information at White Lake along with surface data from the Detroit Metropolitan Airport.

The NRC staff has confirmed that the applicant's annual and monthly morning and afternoon mixing height statistics for White Lake, Michigan, are correct by processing the NCDC 2003–2007 twice-daily mixing height data.

h. Inversions

An air stagnation event is associated with persistent light or calm winds and the presence of an inversion, which is defined as an increase in temperature with height. In FSAR Subsection 2.3.2.1.8, the applicant describes the annual and monthly frequency and persistence of temperature inversions for the 2003–2007 time period, based on the temperature difference (ΔT) between the 10-meter (33-foot) and 60-meter (197-foot) levels at the Fermi onsite meteorological tower being greater than zero. An inversion was present for 13,098 of the 42,800 hours analyzed during the five-year period, which was equivalent to about 30.6 percent of the total hours. About 48.5 percent of the inversions lasted six hour or less, while about 1.3 percent of the inversions lasted longer than 24 hours, with the longest one lasting 76 hours. Inversions are more common during March through October and are most prominent during the summer months of June through August. The applicant states that this concurs with the findings by Wang and Angell (NOAA/Air Resources Laboratory ATLAS No. 1, "Air Stagnation Climatology for the United States (1948-1998)," April 1999) that air stagnation days are highest during July through September.

A comparison of an estimate made by the NRC staff from the hourly ΔT data submitted by the applicant with the summary table presented by the applicant showed reasonable agreement.

i. Atmospheric Stability

In FSAR Subsection 2.3.2.1.9, the applicant discusses atmospheric stability, which is a critical parameter for estimating dispersion characteristics. The dispersion of effluents is greatest for extremely unstable atmospheric conditions (i.e., Pasquill Stability Class A) and decreases progressively through extremely stable conditions (i.e., Pasquill Stability Class G). The applicant based its stability classification on temperature change with height (i.e., vertical temperature difference or ΔT) between the 60-meter and 10-meter height, as measured by the Fermi onsite meteorological monitoring program during the five-year preoperational period 2003–2007 in accordance with the guidance provided in RG 1.23.

The applicant provided seasonal and annual frequencies of atmospheric stability classes. According to the applicant, there is a predominance of neutral stability (Pasquill Stability Class D) and slightly stable (Pasquill Stability Class E) conditions about 56 percent of the time at the proposed Fermi 3 site, which range from approximately 45 percent of the time during the summer to approximately 68 percent of the time during the winter. Extremely unstable conditions (Pasquill Stability Class A) occur most frequently during the summer and least frequently during the winter. Conditions that are extremely and moderately stable (Pasquill Stability Classes G and F, respectively) occur most frequently during the summer and fall months.

The frequency of occurrence for each stability class is one of the inputs to the dispersion models used in FSAR Sections 2.3.4 and 2.3.5. The applicant included these data in the form of a JFD of wind speed and direction data as a function of the stability class. A comparison of a JFD developed by the staff from the hourly data submitted by the applicant with the JFD developed by the applicant showed reasonable agreement.

Based on the NRC staff's past experience with stability data at various sites, a predominance of neutral (Pasquill Stability Class D) and slightly stable (Pasquill Stability Class E) conditions at the proposed Fermi site is considered generally consistent with expected meteorological conditions. A more detailed review of the applicant's hourly ΔT data is provided by the staff in Section 2.3.3 of this SER.

Regional Topography

The proposed Fermi Unit 3 site is located in the northeastern part of Monroe County, Michigan, along the western shoreline of Lake Erie. In FSAR Section 2.3.2.2, the applicant presents maps of topographical features within a 5-mile (8-km) and a 50-mile (80-km) radius of the site. The applicant also presents terrain elevation profiles along each of the 16 standard 22½-degree compass radials to distances of 5 miles (8 km) and 50 miles (80 km). Based on these profiles, the applicant characterizes the proposed Fermi Unit 3 site terrain as flat plains that gently slope to higher elevations to the west and northwest of the site (towards the Irish Hills) and to lower elevations to the northeast clockwise to the southwest of the site (towards Lake Erie).

Based on topography data from the U.S. Geological Survey (USGS) and on a site visit, the staff accepts this terrain characterization. The NRC staff concludes that the applicant has provided the necessary topographic information.

Influence of Fermi 3 and Its Facilities on Local Meteorology

In FSAR Subsection 2.3.2.2, the applicant states that potential impacts from construction activities for Fermi Unit 3 on the local climate are expected to be minor. Fermi Unit 3 will be located in the southwest portion of the Fermi site, which is already cleared of trees and may require a low level of grading, leading to minimal change in the overall topography. In addition, construction of new roads for the new facility and addition of new structures would have little to no effect on the local meteorology of the site. The staff accepts that these construction activities are too small in scale to impact the local meteorological characteristics of the site.

The NDCT for Fermi 3 will be built in the approximate location of the current onsite meteorological tower. Thus, a new meteorological tower will be erected in the southeast corner of the Fermi site (approximately 1268 meters [4160 feet]) from the existing meteorological tower) prior to the construction of Fermi 3. In FSAR Subsection 2.3.2.2, the applicant discusses the possible influence of Fermi 3 and its facilities on the proposed location of the new meteorological tower. The staff's review of this discussion is in Section 2.3.3 of this SER.

The applicant states that emissions of particulate matter and cooling tower plumes associated with large electricity generation could have effects on the local climate. Potential air emission sources of particulate matter include two standby diesel generators, an auxiliary boiler, a diesel fire pump, and increased traffic. Given their small size and infrequent operation, the applicant states that these emission sources will have a minimal impact on the local climate as well as the local and regional air quality. The staff finds the applicant's assessment to be acceptable.

The applicant states that plumes emitted from cooling towers can also influence local climate. Fermi Unit 3 will use the NDCT as a primary means of heat dissipation and two multi-cell mechanical draft cooling towers (MDCTs) as an auxiliary cooling method. The applicant stated that the potential meteorological effects due to the operation of these cooling towers may include enhanced ground-level fogging and icing, plume shadowing, as well as increased salt deposition.

The applicant states that the operation of the two multi-cell MDCTs is expected to be minimal because they will be used to dissipate heat from the plant service water system primarily during plant cool down and shutdown. For this reason, the applicant considers the environmental impact associated with the operation of the two multi-cell MDCTs to be bounded by the impacts associated with the NDCT and therefore only evaluated the potential plume impacts associated with the operation of the NDCT.

The applicant modeled the NDCT plume impacts with EPRI's Seasonal/Annual Cooling Tower Impact (SACTI) prediction code. The applicant states that this model is endorsed by the staff's Environmental Standard Review Plan (NUREG-1555). The applicant executed the SACTI model using five years (2003 through 2007) of meteorological data provided as input to the code in the NCDC card deck 144 (CD-144) format. Wind direction, wind speed, dew-point temperature, and DB temperature data were taken from the onsite meteorological tower. When the CD-144 format is used as the meteorological input to SACTI, the model determines stability class based on measured wind speed, ceiling height, cloud cover, solar elevation angle, and time of day. Because the onsite meteorological tower does not record ceiling height or cloud cover data, these data were obtained from the Detroit Metropolitan Airport. Mean monthly mixing height data from White Lake, Michigan were also used as input to the SACTI cooling tower model analysis.

The NRC staff issued RAI 02.03.02-4 requesting the applicant to justify why meteorological data were provided as input to the code in the CD-144 format instead of the optional NRC format. If the meteorological data were to be provided as input in the NRC format mode, the SACTI code would determine stability class using the NRC RG 1.23 ΔT methodology instead of the ceiling height/cloud cover method mentioned above. In response to RAI 02.03.02-4, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant justified its use of the CD-144 format by stating that no format example or references to any formatting guides are provided in the SACTI user's manual and the NRC format expected by SACTI code is not the official meteorological format published by the NRC in Appendix A of RG 1.23. The applicant further stated that the SACTI model is not extremely robust when it comes to the execution of its code. For example, only two of the five years of onsite data in the NRC format (2005 and 2006) executed successfully and the model did not provide error messages as to why the other three years of onsite data in NRC format would not execute. The applicant compared the results using the five years of meteorological data in the CD-144 format with the results using the two years of meteorological data in the NRC format and concluded there were no significant changes in model-predicted results between the two data sets. The applicant stated that parameters such as maximum annual and seasonal plume length and average hours per year of shadowing showed a decrease in impacts when using the NRC-formatted dataset whereas other parameters such as maximum annual water deposition showed a slight increase. The applicant further stated that maximum annual and seasonal salt deposition showed no change between the two datasets. The NRC staff finds the applicant's assessment acceptable because the staff also ran the SACTI code using onsite meteorological data in the NRC format input to the model and obtained similar results (for example, less than one percent difference in the annual average plume lengths).

In RAI 02.03.02-4, the staff requested the applicant to justify the use of a surface roughness of 100 cm as input to the SACTI cooling tower model analysis. The applicant assumed that the area surrounding the site is an urban environment (a roughness height of 100 cm) by considering that the Fermi facility is an industrial complex. However, the farther area is agricultural land or water bodies. The area of interest is somewhere between urban and rural. In response to RAI 02.03.02-4 (ADAMS Accession No. ML093570220), the applicant stated that it found that the SACTI model shows no sensitivity in the selection of surface roughness heights between 10 cm and 100 cm (0.33 ft and 3.28 ft) for a NDCT analysis. The NRC staff ran the SACTI code with different surface roughness and also found that the SACTI code is insensitive to surface roughness length. Thus the staff accepts the applicant's conclusion because it meets the requirements of 10 CFR 52.79(a)(1)(iii),10 CFR 100.20(c)(2), and 10 CFR 100.21(d).

In the RAI 02.03.02-4, the staff also requested the applicant to justify the use of mean monthly mixing heights as inputs to the SACTI cooling tower model analysis, even though twice-daily morning and afternoon mixing height data are available and are accepted as input by the SACTI code. In response to RAI 02.03.02-4, the applicant stated that monthly average mixing height data were chosen to simplify the analysis since the NCDC twice daily mixing height data would undoubtedly contain missing height values which would require data filling and substitution. The applicant also performed a mixing height sensitivity analysis between monthly mixing heights and twice-daily mixing heights and concluded that there were no significant changes in the model-predicted results between the two data sets. In comparing the model results using the twice-daily mixing height data versus the monthly mixing height data, the applicant found a decrease in maximum annual and seasonal plume lengths and average hours per year of shadowing, no change in maximum and seasonal salt deposition, and a slight increase in maximum water deposition. The NRC staff reran the SACTI code with different mixing height inputs and also found that the SACTI code is insensitive to mixing height input option. Thus the staff accepts the applicant's assessment.

For the reasons stated above, the staff considers RAI 02.03.02-4 to be resolved.

The applicant used its SACTI model runs to conclude that the annual average plume length is 1.15 miles (1.85 km), with seasonal average plume lengths ranging from a high of 1.47 miles (2.37 km) during winter to a low of 0.24 miles (0.39 km) during the summer. The applicant stated that cooling tower plumes will influence some of the ground level meteorological variables very near the base of the cooling tower. The applicant stated that the NDCT draws air at the base of the tower by the driving force of a density differential that exists between the heated (less dense) air inside the stack and the relatively cool (more dense) ambient air outside the tower. As air rises in the tower, it begins to cool and eventually saturates, which forms a plume at the top of the tower. The air flow toward the cooling tower is localized, and thus its effects will likely be limited to the Fermi property. In addition, a hyperbolic-shaped tower such as the NDCT creates a wake effect to the downwind distance of about five times the width of the top of the tower, i.e., about 445 meters (1460 feet). The applicant stated that some of the heat and moisture from the plume is transported downward to the ground downwind of the NDCT and therefore slightly warmer temperatures and increase absolute humidity can be expected at times within a few hundred feet of the tower. The applicant also reported that the SACTI code predicts a water deposition rate for the NDCT of about 0.00001 mm per month, which corresponds to 0.0001 percent of the mean monthly rainfall of the driest month at the Detroit Metropolitan Airport. Thus, water deposition (additional precipitation) from the NDCT is anticipated to be small at the Fermi site. Ground-level fogging occurs when the visible plume strikes the ground. Icing occurs when the visible plume strikes the ground under freezing conditions. Fogging and icing from the NDCT are very unlikely, and thus the SACTI code does not compute fogging and icing impacts for the NDCT.

The staff issued RAI 02.03.02-5 requesting the applicant to provide estimates of the likelihood of drizzle icing effects from the NDCT. The Revision 1 to FSAR Subsection 2.3.2.2.2 addressed icing as a result of fogging from the NDCT plume, but did not discuss icing resulting from drizzle produced by the NDCT plume. In response to RAI 02.03.02-5, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant stated that drizzle and light snow have been observed downwind of the NDCT but it is rare and localized. The applicant further stated that freezing drizzle from the NDCT occurs less frequently, as the surface temperature has to be at or below freezing for freezing drizzle to occur. The SACTI code predicts that water deposition rate from the NDCT to be less than 0.0001 percent of the mean monthly rainfall of the driest month. This would result in an even smaller percent of contribution. The staff finds the applicant’s analysis to be reasonable and RAI 02.03.02-5 is considered resolved.

The staff issued RAI 02.03.02-6 asking the applicant to revise FSAR Subsection 2.3.2.2 to address the effects of the NDCT moisture and salt deposition on electrical transmission lines and electrical equipment (including transformers and switchyard). In response to RAI 02.03.02 6, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant stated that due to the high initial plume height, the SACTI modeling predicts that no salt will be deposited within 4100 meters (13,500 feet) of the NDCT. Given this large distance, no salt deposition is expected at the existing Fermi Unit 2 switchyard or the planned Fermi Unit 3 switchyard and main transformer area, all of which are located within the Fermi property. The other electrical equipment associated with the operation of Fermi Unit 3 are the transmission lines running offsite. The applicant predicted that the maximum seasonal salt deposition rate of 0.02 kilograms per square-kilometer per month ($kg/km^2/month$) (0.017 pounds per square mile per month [$lb/mi^2/month$]) will occur between 4400 and 9400 meters (14,400 and 30,800 feet) east-northeast of the NDCT. The applicant stated that this value is well below the lowest bound salt deposition density level of 300 kg/km^2 for light contamination environments suggested by the Institute of Electrical and Electronics Engineers (IEEE) Standard (Std) C57,19.100-1995 (IEEE-Guide for Application of Power Apparatus Bushings). The applicant concluded that cumulative salt deposition buildup would not cause a contaminated environment on electrical equipment because the predicted maximum monthly deposition rate is in orders of magnitude below the light contamination level and natural precipitation would wash off salt deposition before significant salt buildup would occur.

The staff ran the SACTI code and found that maximum seasonal salt deposition occurs at a rate about four times higher than the applicant’s value and at closer distance but still beyond the Fermi property boundary. The staff’s estimate is still well below the lowest bound salt deposition density level of 300 kg/km^2 (255.47 lb/mi^2) for light contamination environments suggested by IEEE Std C57,19.100-1995. For this reason, the NRC staff finds that the applicant’s conclusion that the operation of the NDCT is not expected to adversely impact the electrical transmission lines and other electrical equipment to be reasonable, and thus considers RAI 02.03.02-6 to be resolved.

The staff ran the SACTI code to examine the plume behaviors using the same tower-specific data, such as tower dimensions, circulating water flow rate, drift loss rate, exit air flow rate, heat rejection rate, and drift droplet diameter spectrum. Rather than using the CD-144 format from the applicant, the staff used onsite meteorological data in the NRC format input to the model and obtained similar results as described above. The staff has verified the applicant's SACTI modeling results and concludes that the applicant has demonstrated that the results presented in the FSAR are a representative and valid analysis of potential impacts associated with operation of the proposed NDCT.

2.3.2.5 *Post Combined License Activities*

There are no post-COL activities associated with this section.

2.3.2.6 *Conclusion*

The NRC staff has reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

In addition, the staff compared the information in the COL application to the relevant NRC regulations, the guidance in Section 2.3.2 of NUREG–0800, and the applicable NRC regulatory guides. The NRC staff's review finds that the applicant has presented and substantiated information describing the local meteorological, air quality, and topographic characteristics important to evaluating the adequacy of the design and siting of this plant. The staff reviewed the information provided and, for the reasons given above, concludes that the identification and consideration of the meteorological, air quality, and topographical characteristics of the site and the surrounding area are acceptable and meet the requirements of 10 CFR 100.20(c)(2) and 100.21(d), with respect to determining the acceptability of the site.

The staff finds that the applicant has considered the appropriate site phenomena in establishing the site characteristics. Specifically, the staff has generally accepted the methodologies used to determine the meteorological, air quality, and topographic characteristics as documented in SERs for previous licensing actions. Because the applicant has correctly implemented these methodologies, as described above, the staff has determined that the use of these methodologies results in site characteristics containing margin sufficient for the limited accuracy, quantity, and period of time in which the data have been accumulated. The staff concludes that the identified site characteristics meet the requirement of 10 CFR 52.79(a)(1)(iii) with respect to identifying the most severe of the natural phenomena historically reported for the site and surrounding area and with a sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated.

The staff's review confirms that the applicant has adequately addressed the COL license information item in accordance with Section 2.3.2 of NUREG–0800.

2.3.3 Meteorological Monitoring

The current Fermi onsite Meteorological Monitoring Program (MMP) has been in place since it was implemented for Fermi 2 pre-operational meteorological assessment beginning in June 1975.

2.3.3.1 *Introduction*

This FSAR Section addresses the pre-application meteorological measurements program as well as the onsite MMP to be used during site preparation and construction, pre-operation, and operation (i.e., the operational meteorological measurements program). The staff's review covers the following specific areas: meteorological instrumentation, including siting of sensors, sensor type and performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, data acquisition and reduction procedures, and special considerations for complex terrain sites.

The staff's review also evaluated the resulting onsite meteorological database from the pre-application monitoring phase, including consideration of the period of record and amenability of the data for use in characterizing atmospheric dispersion conditions.

2.3.3.2 *Summary of Application*

Subsection 2.3.3, "Meteorological Monitoring," of the Fermi 3 COL FSAR addresses site-specific information on the onsite meteorological measurement program. In addition, in FSAR Section 2.3.3, the applicant provides the following:

<u>*COL Item*</u>

- EF3 COL 2.0-9-A Onsite Meteorological Measurements Program

  The purpose of this section is to confirm that the onsite meteorological measurements program provides an adequate meteorological database for estimating atmospheric dispersion for design basis accident and routine radiological releases and for evaluating the effects of plant operation.

2.3.3.3 *Regulatory Basis*

The acceptance criteria for an onsite meteorological measurements program are based on meeting the relevant requirements of 10 CFR Parts 20, 50, 52, and 100. The staff considered the following regulatory requirements in reviewing the applicant's descriptions of its pre-application and operational onsite meteorological measurements programs:

- 10 CFR Part 20, Subpart D, "Radiation Dose Limits for Individual Members of the Public," with respect to the meteorological data used to demonstrate compliance with dose limits for individual members of the public.

- 10 CFR Part 50, Paragraphs 50.47(b)(4), 50.47(b)(8), and 50.47(b)(9), as well as Section IV.E.2 of Appendix E with respect to the onsite meteorological information available for determining the magnitude and continuously assessing the impact of the releases of radioactive materials to the environment during a radiological emergency.

- 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 19, "Control Room," with respect to the meteorological data used to evaluate the personnel exposures inside the control room during radiological and airborne hazardous material accident conditions.

- 10 CFR Part 50, Appendix I, “Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion ‘As Low as Is Reasonably Achievable’ for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents,” with respect to meteorological data used in determining the compliance with numerical guides for design objectives and limiting conditions for operation to meet the requirement that radioactive material in effluents released to unrestricted areas be kept as low as is reasonable achievable.

- 10 CFR 52.79(a)(1)(vi), with respect to a safety assessment of the site, including consideration of major structure, system and components (SSCs) of the facility and site meteorology, to evaluate the offsite radiological consequences at the EAB and LPZ.

- 10 CFR 100.20(c)(2), with respect to the meteorological characteristics of the site that are necessary for safety analysis or that may have an impact upon plant design in determining the acceptability of a site for a nuclear power plant.

- 10 CFR 100.21(c), with respect to the meteorological data used to evaluate site atmospheric dispersion characteristics and establish dispersion parameters such that (1) radiological effluent release limits associated with normal operation can be met for any individual located off site, and (2) radiological dose consequences of postulated accidents meet prescribed dose limits at the EAB and outer boundary of the LPZ.

NUREG-0800, Section 2.3.3 specifies that an application meets the above requirements, if the application provides the following information:

- The pre-application and operational monitoring programs should be described, including (1) a site map (drawn to scale) that shows tower location and true north with respect to man-made structures, topographic features, and other features that may influence site meteorological measurements, (2) distances to nearby obstructions of flow in each downwind sector, (3) measurements made, (4) elevations of measurements, (5) exposure of instruments, (6) instrument descriptions, (7) instrument performance specifications, (8) calibration and maintenance procedures and frequencies, (9) data output and recording systems, and (10) data processing, archiving, and analysis procedures.

- Meteorological data from the pre-application monitoring program should be presented in the form of JFDs of wind speed and wind direction by atmospheric stability class in the format described in RG 1.23. An hour-by-hour listing of the hourly-averaged parameters should be provided in the format described in RG 1.23. If possible, evidence of how well these data represent long-term conditions at the site should also be presented, possibly through comparison with offsite data.

- At least two consecutive annual cycles (and preferably three or more whole years), including the most recent one-year period, should be provided with the application. These data should be used by the applicant to calculate (1) the short-term atmospheric dispersion estimates for accident releases discussed in FSAR Section 2.3.4 and (2) the long-term atmospheric dispersion estimates for routine releases discussed in FSAR Section 2.3.5.

- The applicant should identify and justify any deviations from the guidance provided in RG 1.23.

When independently assessing the acceptability of the information presented by the applicant in FSAR Section 2.3.3, the NRC Staff applied the same above-cited methodologies and techniques.

2.3.3.4 *Technical Evaluation*

The NRC staff reviewed the application and the applicant's responses to RAIs to verify the accuracy, completeness, and sufficiency of the information regarding meteorological monitoring. The staff followed the procedures in Section 2.3.3 of NUREG–0800 as part of this review.

The NRC staff reviewed the application and the applicant's responses to RAIs to verify the accuracy, completeness, and sufficiency of the information regarding the onsite pre-application and operational meteorological measurements programs. The staff followed the procedures described in Section 2.3.3 of NUREG–0800 as part of this review.

<u>*COL Item*</u>

- EF3 COL 2.0-9-A Onsite Meteorological Measurements Program

This COL information item states that the COL applicant should supply site-specific information in accordance with SRP Section 2.3.3; that is, the COL applicant should describe its onsite meteorological measurements program and provide a copy of the resulting meteorological data. In response to this COL information item, the applicant describes the following:

- A description of the pre-application and operational MMPs, including siting of sensors, sensor type and performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, data acquisition and reduction procedures.

- The meteorological database resulting from the pre-application monitoring program, presented in the form of a JFD of wind speed and direction by atmospheric stability class and an hour-by-hour listing of the hourly-averaged parameters.

The NRC staff reviewed the applicant's resolution to EF3 COL 2.0-9-A related to supplying site-specific information in accordance with SRP Section 2.3.3. The staff's review of the applicant's description of its onsite MMP and the resulting meteorological data is described below.

Fermi 3 Pre-application Meteorological Measurement Program

Subsection 2.3.3.1 of the FSAR discusses the pre-application MMP for Fermi Unit 3 that is based on the preexisting operational meteorological monitoring program and equipment used for Fermi 2.

In Subsection 2.3.3 of the FSAR, the applicant states that the current onsite meteorological monitoring program has been in place since June 1975 and complies with proposed Revision 1 to RG 1.23, except for the proximity of trees to the meteorological tower. The staff notes that most of pre-application meteorological data was collected prior to the implementation of

Revision 1 to RG 1.23. Thus, the staff reviewed the pre-application meteorological monitoring program primarily against the criteria in proposed Revision 1 to RG 1.23.

The information on the pre-application meteorological measurements program presented below is based on information presented in FSAR Subsection 2.3.3.1, applicant's responses to RAIs, and an onsite environmental site audit conducted by the staff on February 2-6, 2009.

a. Tower and Instrument Siting

In Subsection 2.3.3.1.1 of the FSAR the applicant discusses the 60-meter (197-foot) open-latticed guyed meteorological tower that serves as the primary data collection system, including redundant sensors at both the 10-meter (33-foot) and 60-meter (197-foot) levels. The width of the tower at its base exceeds 6 meters (20 feet) and decreases with height. The meteorological sensors are mounted on booms which are greater than one tower width away from the tower and are oriented normal to the prevailing wind direction. The tower is situated in a relative flat area with natural ground cover. A small climate controlled instrument shelter is located at the base of the onsite meteorological tower.

Proposed Revision 1 to RG 1.23 states that the meteorological tower site should represent as close as possible the same meteorological characteristics as the region into which any airborne material will be released. Whenever possible, the tower or mast should be sited at approximately the same elevation as finished plant grade. The height of natural or man-made obstructions to air movement should ideally be lower than the measuring level to a horizontal distance of ten times the measuring level height. Revision 1 to RG 1.23 provides clarifying guidance regarding the tower's proximity to obstructions to air movement, stating that wind sensors should be located over level, open terrain at a distance of at least ten times the height of any nearby obstruction if the height of the obstruction exceeds one-half the height of the wind measurement.

Visual inspection during a site audit conducted February 2-6, 2009, indicated that the distance from the meteorological tower to the nearest obstructions (i.e., a wooded area located west of the tower where some of the trees were higher than 10 meters (33 feet)) did not meet the distance offset criterion identified in Revision 1 to RG 1.23. The applicant stated during the audit that this was a self-identified issue which was entered into the Fermi 2 corrective action system in 2004 and was resolved as having no impact on the monitoring program based on a comparison with historic data collected during the previous 30 years. The staff requested the applicant in RAI 02.03.03-1 to identify the current average height of these trees and their closest distance to the tower. The staff also requested the applicant in RAI 02.03.03-1 to describe the 2004 corrective action evaluation that closed out this issue.

In its original response to RAI 02.03.03-1 (dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant provided a figure showing the current separation between the meteorological tower and nearby trees to the west. This figure showed that there are trees within ten times their height of the meteorological tower. The applicant also stated that it evaluated the impact of the trees by comparing the 10-meter (33-foot) and 60-meter (197-foot) wind roses from the 1974/1975 time frame with 10-meter (33-foot) and 60-meter (197-foot) wind roses from 1985, 1994, 2003, 2004, and 2005 and concluded that there was no significant difference in wind direction and speed patterns between the time periods analyzed.

Based on the information provided by the applicant in its December 23, 2009 response to a similar question (environmental RAI AQ6.4-1), the staff compared the percent of time the wind speed was less than 4.83 km/h (3 mph) between the “downwind sectors” (i.e., when the wind was from the west-southwest clockwise to west-northwest sectors and the meteorological tower was downwind of the trees) and the “upwind sectors” (i.e., when the wind was from the north-northwest clockwise to south-southwest sectors and the meteorological tower was upwind of the trees). This comparison indicated that, at the 10-meter (33-foot) level, the percent of time the wind speed was less than three mph for the downwind sectors increased from 5.6 percent in 1985 to 19.9 percent in 1994 to 26.5 percent in 2003-2005. For the upwind sectors, the percent of time the wind speed is less than three mph at the 10-meter (33-foot) level also increased, but not in such a drastic fashion. The staff noted that there was essentially no change in the percent of time the wind speed was less than 4.83 km/h (3 mph at the 60-meter (197-foot) level for either the upwind or downwind sectors during the time periods analyzed. The staff has determined these statistics support the conclusion that the heights of nearby trees have impacted the wind flow in certain wind direction sectors. The staff provided this feedback to the applicant in an e-mail dated January 26, 2010 (ADAMS Accession No. ML100500226).

In response to the January 26, 2010 e-mail, the applicant provided a supplemental response to RAI 02.03.03-1, dated March 30, 2010 (ADAMS Accession No. ML100960474), stating it performed an additional review of the 10-meter (33-foot) and 60-meter (197-foot) wind roses ranging from 1975 through 2003. The applicant concluded that there is an apparent increase in the percent of time that the indicated wind speed was less than 4.83 km/h (3 mph at the 10-meter (33-foot) elevation for a given wind direction sector and therefore the potential exists for the wind measurements at the 10-meter (33-foot) elevation to be lower than the actual wind speed at the 10-meter (33-foot) elevation. The applicant also assessed the effect of lower measured wind speeds at the 10-meter (33-foot) level on a number of evaluations presented within the FSAR, including the short-term (accident) dispersion estimates presented in FSAR Section 2.3.4 and the long-term (routine) dispersion estimates presented in FSAR Section 2.3.5. Because the applicant acknowledged that nearby trees could be impacting the 10-meter (33-foot) wind speed measurements and assessed the effect of lower measured wind speeds at the 10-meter (33-foot) level on a number of evaluations presented in the FSAR, the staff considers RAI 02.03.03-1 to be resolved. The staff has also evaluated the effects of lower measured wind speeds on the applicable evaluations within Sections 2.3.4 and 2.3.5 of this report.

The staff finds that the tower is appropriately located such that it can measure the onshore flow conditions that could affect gaseous effluent releases from Fermi Unit 3. The effect of the nearby trees on prior measurements and the adjustments made to compensate for lower measured wind speeds due to the proximity of the trees, are described above. In all other respects, the staff finds the tower location complies with the recommendations provided in proposed Revision 1 to RG 1.23 and is therefore acceptable to the staff.

b. Instrumentation and Their Accuracies and Thresholds

In FSAR Subsection 2.3.3.1.2, the applicant states that the meteorological tower instrumentation consists of wind speed and wind direction sensors at the 10-meter (33-foot) and 60-meter (197-foot) levels, a temperature sensor at the 10-meter (33-foot) level, a vertical air temperature difference (ΔT) system between the 60-meter (197-foot) and 10-meter (33-foot) levels, and a dew-point temperature sensor at the 10-meter (33-foot) level. A heated tipping bucket precipitation gauge which is surrounded by a windscreen is located at ground level at the base of the meteorological tower. External heaters are installed on the primary wind sensors to minimize data loss during ice storms.

Based on an onsite environmental site audit conducted by the staff on February 2-6, 2009, the staff noticed that the wind speed and wind direction sensor information provided in Revision 0 to FSAR Table 2.3-289 appeared to be in error. The staff also noticed an apparent discrepancy in the dew point monitoring system description in the FSAR. The staff subsequently asked the applicant in RAI 02.03.03-2 to verify all of the instrumentation information provided in FSAR Table 2.3-289, including sensor performance specifications and system accuracies, and update FSAR Table 2.3-289 accordingly. The applicant was also requested to identify any deviations from the guidance provided in RG 1.23.

The applicant provided a response to RAI 02.03.03-2, dated February 8, 2010 (ADAMS Accession No. ML100960472), in which the applicant updated Table 2.3-289 in FSAR Revision 2 by listing the sensor manufacturer and model numbers, range, system accuracy, starting threshold, and measurement resolution. The applicant also revised Subsection 2.3.3.1.2 in FSAR Revision 2 to state that the accuracies and thresholds for each sensor are within the limits specified in the proposed Revision 1 to RG 1.23. The staff reviewed the response to RAI 02.03.03-2 and determined that the question is closed but there were issues that remained unresolved. To address these issues, the staff issued follow-up question RAI 02.03.03-8.

The staff notes that FSAR Table 1.9-202 is intended to evaluate the applicant's conformance with applicable RGs in effect six months prior to the submittal of the Fermi 3 COLA. Included in Table 1.9-202 of FSAR Revision 2 is the applicant's evaluation regarding the pre-application meteorological monitoring program conformance to Revision 1 to RG 1.23. The staff issued RAI 02.03.03-8 regarding the following information contained in FSAR Tables 1.9-202 and 2.3-289 regarding the pre-application MMP:

- Revision 2 to FSAR Table 2.3-289 lists the differential temperature (ΔT) channel as having a system accuracy of ±0.15 °C which exceeds the Revision 1 to RG 1.23 specified accuracy of ±0.1 °C. The staff requested the applicant to revise the FSAR to address the ΔT channel nonconformance with the system accuracy specified in Revision 1 to RG 1.23, including the impact this nonconformance may have on any analyses presented in FSAR Section 2.3.

  In its response to RAI 02.03.03-8, dated September 2, 2010 (ADAMS Accession No. ML102570700), the applicant stated that pre-application monitoring program ΔT channel accuracy of ±0.15 °C is consistent with the guidance provided in proposed Revision 1 to RG 1.23, which was the regulatory guidance in effect during most of the pre-application monitoring program. The staff finds it acceptable that the majority of the onsite ΔT data submitted by the applicant was collected by a monitoring program that was in compliance with the regulatory guidance in effect at the time. The applicant committed to updating FSAR Subsection 2.3.3.1.2 to state that the accuracy of the ΔT channel does not comply with Revision 1 to RG 1.23 but does comply with proposed Revision 1 to RG 1.23, which was the regulatory guidance in effect during most of the pre-application monitoring program.

- Revision 2 to FSAR Subsection 2.3.3.1.1 states the sensors for the existing pre-application MMP are mounted on booms that are greater than one tower width away from the tower. Revision 1 to RG 1.23 states (1) wind sensors on the side of a tower should be mounted at a distance equal to at least twice the longest horizontal dimension of the tower and (2) temperature sensor shield inlets should at least 1½ times the tower horizontal width away from the nearest point on the tower. The staff asked the applicant to revise the FSAR to clarify whether the pre-application MMP was in conformance with the boom length criteria specified in Revision 1 to RG 1.23. If the pre-application program is not in conformance with Revision 1 to RG 1.23, the staff asked the applicant to discuss the impact the nonconformance may have on any analyses presented in FSAR Section 2.3.

In its response (ML102570700) to RAI 02.03.03-8, the applicant stated that the length of the instrument booms on the Fermi 3 pre-application meteorological tower do not meet the Revision 1 to RG 1.23 criteria of two tower widths. However, the width of the meteorological tower at the 10-meter (33-foot) elevation is nearly 6 meters (20 feet) and the staff finds that boom lengths of 12 meters (40 feet) are not practical. The large open areas between the support frames of such a wide open-lattice tower also tend to lessen the impact from turbulent flow downwind of the tower structure. For these reasons, the staff finds the instrument booms on the pre-application meteorological tower to be acceptable. The applicant committed to updating FSAR Subsection 2.3.3.1.1 to address the pre-application monitoring program boom length exception to Revision 1 to RG 1.23.

- Revision 1 to RG 1.23 specifies a digital sampling rate of at least once every 5 seconds. The staff asked the applicant to revise the FSAR to discuss the digital sampling rates for the pre-application meteorological monitoring program. If the pre-application monitoring program is not in conformance with Revision 1 to RG 1.23, the staff requested the applicant to discuss the impact the nonconformance may have on any analyses presented in FSAR Section 2.3.

  In its response to RAI 02.03.03-8 (ADAMS Accession No. ML102570700), the applicant stated that the digital recorders used for the pre-application meteorological monitoring system sample data at least once every five seconds and therefore meet the sampling criteria in Revision 1 to RG 1.23. The applicant committed to updating FSAR Subsection 2.3.3.1.2 to include the digital recorders sampling rate.

The applicant incorporated the information discussed above into Revision 4 of the FSAR.

The staff finds the applicant's response to RAI 02.03.03-8, dated January 10, 2011 (ADAMS Accession No. ML110110550), to be acceptable for the reasons cited above, except that one issue remained unresolved. To address this issue, the staff issued follow-up RAI 02.03.03-9 which is discussed later in this SER Subsection.

c. Instrumentation Calibration

In FSAR Subsection 2.3.3.1.3, the applicant describes the calibration of the sensors, electronics, and recording equipment. The applicant states the sensors, electronics, and recording equipment are calibrated on a six-month basis. More frequent onsite calibrations are performed if the past operating history of the sensor indicates it is necessary. The applicant states any necessary adjustments are made onsite and the equipment that malfunctioned is either corrected onsite or replaced with similar equipment. After any adjustments or repairs, the calibration is repeated. The records documenting the results of calibration drift and the corrective action taken are kept and filed onsite.

The staff requested the applicant in RAI 02.03.03-3 to describe the calibration practices used to ensure that the wind sensors starting thresholds meet the starting threshold criteria presented in

RG 1.23. The applicant provided a response to RAI 02.03.03-3, dated February 8, 2010 (ADAMS Accession No. ML100960472) in which it describes the calibration practices used. In particular, the applicant states that a wind tunnel is used to determine the starting thresholds of the wind speed sensors and the starting thresholds of the wind direction sensors are assessed by rotating the wind direction sensor body with the shaft in the horizontal plane and observing that the vane remains stationary. Because these are standard industry practices, the staff finds the information provided in the response to RAI 02.03.03-3 acceptable and thus RAI 02.03.03-3 is considered to be resolved. The applicant incorporated this information on wind sensor starting threshold tests into Revision 2 of FSAR Subsection 2.3.3.1.3.

The staff requested the applicant in RAI 02.03.03-4 to clarify the statement made by the Fermi meteorological system engineer, during the February 2–6, 2009, Fermi environmental site audit, that the secondary ΔT channel recorded values were consistently higher than the primary ΔT channel values. The staff requested that the applicant (1) identify the ΔT channel having the more accurate measurements, (2) describe the impact of the ΔT channel offset on the atmospheric dispersion and deposition factors presented in FSAR Sections 2.3.4 and 2.3.5, and (3) describe the corrective actions to be taken to address this apparent deviation from RG 1.23 criteria.

The applicant provided a response to RAI 02.03.03-4, dated February 8, 2010 (ADAMS Accession No. ML100960472), in which it presents the conclusions of a review of the meteorological data that evaluated the differences between the primary and secondary ΔT measurements. The applicant's data review indicates that there is not a consistent variance between the primary and secondary ΔT indications. That is, the secondary ΔT does not always indicate higher than the primary ΔT. Instead, the applicant stated that its data review indicated that the instantaneous readings from the primary and secondary ΔT indications consistently follow each other over time and any difference in temperature indications is random. The applicant further states that the review of ΔT data, meteorological instrumentation, calibration and surveillance requirements and historical records, and system configuration identified no consistent data variance in primary and secondary channel measurements. The applicant also clarified the statement made by the Fermi meteorological system engineer during the site audit that the difference between the primary and secondary ΔT channel recorded values is due to sensor "wobble" that is corrected by the plant computer software.

Because the primary and secondary ΔT indications follow reliably over time and do not exhibit a consistent difference between the two channels, the staff considers this issue to be resolved and therefore considers RAI 02.03.03-4 to be closed.

d. Instrumentation Service and Maintenance

Proposed Revision 1 to RG 1.23 states that meteorological instruments should be inspected at a frequency that will ensure data recovery of at least 90 percent on an annual basis.

In FSAR Subsection 2.3.3.1.4, the applicant describes the service and maintenance of the meteorological sensors and supporting equipment. Visits are made periodically to the 60-meter (197-foot) tower to make a visual inspection of the sensors, as well as the data output and recording equipment in the instrument shelter, to see if they are damaged and need maintenance. In the event the sensors or monitoring equipment are found damaged or malfunctioning, the equipment is replaced or corrected in a timely fashion. A stock of spare parts and equipment is maintained to minimize and shorten the periods of outages. The instrumentation is checked using the same precision test equipment used for calibration.

Records documenting the results of major causes of instrument sensor outages and other malfunctions of the meteorological monitoring system are kept and filed onsite.

The staff finds that instrumentation service and maintenance are in accordance with the guidance of proposed Revision 1 to RG 1.23 and follow standard industry practice.

e. Data Reduction and Transmission

In FSAR Subsection 2.3.3.1.5, the applicant describes the data reduction and transmission. The pre-application MMP is composed of two independent meteorological trains of instrumentation – a primary train and a secondary train – mounted on the meteorological tower. Sensor signals from both trains are independently conditioned inside the environmentally controlled instrument shelter located near the base of the meteorological tower and the outputs from the signal conditioning equipment are transmitted to the Fermi 2 control room via two independent transmission lines. Both trains feed the digital data acquisition equipment belonging to the Integrated Plant Computer System (IPCS) located in the Fermi 2 control room.

The staff finds that data reduction and transmission techniques are performed in accordance with proposed Revision 1 to RG 1.23 and follow standard industry practice.

f. Data Acquisition and Processing

Proposed Revision 1 to RG 1.23 states that meteorological monitoring systems should use a dual recording system consisting of one digital and one auxiliary analog system. The Fermi 3 pre-application monitoring program utilizes dual digital recorders that monitor both trains of instrumentation at the meteorological instrument building to archive raw data. An analog backup recorder is utilized as well.

In FSAR Subsection 2.3.3.1.6, the applicant describes data acquisition and processing. Dual IPCS data acquisition multiplexers accept two trains of data from the primary and secondary data acquisition equipment. These data are provided to the IPCS computers to screen data for data validity and quality, perform meteorological calculations, update the data archive, display the information on the man–machine interface, and output the data to communication devices. The IPCS system monitors error signals to determine equipment status. If an instrument input malfunctions, if data are suspect, or if an instrument input is manually removed from service, the IPCS will substitute the reading from the next level of redundancy and indicate the substitution on the IPCS computers.

The applicant states that the meteorological data are generally reviewed each day by personnel to identify possible data problems. The meteorological data are also validated to ensure that the regulatory requirement for minimum recovery rate of 90 percent (on an annual basis), as outlined in RG 1.23, is met. The data validation process includes utilizing software to review the raw data, identifying and editing questionable or invalid data, recovering data from backup sources, and adjusting the data to reflect calibration sources. After the validation process is completed, the processed data are archived and permanently stored electronically.

Meteorological data are available in five different formats: instantaneous values, 1-minute blocked averages, 15-minute rolling averages, 15-minute block averages, and 1-hour block averages. Routine data summaries are generated for each day, calendar month, and calendar year, and then archived on the IPCS computers. In addition, JFDs of wind speed and wind direction for each stability category are created from the 1-hour block averages. The applicant states that the format of the annual onsite meteorological data summaries and JFD tables conforms to the recommended format found in RG 1.23.

The staff finds that the data acquisition and processing conform to the guidelines in proposed Revision 1 to RG 1.23 and follow standard industry practice.

g. Resulting Meteorological Database

The applicant presented several years of meteorological data from the pre-application MMP to support its Fermi 3 COLA:

- Five years of data (2003-2007) were used for evaluation of site meteorological characteristics and cooling tower plume modeling. JFDs of wind speed, wind direction, and atmospheric stability from the onsite MMP for both the 10-meter (33-foot) and 60-meter (197-foot) levels are provided in FSAR Tables 2.3-269 through 2.3-284 for the period 2003 through 2007.

- Six years of data (2002-2007) were used for calculating the short-term off-site and the long-term atmospheric dispersion estimates. JFDs for the 10-meter (33-foot) level are provided in FSAR Tables 2.3-292 through 2.3-299 for the period 2002 through 2007. The applicant used the data in these tables as input to the dispersion analyses discussed in FSAR Sections 2.3.4 and 2.3.5.

- Seven years of data (2001-2007) were used for calculating the short-term on-site atmospheric dispersion estimates. The applicant provided an hourly listing of the original 2001-2007 onsite meteorological database in its response to environmental RAI AQ2.7-3 dated October 30, 2009.

The staff asked the applicant in RAI 02.03.03-5 to explain apparently data discrepancies within Revision 0 to FSAR Tables 2.3-269 through 2.3-284. In particular, the number of hourly observations reported in these tables (17,533 hours for the 10-meter (33-foot) level and 17,520 hours for the 60-meter (197-foot) level) was considerably less than the 43,842 hours contained in the five-year period 2003-2007. Also, the number of hours reported for each stability category did not total the number of hours reported for all stability categories combined. In its response to RAI 02.03.05-5, dated February 8, 2010 (ADAMS Accession No. ML100960472), the applicant stated that the JFDs in FSAR Tables 2.3-269 through 2.3-284 were incorrect and provided a revised set of tables that were eventually incorporated into Revision 2 to the FSAR. This revised set of tables reported 43,018 hours of data for the 10-meter (33-foot) level and 42,956 hours of data for the 60-meter (197-foot) level. The number of hours reported for each stability category also totaled the number of hours reported for all stability categories. Because the revised set of Tables 2.3-269 through 2.3-284 presented in FSAR Revision 2 addresses the staff’s concerns, RAI 02.03.03-5 is considered to be resolved.

The applicant provided a copy of the original 2001-2007 hourly database to the staff in its response to environmental RAI AQ2.7-3. The staff performed a quality review of this database using the methodology described in NUREG–0917, “Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data,” issued in July 1982. The staff used computer spreadsheets to further review the data. As expected, the staff’s examination of the data revealed generally stable and neutral atmospheric conditions at night and unstable and neutral conditions during the day. Wind speed, wind direction, and stability class frequency distributions for each measurement channel were reasonably similar from year to year.

The staff performed a comparison of stability category frequency distributions (based on the onsite meteorological tower ∆T measurements) between the 1974-1975 period of record reported in the Fermi 2 FSAR Table 2.3-11 and the 2002-2007 period of record reported in Fermi 3 FSAR (Revision 0), Tables 2.3-292 through 2.3-298 and found the following:

Stability Category Frequency Distribution (Values in Percent)

Stability Category	Period of Record	
	1974–1975	2002–2007
A (extremely unstable)	9.2	20.1
B (moderately unstable)	2.1	5.4
C (slightly unstable)	2.4	5.2
D (neutral)	30.3	30.7
E (slightly stable)	40.5	24.5
F (moderately stable)	10.3	9.4
G (extremely stable)	5.3	4.6

In its review of the original 2001-2007 hourly ∆T measurements, the staff also found that during the period 2004-2007 there were approximately 420 occurrences per year (on average) when the autoconvective lapse rate of -3.4 °C per 100 meters was exceeded (the autoconvective lapse rate represents severe extremely unstable conditions when the density of the atmosphere increases with height). Many of these hours exceeded a lapse rate of -5.0 °C per 100 meters. Consequently, the staff issued RAI 02.03.03-6 requesting that the applicant explain the almost 11 percent annual increase in A stability occurrences (from 9.2 percent to 20.1 percent) and the almost 16 percent annual decrease in E stability occurrences (from 40.5 percent to 24.5 percent) from 1974-1975 to 2002-2007. The staff also requested the applicant in RAI 02.03.03-6 to explain the relatively frequent occurrence (approximately five percent of the time annually) of autoconvective lapse rate conditions during 2004-2007.

In its response to RAI 02.03.03-6 dated February 8, 2010 (ADAMS Accession No. ML100960472), the applicant stated that it evaluated the atmospheric stability category frequency distribution for each year from 1995 through 2007 in an effort to correlate any possible data inconsistencies with instrumentation replacements or modifications. The applicant found a noticeable decreasing trend in the frequency of neutral (stability category D) conditions with a corresponding trend in increasing frequency of both stable (stability categories E, F, and G) and unstable (stability Category A, B, and C) conditions. The applicant also reviewed stability information from the Detroit Metropolitan Airport for the same time period and found similar trends in stability conditions. The applicant concluded that although it found a trend in the Fermi onsite stability frequencies, no correlations with instrumentation change-outs were evident and the stability classification trend was also verified to be consistent with other local meteorological data.

The applicant also reported in its response to RAI 02.03.03-6 that approximately 3.9 percent of the hourly ∆T measurements for the years 2001 through 2007 exceeded the autoconvective lapse rate. The applicant found that most of these occurrences were at times when the wind direction was onshore from Lake Erie when strong cold advection is affecting the 60-meter

(197-foot) tower level more than the 10-meter (33-foot) tower level. This occurs because the lower portion of the onshore flow is heated first by the land surface as it comes ashore.

In its supplemental response to RAI 02.03.04-3 dated March 30, 2010 (ADAMS Accession No. ML100960474), the applicant stated that it performed further reviews of the original 2001-2007 hourly database submitted to the staff in its response to environmental RAI AQ2.7-3. Included in this evaluation was a review of the hourly data for cases when the ∆T measurements exceeded the autoconvective lapse rate. The applicant found that most of the occurrences when the wind direction was not onshore from Lake Erie to be improbable and removed these occurrences from the analysis.

The staff has determined that the Fermi onsite meteorological data trends in decreasing frequency of neutral conditions with corresponding increasing frequencies of both stable and unstable conditions is plausible based on similar data trends observed at the Detroit Metropolitan Airport for the same time period. The staff also finds that the applicant's explanation that autoconvective lapse rate occurs during onshore flows with rapid heating at the surface to be plausible. Consequently, the staff considers RAI 02.03.03-6 to be resolved.

The applicant also stated in its supplemental response to RAI 02.03.04-3 that it performed other data reviews to confirm the validity of the original 2001-2007 Fermi onsite meteorological data submitted in response to environmental RAI AQ2.7-3. The applicant also found 460 occurrences where either the 10-meter (33-foot) or the 60-meter (197-foot) measurements were deemed too improbable because of unreasonable ratios between the 10-meter (33-foot) and 60-meter (197-foot) wind speeds and removed these occurrences from the analysis.

As a result of its review of the Fermi onsite meteorological data discussed above, the applicant proposed numerous changes to the FSAR. Included in these proposed revisions were updates to the JFDs presented in FSAR Tables 2.3-269 through 2.3-284 and Tables 2.3-292 through 2.3-299 and the wind roses presented in FSAR Figures 2.3-230 through 2.3-255. The applicant incorporated these revised tables and figures into Revision 4 of the FSAR.

The applicant also provided a copy of the 1985-1989 Fermi onsite meteorological database in its supplemental response to RAI 02.03.03-1, dated March 30, 2010 (ADAMS Accession No. ML100960472). The applicant stated that aerial photographs of the area surrounding the Fermi meteorological tower in 1981 and 1991 confirm the absence of significant air flow obstructions to wind measurements at the 10 meter (33-foot) elevation. Therefore the applicant presented the 1985-1989 meteorological database as an alternative for performing dispersion analysis in those situations where it is not apparent that lower wind speeds measured at the 10-meter (33-foot) level produce conservative results.

The staff generated a JFD from the 1985-1989 data for comparison with the revised 2002-2007 JFD presented by the applicant in its supplemental response to RAI 02.03.04-3 (ADAMS Accession No. ML100960474). The staff found similar 10-meter (33-foot) and 60-meter (197-foot) wind direction frequency distributions between the two JFDs. However, the staff found that the 1985-1989 JFD had a lower frequency of (1) 10-meter (33-foot) low wind speed conditions (the frequency of winds less than 1.5 meters per second (m/s) increased from 9.1 percent in the 1985-1989 data to 17.0 percent in the 2002-2007 data) and (2) extremely unstable (stability category A) conditions (the frequency of extremely unstable conditions increased from 7.1 percent in the 1985-1989 data to 19.3 percent in the 2002-2007 data). Discrepancies in wind speed and stability class frequency distributions between these two databases create uncertainty as to which meteorological data set (1985-1989 versus 2002-

2007) is most representative of long-term site conditions. Given the uncertainty in the data, the staff believes the dispersion analyses presented in FSAR Subsections 2.3.4 and 2.3.5 should be evaluated using both sets of data and the more conservative (bounding) dispersion estimates be used. This topic is discussed in more detail in Sections 2.3.4 and 2.3.5 of this SER.

Site Preparation and Construction, Pre-Operational, and Operational Onsite Meteorological Monitoring Program

FSAR Subsection 2.3.3.2 states that because the NDCT for Fermi Unit 3 will be built in the approximate location of the current (pre-application) onsite meteorological tower, a new meteorological tower will be erected in the southeast corner of the Fermi site. The applicant has made a commitment (COM 2.3-003) in FSAR Subsection 2.3.3.2 that the new tower will be operational for at least one year prior to the decommissioning of the existing onsite meteorological tower.

> **[START COM FSAR-2.3-003]**. The new meteorological tower will be operational for at least one year prior to the decommissioning of the existing onsite meteorological tower. The meteorological data recorded concurrently from the current and new onsite meteorological towers will undergo a detailed analysis to ensure the meteorological parameters measured at the new meteorological tower are representative of the atmospheric conditions at the Fermi site **[END COM FSAR-2.3-003]**.

The meteorological data recorded concurrently from the current (pre-application) and new (operational) onsite meteorological towers will undergo a detailed analysis to ensure the meteorological parameters measured at the new meteorological tower are representative of the atmospheric conditions at the Fermi site.

The proposed operational onsite meteorological monitoring program is described in greater detail in the following sections.

a. Tower and Instrument Siting

The NDCT for Fermi 3 will be built in the approximate location of the current onsite meteorological tower. Thus, the applicant states that a new meteorological tower will be erected in the southeast corner of the Fermi site (approximately 1268 meters (4160 feet)) from the existing meteorological tower) prior to the construction of Fermi 3. The new meteorological tower will be a guyed open-latticed tower that will be 60 meters (197 feet) tall.

FSAR Subsection 2.3.2.2 discusses the possible influence of Fermi 3 and its facilities on the proposed location of the new meteorological tower. That discussion is reviewed here.

Wind flow may be altered immediately adjacent to and downwind of larger site structures, but these effects will likely dissipate within ten structure heights downwind. The applicant states that the large structures associated with the operation of Fermi Unit 3, such as a 182.9-meter (600-foot) tall NDCT, the two multi-cell mechanical-draft cooling towers (MDCTs), and the 48.2-meter (158-foot) tall RB, will influence the airflow trajectories downwind of the new structures. Revision 1 to RG 1.23 states that a meteorological tower should be located at a distance of at least ten times the height of any nearby obstructions (e.g., large structures, trees, and nearby terrain) to avoid airflow modifications by the obstructions. The building wakes from the Fermi 3 RB and MDCTs should not impact the new meteorological tower since the new tower will be located more than ten times the heights of these obstructions downwind.

The ten-building-height distance of separation is typically applied to square or rectangular structures, whereas rounded and sloping structures such as hyperbolic NDCTs can be expected to produce a smaller wake zone. According to the applicant, the NDCT will be built to a height of 182.3 meters (600 feet) above plant grade, the tallest structure at the Fermi site. The NDCT will be hyperbolically shaped with a maximum width at the base of 140.2 meters (460 feet) and will be located at a distance of approximately 1268 meters (4160 feet) northwest of the new meteorological tower.

Section 123 of the Clean Air Act as amended in 1990 defines good engineering practice stack height as the height necessary to ensure that emissions from a stack do not result in excessive concentrations of any air pollutant in the immediate vicinity of a source as a result of atmospheric downwash, eddies, and wakes which may be created by the source itself, by nearby structures, or by nearby terrain obstacles. The EPA defines “nearby structures” in its regulations (40 CFR 51.100(jj)(1)) as that distance up to five times the lesser of the height or the width dimension of a structure; that is, the downwind distance in which a structure is presumed to have a significant influence as a result of downwash, eddies, and wakes extends downwind approximately five times either the height or width (whichever is less) of the structure. The EPA regulatory guidance document for determining good engineering practice stack heights (EPA-450/4-80-023R, June 1985) also states that this area of influence becomes significantly smaller as the height to width ratio of a structure increases. Based on the EPA guidance for this type of structure, which will have a maximum width of 140.2 meters (460 feet), the outermost boundary of influence exerted by the proposed NDCT is estimated to be approximately 701 meters (2300 feet). Since this distance is shorter than the 1268 meters (4160 feet) separation between the proposed NDCT and the new meteorological tower, the staff concludes that the proposed NDCT will not adversely affect measurements made at the new meteorological tower.

The applicant states in FSAR Subsection 2.3.3.2.1 that other structures near the location of the new meteorological tower include a water tower with a height of 44.2 meters (144.9 feet) and a maximum width of approximately 16.2 meters (53.3 feet). The water tower is circular and the tank head is spherical with a sloping surface. Based on the EPA guidance for this type of structure (as discussed above), the outermost boundary of influence exerted by the water tower with a maximum width of 16.2 meters (53.3 feet) is estimated to be approximately 81 meters (266 feet). Since this distance is shorter than the 210.9 meter (692 foot) separation between the water tank and the new meteorological tower, the staff concludes that the water tank will not adversely affect measurements made at the new meteorological tower.

The applicant states that the operational meteorological tower will have meteorological sensors located at the 10-meter (33-foot) and 60-meter (197-foot) elevations to estimate dispersion conditions. Wind sensors will be mounted at a distance equal to at least twice of the longest horizontal dimension of the triangular tower. Temperature sensors will be oriented such that the aspirated temperature shields are either pointed downward or laterally towards the north and the shield inlet is at least 1½ times the tower horizontal width away from the nearest point on the tower.

The applicant states that influence of terrain near the base of the new meteorological tower on temperature measurements is expected to be minimal because the area surrounding the new meteorological tower will not be paved or contain temporary land disturbances such as plowed fields and rock piles. The applicant further states that the tower will be situated in a relatively flat area that will be at a similar elevation as the plant structures. Because the location of the new meteorological tower is wooded and contains trees that would influence wind measurements if left at their current height, the applicant states the trees will be trimmed to a height outwards to a distance that satisfies the ten-obstruction-height distance separation criterion stated in Revision 1 to RG 1.23.

The staff finds that the new meteorological tower will be appropriately located such that it can measure the onshore flow conditions that could affect gaseous effluent releases from Fermi Unit 3. The staff finds the tower location complies with the recommendations provided in Revision 1 to RG 1.23 and is therefore acceptable to the staff.

b. Instrumentation

In FSAR Subsection 2.3.3.2.2, the applicant states that the new meteorological tower instrumentation will consist of wind speed and wind direction sensors at the 10-meter and 60-meter levels, a temperature sensor at the 10-meter (33-foot) level, a ΔT system between the 60-meter (197-foot) and 10-meter (33-foot) levels, and a dew-point temperature sensor at the 10-meter (33-foot) level. A heated tipping bucket precipitation gauge surrounded by a windscreen will be located at ground level at the base of the meteorological tower. External heaters will be installed on the primary wind sensors to minimize data loss during ice storms. Redundant secondary wind and temperature sensors will also be installed at the 10-meter (33-foot) and 60-meter (197-foot) levels. The applicant states the accuracies and thresholds for each sensor on the new meteorological tower will be within the values specified in RG 1.23.

Revision 2 to FSAR Subsection 2.3.3.2.2 states the new meteorological tower will use meteorological instrumentation that matches the manufacturer and model numbers used on the current tower and FSAR Table 2.3-289 provides the accuracies for each meteorological sensor located on the current meteorological tower. Revision 2 to FSAR Table 2.3-289 shows that the system accuracy for the differential temperature instrumentation is ±0.15 degrees °C (± 0.27 degrees F) which exceeds the Revision 1 to RG 1.23 specified accuracy of ±0.1 degrees °C ((± 0.18 degrees F). Consequently, the staff requested the applicant in RAI 02.03.03-9 to justify why the differential temperature instrumentation accuracy for the new meteorological tower that will be erected to support the operational MMP will exceed the Revision 1 to RG 1.23 criterion of ±0.1 degrees °C (± 0.18 degrees F).

In its response to RAI 02.03.03-9 dated January 10, 2011 (ADAMS Accession No. ML110110550), the applicant clarified that the reference to Table 2.3-289 in FSAR Subsection 2.3.3.2.2 was intended to present the accuracies for the current instrumentation and was not intended to imply that these same accuracies would be used for the new meteorological tower instrumentation. The applicant revised Subsection 2.3.3.2.2 in Revision 4 of the FSAR to clarify that the accuracies and thresholds for each sensor on the new meteorological tower will be within the values specified in Revision 1 to RG 1.23. The staff finds this response to be acceptable and considers RAI 02.03.03-9 to be resolved.

The applicant also states that the data recording process planned for the new meteorological tower will mirror the data recording process for the existing (preoperational) meteorological tower. The staff finds this acceptable.

c. Instrument Calibration, Service, and Maintenance

The applicant states the instrumentation, service, and maintenance procedures in place for the existing (pre-application) MMP as described in FSAR Subsections 2.3.3.1.3 and 2.3.3.1.4 will continue for the new MMP. The staff finds this acceptable.

d. Data Reduction, Transmission, Acquisition, and Processing

The applicant states the method of data reduction, transmission, acquisition, and processing described in FSAR Subsections 2.3.3.1.5 and 2.3.3.1.6 for the pre-application monitoring program will be used for the new MMP. The staff finds this acceptable.

The staff requested the applicant in RAI 02.03.03-7**,** in accordance with criteria specified in Section C.8 of RG 1.23, to discuss any provisions that will be in place to obtain representative meteorological data (e.g., wind speed and direction representative of the 10-meter (33-foot) level and an estimate of atmospheric stability) from alternative sources during an emergency, if the site meteorological monitoring system should be unavailable.

The applicant provided a response to RAI 02.03.03-7, dated February 8, 2010 (ADAMS Accession No. ML100960472) in which it was stated that there is sufficient redundancy built into the meteorological measurement system such that only under the most unusual circumstances would data be unavailable. Should any of the parameters required for dose assessment become unavailable, supplementary meteorological data will be available via the corporate computer system. As indicated in Section H, Sections 6 and 7, of the Fermi 3 Emergency Plan, in the unlikely event that both the primary and backup meteorological systems become inoperable during an emergency, Detroit Edison maintains a contract with a vendor to provide pertinent weather and forecast data. In addition, ambient temperature, wind direction, wind speed, and estimated atmospheric stability data will be available by contacting the nearest NWS office.

The staff finds that sufficient provisions are in place for Fermi 3 to obtain representative meteorological data from alternative sources in the event of an emergency when meteorological data from the site are unavailable. The staff considers RAI 02.03.03-7 to be resolved.

The staff's review finds that the applicant has described an onsite meteorological monitoring program and generated a resulting database, which are acceptable and meet the requirements of 10 CFR 100.20 and 100.21 with respect to determining the acceptability of the site.

2.3.3.5 *Post Combined License Activities*

The applicant identifies the following commitment:

- **Commitment (COM 2.3-003)** – The new meteorological tower will be operational for at least one year prior to the decommissioning of the existing onsite meteorological tower. The meteorological data recorded concurrently from the current and new onsite meteorological towers will undergo a detailed analysis to ensure the meteorological parameters measured at the new meteorological tower are representative of the atmospheric conditions at the Fermi site.

Table 2.3-1 of Part 10 of the COLA contains EP inspection, test, analysis, and acceptance criteria (ITAAC). The following EP-ITAAC involve demonstrating that the operational onsite MMP appropriately supports the emergency plan:

- EP Program Element 8.6: The means exists to provide meteorological information, consistent with Appendix 2 of NUREG-0654/FEMA-REP-1, Revision 1. The acceptance criterion is that the means to obtain meteorological information described in Section II.H.7 of the Fermi 3 COLA Emergency Plan are addressed in emergency plan implementing procedures, "Dose Assessment Methodology."

- EP Program Element 9.3: The means exist to continuously assess the impact of the release of radioactive materials to the environment, accounting for the relationship between effluent monitor readings, and onsite and offsite exposures and contamination for various meteorological conditions. The acceptance criterion is that Emergency Plan implementing procedure, "Dose Assessment Methodology," and the ODCM calculate the relationship between effluent monitor readings and offsite exposures and contamination for various meteorological conditions.

- EP Program Element 9.4: The means exists to acquire and evaluate meteorological information. The acceptance criteria are (1) the specified meteorological data (i.e., wind speed at 10 meters and 60 meters, wind direction at 10 meters and 60 meters, and ambient air temperature at 10 meters and 60 meters) are available at the control room, technical support center (TSC), and emergency operations facility and (2) the specified meteorological data are transmitted to and received by the offsite NRC center and State of Michigan.

EP and EP-ITAAC are addressed in SER Section 13.3, "Emergency Planning."

2.3.3.6 *Conclusion*

The NRC staff has reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

In addition, the staff compared the information in the COL application to the relevant NRC regulations, the guidance in Section 2.3.3 of NUREG–0800, and the applicable NRC regulatory guides. The NRC staff's review confirms that the applicant has presented and substantiated information pertaining to the onsite MMP and the resulting database. The staff's review finds that the applicant has established the structure for the onsite MMP and the resulting database, which are acceptable and meet the requirements of 10 CFR 100.20 and 100.21 with respect to determining the acceptability of the site.

The staff concludes that the onsite data also provide an acceptable basis for estimating atmospheric dispersion for design-basis accident and routine releases from the plant. The data meet the requirements of GDC 19, 10 CFR 100.20, 10 CFR 100.21, 10 CFR Part 20, and Appendix I to 10 CFR Part 50. Finally, the equipment for measuring meteorological parameters during the course of accidents is sufficient to reasonably predict atmospheric dispersion of airborne radioactive materials, in accordance with 10 CFR 50.47(b) and Appendix E to 10 CFR Part 50.

The staff's review confirms that the applicant has adequately addressed the COL license information item in accordance with Section 2.3.3 of NUREG–0800.

2.3.4 Short-Term (Accident) Diffusion Estimates

The consequence of a design basis accident in terms of personnel exposure is a function of the atmospheric dispersion conditions at the site of the potential release. Atmospheric dispersion conditions are represented by relative air concentration (χ/Q) values. This FSAR section describes the development of the short-term dispersion estimates that are used to evaluate design basis accident radiological exposures for the EAB, the outer boundary of the LPZ, and the control room.

2.3.4.1 *Introduction*

Section 2.3.4 of the Fermi 3 FSAR addresses the atmospheric dispersion factor (χ/Q or relative concentration) estimates at the EAB, the outer boundary of the LPZ, the control room, and TSC for postulated design-basis accidental radioactive airborne releases. Appendix 2A of the Fermi 3 COL FSAR addresses the use of the ARCON96 atmospheric dispersion model to derive site-specific control room and TSC χ/Q values.

Dispersion estimates from the onsite and/or offsite airborne releases of hazardous materials such as flammable vapor clouds, toxic chemicals, and smoke from fires are reviewed in SER Section 2.2.3.

2.3.4.2 *Summary of Application*

Section 2.3.4 and Appendix 2A of the Fermi 3 COL FSAR, Revision 7, describes the atmospheric dispersion factor (χ/Q or relative concentration) estimates at the EAB, the outer boundary of the LPZ, the control room, and TSC for postulated design-basis accidental radioactive airborne releases. In addition, the applicant provides the following:

<u>*COL Items*</u>

- EF3 COL 2.0-10-A Short-Term Dispersion Estimates for Accidental Atmospheric Releases

  Section 2.3.4 describes the development of the short-term atmospheric dispersion estimates for the EAB, outer boundary of the LPZ and the control room.

- EF3 COL 2A.2-1-A Confirmation of the ESBWR χ/Q Values

  Section 2.3.4 and Appendix 2A describe the development of the short-term atmospheric dispersion estimates for the control room and TSC. Section 2.0 compares the resulting control room and TSC χ/Q values with the corresponding ESBWR DCD site parameter values.

- EF3 COL 2A.2-2-A Confirmation of the Reactor Building χ/Q Values

  Appendix 2A states that the doors and personnel air locks on the east sides of the reactor building and fuel building are administratively controlled to remain closed during movement of irradiated fuel.

2.3.4.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the short-term atmospheric dispersion estimates for accident releases, and the associated acceptance criteria, are in Section 2.3.4 of NUREG–0800. The acceptance criteria for identifying short-term atmospheric dispersion estimates for accident radiological releases are based on meeting the relevant requirements of 10 CFR Parts 52 and 100. The staff considered the following regulatory requirements in reviewing the applicant's discussion of site location and description:

- 10 CFR Part 50, Appendix A, GDC 19, "Control Room," with respect to the meteorological considerations used to evaluate the personnel exposures inside the control room during radiological accident conditions.

- 10 CFR 52.79(a)(1)(vi), with respect to a safety assessment of the site, including consideration of major SSCs of the facility and site meteorology, to evaluate the offsite radiological consequences at the EAB and LPZ.

- 10 CFR 100.21(c)(2), with respect to the atmospheric dispersion characteristics used in the evaluation of EAB and LPZ radiological dose consequences for postulated accidents.

NUREG–0800, Section 2.3.4 specifies that an application meets the above requirements if the application provides the following information:

- A description of the atmospheric dispersion models used to calculate χ/Q values for accidental releases of radioactive materials into the atmosphere.

- Meteorological data used for the evaluation (as inputs to the dispersion models), which represent annual cycles of hourly values of wind direction, wind speed, and atmospheric stability for each mode of accidental release.

- A discussion of atmospheric diffusion parameters, such as lateral and vertical plume spread (σ_y and σ_z), as a function of distance, topography, and atmospheric conditions, should be related to measured meteorological data.

- Hourly cumulative frequency distributions of χ/Q values from the effluent release point(s) to the EAB and LPZ constructed to describe the probabilities that these χ/Q values will be exceeded.

- Atmospheric dispersion factors used for the assessment of consequences related to atmospheric radioactive releases to the control room for design-basis accidents.

- For control room habitability analysis, a site plan drawn to scale showing true North and potential atmospheric accident release pathways, control room intake, and unfiltered in-leakage pathways.

In addition, the short-term atmospheric dispersion estimates for accident radiological releases should be consistent with the appropriate sections from the following RGs:

- RG 1.23, Revision 1, "Meteorological Monitoring Programs for Nuclear Power Plants," provides criteria for an acceptable onsite meteorological measurements program; these data are used as inputs to atmospheric dispersion models.

- RG 1.145, Revision 1, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," presents criteria that characterize atmospheric dispersion conditions and evaluate the consequences of radiological releases to the EAB and LPZ.

- RG 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants," presents criteria that characterize atmospheric dispersion conditions and evaluate the consequences of radiological releases to the control room.

When independently assessing the acceptability of the information presented by the applicant in FSAR Tier 2, Section 2.3.4, the NRC staff applied the same methodologies, models, and techniques cited above.

2.3.4.4 *Technical Evaluation*

The NRC reviewed the application and the applicant's responses to RAIs to verify the accuracy, completeness, and sufficiency of the information from the applicant regarding short-term atmospheric dispersion estimates for accident releases. The staff followed the procedures described in Section 2.3.4 of NUREG–0800 as part of this review.

<u>*COL Items*</u>

- EF3 COL 2.0-10-A — Short-Term Dispersion Estimates for Accidental Atmospheric Releases

  This COL information item states that the applicant supply site-specific information, in accordance with SRP Subsection 2.3.4, to show that the site's meteorological dispersion values as calculated in accordance with RG 1.145 and RG 1.194 and compared to dispersion values in Chapter 15, result in doses less than those stipulated in 10 CFR 52.79(a)(1)(vi) and the applicable portions of SRP Sections 11 and 15.

In response to this COL information item, the applicant describes (1) the atmospheric dispersion models to calculate atmospheric dispersion factors for postulated accidental radioactive airborne releases, (2) the meteorological data and other assumptions used as inputs to atmospheric dispersion models, (3) the derivation of diffusion parameters (σ_y and σ_z), and (4) the determination of conservative χ/Q values used to assess the consequences of postulated design-basis atmospheric radioactive releases to the EAB, LPZ, control room, and TSC.

The NRC reviewed the applicant's resolution to EF3 COL 2.0-10-A related to the determination of conservative χ/Q values used to assess the consequences of postulated design-basis atmospheric radioactive releases to the EAB, LPZ, control room, and TSC in accordance with RGs 1.145 and 1.194. The staff's review of the applicant's offsite (i.e., EAB and LPZ) and onsite (i.e., control room and TSC) meteorological dispersion estimates is discussed later in this subsection.

The staff also reviewed the applicant's atmospheric dispersion values to ensure that they result in doses less than those stipulated in 10 CFR 52.79(a)(1)(vi) and in the applicable portions of SRP Sections 11 and 15. This review involves demonstrating that the Fermi 3 meteorological dispersion (accidental release) site characteristic values fall within the corresponding ESBWR DCD meteorological dispersion site parameter values. Section 2.0 of the Fermi 3 COL FSAR evaluated whether the Fermi 3 site characteristics fall within the ESBWR DCD site parameter values. A comparison of the ESBWR DCD accidental atmospheric dispersion factors with the Fermi 3 accidental atmospheric dispersion factors is in Fermi 3 COL FSAR, Table 2.0-201. Smaller χ/Q values are associated with a greater dilution capability, resulting in lower radiological doses. When comparing an ESBWR DCD site parameter χ/Q value and a Fermi 3 site characteristic χ/Q value, the Fermi 3 site is acceptable for the ESBWR design if the Fermi 3 site characteristic χ/Q value is smaller than the corresponding ESBWR site parameter χ/Q value. Such a comparison shows that the Fermi 3 site has better dispersion characteristics than the ESBWR reactor design requires.

The staff reviewed this comparison to ensure the applicant appropriately compared the ESBWR DCD site parameter values with the Fermi 3 site characteristics. The staff issued RAI 02.03.04-6, requesting that the applicant justify the values selected as the Fermi 3 RWB unfiltered in-leakage and air intake χ/Q site characteristic values for the control room.

In its response to RAI 02.03.04-6 dated September 2, 2010 (ADAMS Accession No. ML102570700), the applicant stated that the Fermi 3 site characteristic values used for comparison with the ESBWR DCD control room RWB unfiltered in-leakage and air intake χ/Q site parameter values are the same values used for the PCCS vent releases. The applicant pointed out that the relevant analysis in the ESBWR DCD that uses χ/Q values from the RWB is the liquid-containing tank failure described in DCD Tier 2, Section 15.3.16. The applicant stated that the ESBWR DCD used the PCCS vent χ/Q values in this analysis because the PCCS vent χ/Q values are assumed to bound any release from the RWB based on distance and direction to the control room receptors. The applicant therefore concludes that its use of the PCCS vent release site characteristic χ/Q values to represent releases from the RWB is consistent with the ESBWR DCD.

The staff reviewed the Fermi 3 RWB site characteristic χ/Q values and confirmed that they are bounded by the Fermi 3 PCCS vent site characteristic χ/Q values. Consequently, the staff finds the use of the PCCS vent release site characteristic χ/Q values to represent releases from the RWB to be conservative and therefore acceptable and considers RAI 02.03.04-6 to be resolved.

Fermi 3 COL FSAR, Table 2.0-201 shows that the Fermi 3 EAB, LPZ, control room, and TSC site characteristic χ/Q values are all less than the corresponding ESBWR DCD site parameter χ/Q values, thereby demonstrating that site meteorological dispersion conditions result in doses less than those stipulated in 10 CFR 52.79(a)(1)(vi) and in the applicable portions of SRP Sections 11 and 15.

- EF3 COL 2A.2-1-A Conformation of the ESBWR χ/Q Values

  This COL information item states that when referencing the ESBWR DCD to confirm that site characteristics at a given site are bounded by the ESBWR DCD site parameter values per 10 CFR 52.79, the COL applicant shall perform ARCON96 determinations for all source/receptor pairs listed in ESBWR DCD Tables 2A-3 and 2A-4 using site-specific meteorological data. The applicant responded to this COL information item by calculating and presenting control room and TSC χ/Q values in FSARs Tables 2.3-301 and 2.3-378 and comparing them to the corresponding ESBWR DCD site parameter values in FSAR Table 2.0 201.

The staff's review of the applicant's resolution to COL Information Item EF3 COL 2A.2-1-A is discussed later in this section.

- EF3 COL 2A.2-2-A Conformation of the Reactor Building χ/Q Values

  This COL information item states that if the χ/Q values for a release from any door on the east sides of the reactor building or fuel building have χ/Q values that would result in doses greater than the bounding dose consequence reported for the fuel handling accident (DCD Tier 2, Table 15.4-4), the affected doors or personnel air locks are administratively controlled to remain closed during movement of irradiated fuel bundles. The applicant responded to this COL information item by stating that the doors and personnel air locks on the east sides of the RB and FB are administratively controlled to remain closed during movement of irradiated fuel.

The NRC staff has reviewed the applicant's resolution to EF3 COL 2A.2-2-A and finds it acceptable because the applicant is going to administratively control the doors on the east sides of the RB and FB to remain closed during the movement of irradiated fuel bundles regardless of the RB or FB χ/Q values.

Offsite Dispersion Estimates

a. Atmospheric Dispersion Model

The applicant used the computer code PAVAN (NUREG/CR–2858, "PAVAN: An Atmospheric Dispersion Program for Evaluating Design-Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations") to estimate χ/Q values at the EAB and at the outer boundary of the LPZ for potential accidental releases of radioactive material. The PAVAN model implements the methodology outlined in RG 1.145.

The PAVAN code estimates χ/Q values for various time-averaged periods ranging from 2 hours to 30 days. The meteorological input to PAVAN consists of a JFD of hourly values of wind speed and wind direction by atmospheric stability class. The χ/Q values calculated through PAVAN are based on the theoretical assumption that material released into the atmosphere will be normally distributed (Gaussian) about the plume centerline. A straight-line trajectory is assumed between the point of release and all distances for which χ/Q values are calculated.

For each of the 16 downwind direction sectors (N, NNE, NE, ENE, etc.), PAVAN calculates χ/Q values for each combination of wind speed and atmospheric stability at the appropriate downwind distance (i.e., the EAB and the outer boundary of the LPZ). The χ/Q values calculated for each sector are then placed in order from the greatest to the smallest, and an associated cumulative frequency distribution is derived based on the frequency distribution of wind speed and stabilities for each sector. The smallest χ/Q value in a distribution will have a corresponding cumulative frequency equal to the wind direction frequency for that particular sector. PAVAN determines for each sector an upper envelope curve based on the derived data (plotted as χ/Q versus probability of being exceeded), so that no plotted point is above the curve. From this upper envelope, the χ/Q value, which is equaled or exceeded 0.5 percent of the total time, is obtained. The maximum 0.5 percent χ/Q value from the 16 sectors becomes the 0–2 hour "maximum sector χ/Q value."

Using the same approach, PAVAN also combines all χ/Q values independent of wind direction into a cumulative frequency distribution for the entire site. An upper envelope curve is determined, and the program selects the χ/Q value that is equaled or exceeded no more than 5.0 percent of the total time. This value is known as the 0–2 hour "5-percent overall site χ/Q value."

The larger of the two χ/Q values, either the 0.5-percent maximum sector value or the 5-percent overall site value, is selected from the PAVAN output by the user to represent the χ/Q value for the 0–2 hour time interval. Note that this resulting χ/Q value is based on 1-hour averaged data, but it is conservatively assumed to apply for 2 hours.

To determine LPZ χ/Q values for longer time periods (e.g., 0–8 hours, 8–24 hours, 1–4 days, and 4–30 days), PAVAN performs a logarithmic interpolation between the 0–2 hour χ/Q values and the annual average (8,760 hours) χ/Q values for each of the 16 sectors and the overall site. For each time period, the highest among the 16-sector and overall site χ/Q values is identified and becomes the short-term site characteristic χ/Q value for that time period.

b. Release Characteristics and Receptors

The applicant modeled one ground-level release point and did not take credit for building wake effects. Ignoring building wake effects for a ground-level release decreases the amount of atmospheric turbulence assumed to be in the vicinity of the release point, resulting in higher (more conservative) χ/Q values for a flat terrain site such as Fermi 3. A ground-level release assumption that does not take credit for building wake effects is therefore acceptable to the staff.

Revision 0 to FSAR Subsection 2.3.4.1 stated the EAB and outer boundary of the LPZ are both circles centered at the RB, with radii of 892 m and 4824 m (0.55 mi and 3 mi), respectively. The staff requested the applicant in environmental RAI AQ2.7-5 to describe and justify the methodology used to determine the distances to the EAB and LPZ. It was not apparent to the staff that the applicant followed the guidance in RG 1.145 in determining the distances to the EAB and LPZ. RG 1.145 states that, for ground-level releases through vents or building penetrations, the distances for each of the 16 downwind sectors for the EAB and LPZ χ/Q calculations should be based on the nearest point on the building to the EAB or LPZ within a 45-degree sector centered on the compass direction of interest.

In its response to environmental RAI AQ2.7-5, dated August 25, 2009, the applicant defined an effective (dose calculation) EAB and LPZ for the purposes of determining χ/Q values. The applicant drew a circle from the center of the RB which encompasses all the postulated design basis accident release locations and defined the dose calculation EAB and LPZ as the distance between this circle and the EAB and LPZ, respectively. The resulting distances for the dose calculation EAB and LPZ were 740 m and 4670 m (0.46 mi to 2.9 mi), respectively. The staff found that the applicant's revised approach for calculating distances to the EAB and LPZ acceptable because it follows the guidance of RG 1.145. The applicant also provided the revised PAVAN input and output files in its response to environmental RAI AQ2.7-4 dated September 30, 2009.

The staff subsequently issued RAI 02.03.04-1 requesting that the applicant revise FSAR Section 2.3.4 and Table 2.0-201 to present the higher of either the 0.5 percentile maximum sector or 5 percentile overall site χ/Q values (pursuant to RG 1.145) resulting from the new dose calculation EAB and LPZ distances presented in environmental RAI AQ2.7-5. The applicant provided the requested information in Revision 2 to the FSAR. Therefore, the staff considers RAI 02.03.04-1 to be resolved.

c. Meteorological Data Input

The meteorological input to PAVAN used by the applicant consisted of a JFD of wind speed, wind direction, and atmospheric stability based on hourly onsite data from 2002 through 2007. The wind data were obtained from the 10-meter level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-T) measurements taken between the 60-m (197-ft) and 10-m (33-ft) levels on the onsite meteorological tower.

d. Diffusion Parameters

The applicant chose to implement the diffusion parameter assumptions outlined in RG 1.145 as a function of atmospheric stability for the PAVAN model runs. The EAB extends over Lake Erie in the east-northeast clockwise to the southeast sectors and outer boundary of the LPZ extends over Lake Erie in the northeast clockwise to the southwest sectors. Subsequently, the staff requested the applicant in RAI 02.03.04-2 to discuss the impact of changes in surface temperature and roughness resulting from over-water trajectories on the resulting offsite short-term atmospheric dispersion estimates. Dispersion parameters obtained over land and classified according to overland stabilities may not be directly applicable over water. The smooth water surface can result in less mechanically generated turbulence than over land, while the air-water temperature difference can either enhance or hinder convective turbulence.

In its response to RAI 02.03.04-2, dated February 8, 2010 (ADAMS Accession No. ML100960472), the applicant stated it did not consider it necessary to specifically account for potential impacts to the atmospheric dispersion factors due to surface temperature and roughness resulting from over-water trajectories. The response to RAI 02.03.04-2 states that the applicant used the default open terrain correction factors provided by the PAVAN atmospheric dispersion model to account for spatial and temporal variations in airflow resulting from recirculation and stagnation effects. The staff notes the PAVAN model only uses the open terrain correction factors in calculating the annual average χ/Q values that are used in the logarithmic interpolation to derive the intermediate time period (0-8 hours, 8-24 hours, 1-4 days, and 4-30 days) LPZ χ/Q values. The open terrain correction factors also do not account for changes in surface temperature and reduced surface roughness resulting from over water trajectories.

The response to RAI 02.03.04-2 also stated that the PAVAN maximum atmospheric dispersion values chosen as site characteristics for comparison with the ESBWR site parameters occurred in the ESE direction over Lake Erie and not over habitable locations. The applicant considers this to be a conservative approach. The staff disagrees in that the EAB and outer boundary of the LPZ are both hypothetical boundaries; it makes no difference in the dose analysis whether these boundaries are over land or over water.

Although the applicant did not specifically account for potential impacts to the atmospheric dispersion factors due to surface temperature and roughness resulting from over-water trajectories, the staff finds that the applicant has presented conservative short-term atmospheric dispersion estimates by using the 2002-2007 JFD. As discussed in the applicant's supplemental response to RAI 02.03.03-1 dated March 30, 2010 (ADAMS Accession No. ML100960474), the potential exists for the 2002-2007 wind speed measurements to be lower than the actual wind speed at the 10-meter elevation. This is especially true for the ESE downwind sector, where the PAVAN maximum atmospheric dispersion values chosen as site characteristics occurred, because the meteorological tower is downwind of the nearby trees in this sector. The use of lower wind speeds at the 10-meter elevation produces higher (more conservative) χ/Q values from the PAVAN model which compensates for potential impacts to the atmospheric dispersion factors resulting from over-water trajectories. Therefore, the staff considers RAI 02.03.04-2 to be resolved.

e. Resulting Relative Concentration Factors

The staff performed an independent evaluation of the applicant's PAVAN results by generating a JFD from the original 2002-2007 hourly onsite meteorological database provided in response to environmental RAI AQ2.7-3 dated October 30, 2009 and rerunning the PAVAN computer code. The staff's JFD was based on the wind speed classes presented in Table 3 of Revision 1 to RG 1.23 (i.e., calm, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 6.0, 8.0, 10.0 and > 10.0 meters per second). The staff's results were more conservative (i.e., higher) than those generated by the applicant's PAVAN run. The staff believes its more conservative results were primarily due to the difference in the frequency of calm winds between the applicant's JFD and the staff's JFD. The staff issued RAI 02.03.04-3 requesting that the applicant explain the difference in the number of calm winds presented in FSAR (Revision 0), Tables 2.3-292 through 2.3-299 versus the number of hours of calm winds reported in the 2002-2007 hourly database. The staff also asked the applicant to explain how the calm winds presented in FSAR (Revision 0), Tables 2.3-292 through 2.3-299 were assigned to wind direction sectors for executing PAVAN and justify any deviations from the methodologies presented in RG 1.23 and RG 1.145. RG 1.23 states that the starting threshold for the wind sensors should be less than 0.45 meters per second and RG 1.145 states that wind directions during calm conditions should be assigned in proportion to the directional distribution of non-calm winds with speeds less than 1.5 meters per second.

In its supplemental response to RAI 02.03.04-3, dated March 30, 2010 (ADAMS Accession No. ML100960474), the applicant stated that it performed further reviews of the original 2001-2007 hourly Fermi onsite meteorological database submitted to the staff in its response to environmental RAI AQ2.7-3 and revised the database accordingly. A copy of the revised 2001-2007 database (in RG 1.23 format) was provided as part of the applicant's supplemental response to environmental RAI AQ2.7-3 dated March 30, 2010; a copy of the revised 2002-2007 database (in RG 1.194 format) was also provided as part of the applicant's supplemental response to RAI 02.03.04-4 dated March 30, 2010 (ADAMS Accession No. ML110960474). The applicant used the revised 2002-2007 database to derive a new JFD assuming a wind sensor starting threshold of 0.45 meters per second (one mile per hour) and assigning wind directions during calm conditions consistent with the guidance in RG 1.145. This new JFD was included in the supplemental response to RAI 02.03.04-3 as proposed revisions to FSAR Tables 2.3-292 through 2.3-299. The staff generated its own JFD frequency distribution from the revised 2002-2007 database submitted in the supplemental response to RAI 02.03.04-4 and obtained similar results.

Because the applicant provided a revised JFD and assigned wind directions during calm conditions consistent with the guidance provided in RG 1.145, RAI 02.03.04-3 is considered to be resolved. The applicant incorporated the revised FSAR Tables 2.3-292 through 2.3-299 into Revision 4 of the FSAR.

The applicant reran the PAVAN atmospheric dispersion model for the dose calculation EAB (740 meters) and LPZ (4670 meters) using the revised 2002-2007 JFD distribution and presented the results in a proposed revision to FSAR Section 2.3.4 as part of its supplemental response to RAI 02.03.04-3. The staff independently reran the PAVAN code using a JFD it derived from the revised 2002-2007 database submitted in the supplemental response to RAI 02.03.04-3 and obtained similar results (± 2 percent). The applicant incorporated the revised PAVAN results into Revision 4 of the FSAR.

In its supplemental response to RAI 02.03.04-3 (ADAMS Accession No. ML100960474), the applicant also proposed a revision to FSAR Subsection 2.3.4.2 stating that the meteorological tower is located east of a grove of trees that is situated less than ten times the obstruction height recommended in RG 1.23. The impact of the trees is to reduce the measured wind speed at the 10-meter level for upwind sectors. The proposed FSAR revision further states that the use of lower measured wind speeds provides conservative results for the PAVAN model. In order to test this hypothesis, the staff independently reran the PAVAN model using a JFD derived from the 1985-1989 database submitted in the applicant's supplemental response to RAI 02.03.03-1. The applicant stated that aerial photographs of the area surrounding the Fermi meteorological tower during this time period confirm the absence of significant air flow obstructions to wind measurements at the 10 meter elevation. The staff found that its resulting short-term atmospheric dispersion values using the 1985-1989 JFD were lower (less conservative) than the site characteristic values selected by the applicant using the revised 2002-2007 JFD. The staff therefore concludes that the applicant has selected conservative EAB and LPZ short-term atmospheric dispersion factors as site characteristic values by using the revised 2002-2007 JFD.

Atmospheric Dispersion Factors for On-Site Doses

a. Atmospheric Dispersion Model

The applicant used the computer code ARCON96 (NUREG/CR–6331, "Atmospheric Relative Concentrations in Building Wakes") to estimate χ/Q values at the control room and TSC for potential accidental releases of radioactive material. The ARCON96 model implements the methodology outlined in RG 1.194.

The ARCON96 code estimates χ/Q values for various time-averaged periods ranging from 2 hours to 30 days. The meteorological input to ARCON96 consists of hourly values of wind speed, wind direction, and atmospheric stability class. The χ/Q values calculated through ARCON96 are based on the theoretical assumption that material released into the atmosphere will be normally distributed (Gaussian) about the plume centerline. A straight-line trajectory is assumed between the release points and receptors. The diffusion coefficients account for an enhanced dispersion under low wind speed conditions and in building wakes.

The hourly meteorological data are used to calculate hourly relative concentrations. The hourly relative concentrations are then combined to estimate concentrations ranging in duration from 2 hours to 30 days. Cumulative frequency distributions are prepared from the average relative concentrations and the relative concentrations that are exceeded no more than 5 percent of the time for each averaging period are selected.

b. Meteorological Data Input

The meteorological input to ARCON96 used by the applicant consisted of hourly onsite wind speed, wind direction, and atmospheric stability data from two periods of record: 1985 through 1989 and 2001 through 2007. The wind data were obtained from the 10-meter and 60-meter levels of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-T) measurements taken between the 60-meter and 10-meter levels on the onsite meteorological tower.

c. Diffusion Parameters

The diffusion coefficients used in ARCON96 have three components. The first component, the diffusion coefficient, is used in other NRC models such as PAVAN. The other two components are corrections to account for the enhanced dispersion under low wind speed conditions and in building wakes. These components are based on an analysis of diffusion data collected in various building wake diffusion experiments, under a wind range of meteorological conditions. Because the diffusion occurs at short distances within the plant's building complex, the ARCON96 diffusion parameters are not affected by nearby topographic features, such as bodies of water. Therefore, the NRC staff found that the applicant's use of the ARCON96 diffusion parameter assumptions is acceptable.

d. Resulting Relative Concentrations

Appendix 2A to ESBWR DCD, Tier 2 provides the source/receptor inputs required to execute the ARCON96 model using site-specific meteorological data. Included in Appendix 2A is Figure 2A-1 which shows the location of potential atmospheric accident release pathways and the control room and TSC receptors. Note that the Fermi 3 site plan in FSAR Figure 2.1-204 shows that true north is approximately nineteen degrees counter-clockwise from plant north. True north is the basis for the wind direction data recorded by the Fermi 3 onsite meteorological program whereas plant north is the basis for the source/receptor directions presented in Table 2A-4 in Appendix 2A of ESBWR DCD, Tier 2. Therefore, the applicant adjusted the source-to-receptor data presented in ESBWR DCD, Tier 2, Table 2A-4 by nineteen degrees to account for the difference in angle between the ESBWR plant north and the Fermi 3 true north.

The staff attempted to independently confirm the applicant's ARCON96 atmospheric dispersion model results by executing the ARCON96 model using the meteorological data provided in response to environmental RAI AQ2.7-3. Because the meteorological data provided in response to environmental RAI AQ2.7-3 were in a format compatible to Appendix A to RG 1.23, the staff had to convert these data into RG 1.194 format for input into the ARCON96 model. The staff executed the ARCON96 model using its converted meteorological database and obtained ARCON96 results that, in some cases, differed from the applicant's results reported in the FSAR. Subsequently, the staff requested the applicant in RAI 02.03.04-4 to provide in electronic form the meteorological input file and all the output files associated with these ARCON96 computer code runs. These files were necessary for the staff to complete its assessment of the applicant's resulting onsite χ/Q estimates.

The applicant provided the requested information in its supplement response to RAI 02.03.04-4, dated March 30, 2010 (ADAMS Accession No. ML100960474). The supplemental response to RAI 02.03.04-4 provided a revised set of 2001-2007 ARCON96 meteorological input files based on the review of the original 2001-2007 database described in the supplemental response to RAI 02.03.04-3. The supplemental response to RAI 02.03.04-4 also provided a revised set of input and output files associated with rerunning the ARCON96 computer code with the revised 2001-2007 meteorological data. Because the applicant provided the requested files, the staff considers RAI 02.03.04-4 to be resolved.

The staff believes that there were numerous data discrepancies in the applicant's original 2001-2007 RG 1.194 formatted meteorological database that the applicant used to run ARCON96 and that these data discrepancies resulted in the staff obtaining ARCON96 results that were different from the applicant's results. These data discrepancies appear to have been resolved by the applicant with the revised set of ARCON96 input files provided in the applicant's supplemental response to RAI 02.03.04-4. To verify this hypothesis, the staff generated a JFD from the revised 2002-2007 ARCON96 database for comparison with the revised 2002-2007 JFD presented in the applicant's response to RAI 02.03.04-3. The staff found the two JFDs to be similar. The staff also reran the ARCON96 computer code with the revised 2001-2007 ARCON96 database and obtains results that were similar to the applicant's.

In its supplemental responses to RAI 02.03.03-1 and RAI 02.03.04-3, the applicant explains that the meteorological tower is located east of a grove of trees that is situated less than ten times the obstruction height recommended in RG 1.23. The impact of these trees is to reduce the measured wind speed at the 10-meter level for upwind sectors. Because the ARCON96 diffusion coefficients are a function of a low wind speed correction and a building wake correction, the limiting ARCON96 χ/Q values may not occur at the lowest wind speeds. Therefore, the applicant generated control room and TSC χ/Q values using two sets of meteorological data: 1985-1989 and the revised 2001-2007. The applicant concluded that χ/Q values from both data sets are bounded by the corresponding DCD site parameter values. Nonetheless, in its response to RAI 02.03.04-3, the applicant proposed presenting only ARCON96 χ/Q values derived from the revised 2001-2007 meteorological data as control room and TSC site characteristics in the FSAR.

The applicant provided a copy of the 1985-1989 data from the Fermi meteorological tower in its supplemental response to RAI 02.03.03-1. The staff compared these data against the 2001-2007 dataset and found the older dataset had lower frequencies of (1) low wind speed conditions at the 10-meter elevation and (2) extremely unstable (stability class A) conditions. Discrepancies in wind speed and stability class frequency distributions create uncertainty as to which meteorological data set (1985-1989 versus 2001-2007) is most representative of site conditions. Given the uncertainty in the data, the staff requested the applicant in RAI 02.03.04-5 to justify why both sets of control room and TSC atmospheric dispersion factors should not be presented in FSAR Subsection 2.3.4.3 and the more conservative resulting χ/Q values be presented in FSAR Table 2.0-201 as Fermi 3 site characteristic values.

In its response to RAI 02.03.04-5, dated September 2, 2010 (ADAMS Accession No. ML102570700), the applicant agreed to revise FSAR Section 2.3.4.3 to include χ/Q values calculated with both the 1985-1989 data base and the 2001-2007 data base and to include the more conservative results in FSAR Table 2.0-201. The applicant also recalculated the 1985-1989 and 2001-2007 control room and TSC χ/Q values using revised input parameters to the ARCON96 model as specified in Revision 8 of Appendix 2A to ESBWR DCD, Tier 2, Chapter 2. The applicant implemented these proposed changes in Revision 4 of the FSAR. Because the applicant revised the FSAR to include χ/Q values calculated with both the 1985-1989 and 2001-2007 data sets, RAI 02.03.04-5 is considered to be resolved.

Included in the response to RAI 02.03.04-5 were ARCON96 input and output files for both the 1985-1989 and 2001-2007 meteorological data sets. The staff reviewed the applicant's inputs to the ARCON96 code and finds them consistent with the information presented in Appendix 2A of Revision 8 to ESBWR DCD, Tier 2, Chapter 2.

Because the FSAR included χ/Q values calculated with both the 1985-1989 data base and the 2001-2007 data base, the staff accepts the control room and TSC χ/Q values presented by the applicant.

The staff has reviewed the information provided and, for the reasons given above, concludes that the applicant's atmospheric dispersion estimates are acceptable and meet the relevant requirements of 10 CFR 100.21(c)(2).

2.3.4.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.3.4.6 *Conclusion*

The NRC staff has reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

In addition, the staff compared the information in the COL application to the relevant NRC regulations, the guidance in Section 2.3.4 of NUREG–0800, and the applicable NRC regulatory guides. The NRC staff's review finds that the applicant has presented and substantiated information regarding short-term atmospheric dispersion estimates for accident releases. The staff has reviewed the information provided and, for the reasons given above, concludes that the applicant's atmospheric dispersion estimates are acceptable and meet the relevant requirements of 10 CFR 100.21(c)(2). This conclusion is based on the conservative assessments of post-accident atmospheric dispersion conditions that have been made by the applicant and the staff from the applicant's meteorological data and appropriate dispersion models. These atmospheric dispersion estimates are appropriate for the assessment of consequences from radioactive releases for design basis accidents in accordance with 10 CFR 52.79(a)(1)(vi) and GDC 19.

The staff's review confirms that the applicant has adequately addressed the COL license information items in accordance with Section 2.3.4 of NUREG–0800.

2.3.5 Long-Term (Routine) Diffusion Estimates

For a routine release, the concentration of radioactive material in the surrounding region depends on the amount of effluent released, the height of the release, the momentum and buoyancy of the emitted plume, the wind speed, atmospheric stability, airflow patterns of the site, and various effluent removal mechanisms.

2.3.5.1 *Introduction*

Section 2.3.5 of the Fermi 3 FSAR addresses the atmospheric dispersion factor (χ/Q or relative concentration) and atmospheric deposition factor (D/Q or relative deposition) estimates to a distance of 80 kilometers (50 miles) from the plant for releases of radiological effluents to the atmosphere during normal plant operation for annual average release limit calculations and offsite dose estimates. Appendix 2B of the Fermi 3 COL FSAR presents the gaseous effluent release pathway information for each of the three ventilation stacks for use in generating site-specific long-term χ/Q and D/Q values.

2.3.5.2 *Summary of Application*

Subsection 2.3.5 and Appendix 2B of the Fermi 3 COL FSAR, Revision 7 address site-specific information on long-term atmospheric dispersion estimates for routine releases. In addition, in FSAR Section 2.3.5, the applicant provides the following:

<u>COL Item</u>

- EF3 COL 2.0-11-A Long-Term Diffusion Estimates

  This COL information item states that the applicant supply site-specific information in accordance with SRP Section 2.3.5; that is, the COL applicant should provide χ/Q and D/Q estimates for calculating concentrations in the air and the amount of material deposited on the ground as a result of routine releases of radiological effluents into the atmosphere during normal plant operation.

2.3.5.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the long-term atmospheric dispersion estimates for routine releases, and the associated acceptance criteria, are in Section 2.3.5 of NUREG–0800. The acceptance criteria are based on meeting the relevant requirements of 10 CFR Parts 20, 50, and 100. The NRC staff considered the following regulatory requirements in reviewing the applicant's discussion of site location and description:

- 10 CFR Part 20, Subpart D, with respect to establishing atmospheric dispersion site characteristics for demonstrating compliance with dose limits for individual members of the public.

- 10 CFR 50.34a and Sections II.B, II.C and II.D of Appendix I of 10 CFR Part 50, with respect to establishing atmospheric dispersion site characteristics for evaluating the numerical guides for design objectives and limiting conditions for operation to meet the requirements that radioactive material in effluents released to unrestricted areas be kept as low as is reasonably achievable.

- 10 CFR 100.21(c)(1), with respect to establishing atmospheric dispersion site characteristics so that radiological effluent release limits associated with normal operation can be met for any individual located offsite.

NUREG–0800, Section 2.3.5 specifies that an application meets the above requirements if the application provides the following information:

- A detailed description of the atmospheric dispersion and deposition models used by the applicant to calculate annual average concentrations in the air and the amount of material deposited as a result of routine releases of radioactive materials into the atmosphere.

- A discussion of atmospheric diffusion parameters, such as a vertical plume spread (σ_z), as a function of distance, topography, and atmospheric conditions.

- Meteorological data summaries (onsite and regional) used as input to the dispersion and deposition models.

- Points of routine release of radioactive material into the atmosphere, including the characteristics (e.g., location and release mode) of each release point.

- The specific location of potential receptors of interest (e.g., nearest vegetable garden, nearest resident, nearest milk animal, and nearest meat cow in each 22½-degree direction sector within a 5-mile [8-kilometer] radius of the site).

- The χ/Q and D/Q values to be used for assessing the consequences of routine airborne radiological releases described in Section 2.3.5.2 of RG 1.206:

  1. Maximum annual average χ/Q values and D/Q values at or beyond the site boundary and at specific locations of potential receptors of interest utilizing appropriate meteorological data for each routine venting location, and

  2. Estimates of annual average χ/Q values and D/Q values for 16 radial sectors to a distance of 50 miles (80 kilometers) from the plant using appropriate meteorological data.

In addition, the long-term atmospheric dispersion estimates for routine releases should be consistent with appropriate sections from the following RGs:

- RG 1.23, provides criteria for an acceptable onsite meteorological measurements program; the program data are used as inputs to atmospheric dispersion models.

- RG 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," presents criteria for identifying specific receptors of interest.

- RG 1.111, Revision 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," provides acceptable methods for characterizing atmospheric transport and diffusion conditions and for evaluating the consequences of routine effluent releases.

- RG 1.112, Revision 1, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," provides criteria for identifying release points and release characteristics.

When independently assessing the acceptability of the information presented by the applicant in FSAR Tier 2, Section 2.3.5, the NRC staff applied the same methodologies, models, and techniques cited above.

2.3.5.4 *Technical Evaluation*

The NRC staff reviewed the application and the applicant's responses to RAIs to verify the accuracy, completeness, and sufficiency of the information regarding long-term atmospheric dispersion estimates for routine releases. The staff followed the procedures described in Section 2.3.5 of NUREG–0800 as part of this review.

COL Item

- EF3 COL 2.0-11-A Long-Term Diffusion Estimates

  In FSAR Section 2.3.5, the applicant states:

  > For a routine release, the concentration of radioactive material in the surrounding region depends on the amount of effluent released, the height of the release, the momentum and buoyancy of the emitted plume, the wind speed, atmospheric stability, airflow patterns of the site, and various effluent removal mechanisms. Annual average relative concentration, χ/Q, and annual average relative deposition, D/Q, for gaseous effluent routine releases were, therefore, calculated.

In response to this COL information item, the applicant describes the following:

- Atmospheric dispersion models used to calculate concentrations in air and the amount of material deposited as a result of routine releases of radioactive material into the atmosphere
- The characteristics assumed for each release point and the location of potential receptors for dose computations
- Meteorological data and other assumptions used as inputs to the atmospheric dispersion models
- Diffusion parameters (σ_z)
- χ/Q and D/Q values used to assess the consequences of routine airborne radioactive releases

The NRC staff reviewed the applicant's resolution to EF3 COL 2.0-11-A related to supplying site-specific information in accordance with SRP Subsection 2.3.5. The staff's review of the applicant's χ/Q and D/Q estimates for calculating concentrations in the air and the amount of material deposited on the ground as a result of routine releases of radiological effluents into the atmosphere during normal plant operation is described below.

a. Atmospheric Dispersion Model

The applicant used the NRC-sponsored computer code XOQDOQ (described in NUREG/CR-2919, "XOQDOQ Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations") to estimate χ/Q and D/Q values resulting from routine releases. The XOQDOQ model implements the constant mean wind direction model methodology outlined in RG 1.111.

The XOQDOQ model is a straight-line Gaussian plume model based on the theoretical assumption that material released into the atmosphere will be normally distributed (Gaussian) about the plume centerline. In predictions of χ/Q and D/Q values for long time periods (i.e., annual averages), the plume's horizontal distribution is assumed to be evenly distributed within the downwind direction sector (e.g., "sector averaging"). A straight-line trajectory is assumed between the release point and all receptors.

Because geographic features such as hills, valleys, and large bodies of water can potentially influence dispersion and airflow patterns, terrain recirculation factors can be used to adjust the results of a straight-line trajectory model such as XOQDOQ to account for terrain-induced flows, recirculation, or stagnation. In order to account for possible lake breeze and land breeze effects from Lake Erie on the long-term atmospheric dispersion estimates for routine releases, the applicant used default open terrain correction factors from the XOQDOQ dispersion model. This means that all χ/Q and D/Q values out to a distance of one kilometer were multiplied by a factor of four and all χ/Q and D/Q values between one and ten kilometers were multiplied by a factor that deceased logarithmically from four at one kilometer to one at ten kilometers.

The staff has agreed with the applicant that the use of the default XOQDOQ open terrain correction factors conservatively account for possible recirculation due to land-water boundaries at the proposed Fermi 3 site.

b. Release Characteristics and Receptors

The ESBWR standard design employs three ventilation stacks that are routine airborne release points: the RB/FB vent stack, the turbine building (TB) vent stack, and the RWB vent stack. Two of these stacks, the RB/FB vent stack and the TB vent stack, qualify as mix-mode (part-time elevated, part-time ground-level) releases pursuant to RG 1.111 because their release points (52.8 meters and 71.3 meters above finished ground level, respectively) are above the height of adjacent solid structures (i.e., the 52.0-meter high turbine building), but less than two times the height of adjacent solid structures. The third stack, RWB vent stack, qualifies as a ground-level release because its release point (18.2 meters above finished ground level) is below the height of adjacent solid structures.

The applicant executed the XOQDOQ computer code assuming a mix-mode release for both the RB/FB vent stack and the TB vent stack. The RB/FB vent stack was modeled assuming a release height of 52.77 meters, an adjacent FB height of 48.2 meters, an inside vent diameter of 2.4 meters, and an average vent exit velocity of 17.78 meters per second. The TB vent stack was modeled assuming a release height of 71.3 meters, an adjacent turbine building height of 52 meters, an inside vent diameter of 1.95 meters, and an average vent exit velocity of 17.78 meters per second. The applicant also executed the XOQDOQ computer code assuming a ground-level release for the RWB vent stack with an adjacent building height conservatively set equal to zero.

Although the ESBWR standard design has three normal operation release pathways to the atmosphere, the applicant originally used one set of distances to the site boundary and special receptors of interest to model releases from all three pathways in Revision 0 to the FSAR. The locations for the special receptors of interest (i.e., nearest resident, garden, sheep, goat, meat cow, and milk cow) were based on the 2005 through 2007 land use census. The staff requested the applicant in RAI 02.03.05-1 to explain the methodology used to derive the one set of distances to each receptor location. If applicable, the staff asked the applicant to justify not using a “power block envelope” concept that encompasses all the normal operation release pathways for determining the distance to each receptor location.

In its response to RAI 02.03.05-1, dated November 4, 2009 (ADAMS Accession No. ML093130117), the applicant stated that the long-term χ/Q and D/Q values are based on the distance from the RB centerline to the various receptors. The applicant estimated the distances from each of the vent stacks to the site boundary in each direction and found that in many cases the distances from the vent stacks to the various receptors were shorter than the distances from the RB to the same receptors. Nonetheless, the applicant defended the selective use of long-term χ/Q and D/Q values based on the distance from the RB centerline to the various receptors depending on the analysis being performed.

However, in its subsequent responses to RAIs 02.03.05-3 and 02.03.05-4 dated July 26, 2010 (ADAMS Accession No. ML102180224), the applicant provided a revised set of long-term χ/Q and D/Q values to the site boundary and receptors of interest based on the distance from the outer edge of a circle, centered on the RB, which encompasses all possible release points to the receptors. Because the applicant eventually recalculated the long-term χ/Q and D/Q values using a "power block envelope" concept, the staff considers RAI 02.03.05-1 to be resolved.

The applicant added Appendix 2B, "Ventilation Stack Pathway Information for Long-Term χ/Q Values," to Revision 2 of the Fermi 3 FSAR. Table 2B-201 in FSAR Appendix 2B provides gaseous effluent release pathway information for each of the three ventilation stacks. The ventilation stack parameters presented in Revision 2 to FSAR Table 2B-201 reflected the values presented in Revision 7 to ESBWR DCD, Tier 2, Table 2B-1. Several of these parameter values were revised in Revision 7 to the ESBWR DCD. However, the applicant's letter dated November 9, 2010 which was submitted to identify proposed changes to the Fermi 3 COL FSAR to reflect ESBWR DCD Revision 7 and anticipated changes to ESBWR DCD Revision 8 did not identify these changes in FSAR Table 2B-201 ventilation stack parameter values. Consequently, the staff requested the applicant in RAI 02.03.05-5 to revise FSAR Table 2B-201 to reflect the gaseous effluent release pathway information presented in Revision 8 to the ESBWR DCD and revise FSAR Appendix 2B to identify any assumptions used in deriving the Fermi 3 long-term dispersion site characteristic values that differ from the information provided in the revised FSAR Table 2B-201.

In its response to RAI 02.03.05-5, dated January 10, 2011 (ADAMS Accession No. ML110110550), the applicant stated that FSAR Appendix 2B is intended to incorporate the information in ESBWR DCD, Tier 2, Appendix 2B with no site specific changes. Consequently, the applicant updated Revision 4 to FSAR Appendix 2B, including Table 2B-1, to indicate that DCD Tier 2, Appendix 2B is incorporated by reference with no departures or supplements. The staff finds this response acceptable and considers RAI 02.03.05-5 to be resolved.

c. Meteorological Data Input

The applicant originally executing the XOQDOQ model using a JFD of wind speed, wind direction, and atmospheric stability based on hourly onsite data from the 6-year period 2002-2007. The wind data were obtained from the 10-meter level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-T) measurements taken between the 60-meter and 10-meter levels on the onsite meteorological tower.

The supplemental response to RAI 02.03.03-1, dated March 30, 2010 (ADAMS Accession No. ML100960474) states that after a review of wind rose data spanning a period of over 30 years, the applicant concluded that the potential exists for recent wind speed measurements at the 10-meter elevation to be slower than the actual wind speeds at the 10-meter elevation due to trees located in the vicinity of the Fermi meteorological tower. The applicant further concluded that the slower wind speeds measured at the 10-meter elevation during 2002-2007 produces higher (more conservative) long-term χ/Q and D/Q values as compared to faster actual wind speeds at the 10-meter elevation. In its supplemental response to RAI 02.03.04-3, the applicant proposed a revision to FSAR Subsection 2.3.5.2 stating that the meteorological tower is located east of a grove of trees that is situated less than ten times the obstruction height recommended in RG 1.23. The impact of the trees is to reduce the measured wind speed at the 10-meter level for upwind sectors. The proposed FSAR revision further stated that the use of lower measured wind speeds provides conservative results for the XOQDOQ model.

The staff disagreed with the assessment that slower wind speeds at the 10-meter elevation produce higher χ/Q and D/Q values for mixed-mode (part-time ground, part-time elevated) releases. The applicant has modeled the RB/FB vent stack and the TB vent stack as mixed-mode releases pursuant to RG 1.111 because these two stacks are higher than the adjacent buildings. Regulatory position C.2.b of RG 1.111 states that mixed-mode releases can be considered to be elevated releases whenever the plume exit velocity is at least five times the horizontal wind speed at the height of the release. Because the wind speed provided as input to the XOQDOQ dispersion code is measured at 10-meters, the code corrects the 10-meter wind speed to the stack height. Providing faster 10-meter elevation wind speeds as input to the XOQDOQ dispersion code decreases the percent of time the plume is assumed to be an elevated release, potentially resulting in higher χ/Q and D/Q values.

The applicant provided a copy of the 1985-1989 data from the Fermi meteorological tower in its supplemental response to RAI 02.03.04-4, dated March 30, 2010 (ADAMS Accession No. ML100960474). The applicant stated that aerial photographs of the area surrounding the Fermi meteorological tower in 1981 and 1991 confirm the absence of significant air flow obstructions to wind measurements at the 10 meter (33-foot) elevation during this time period. The staff generated a JFD from the 1985-1989 data for comparison with the new 2002-2007 JFD presented by the applicant in its supplemental response to RAI 02.03.04-3. The staff found the 1985-1989 JFD has a lower frequency of (1) slow wind speed conditions (the frequency of wind speeds less than 1.5 meters per second increased from 9.1 percent in the 1985-1989 data to 17.0 percent in the 2002-2007 data) and (2) extremely unstable (stability class A) conditions (the frequency of extremely unstable conditions increased from 7.1 percent in the 1985-1989 data to 19.3 percent in the 2002-2007 data). These discrepancies in wind speed and stability class frequency distributions discussed above create uncertainty as to which meteorological data set (1985-1989 versus 2002-2007) is most representative of long-term site conditions. Given the uncertainty in the data, the staff requested the applicant in RAI 02.03.05-3 to justify why the long-term (routine) χ/Q and D/Q values should not be generated using both meteorological data sets and the more conservative resulting χ/Q and D/Q values be presented in FSAR Section 2.3.5.

In its response to RAI 02.03.05-3, dated July 26, 2010 (ADAMS Accession No. ML102180224), the applicant stated that it reran the XOQDOQ dispersion code using meteorological data from the 1985-1989 time frame to assess the influence of the trees on the χ/Q and D/Q values. The applicant compared the 1985-1989 χ/Q and D/Q values to the XOQDOQ results using the 2002-2007 meteorological data and found that in several cases the 1989-1989 meteorological data provided higher χ/Q and D/Q values than the 2002-2007 meteorological data. The applicant subsequently presented χ/Q and D/Q values from both sets of data in Revision 4 of the FSAR. For this reason, RAI 02.03.05-3 is considered to be resolved.

d. Diffusion Parameters

The applicant initially chose to implement the diffusion parameter assumptions outlined in RG 1.111, as a function of atmospheric stability for the XOQDOQ model runs.

The applicant did not generate estimates for site boundary χ/Q and D/Q values in the east-northeast clockwise through southeast sectors because the site boundary is directly overwater for these sectors. For the same reason, there are no special receptors of interest in these downwind sectors. However, the applicant did generate annual average χ/Q and D/Q values out to a distance of 80 kilometers (50 miles) in all downwind sectors as provided in FSAR Tables 2.3-328 through 2.3-339. These latter set of χ/Q and D/Q values are used by the applicant to generate population dose estimates for the 80 kilometer (50-mile) population in support of the gaseous radwaste system design basis cost benefit evaluation required by 10 CFR Part 50, Appendix I, Section II.D. Because some of these χ/Q and D/Q values represent plume transport over water for significant distances, the staff requested the applicant in RAI 02.03.05-2 to revise the FSAR as necessary to discuss the impact of changes in surface temperature and roughness resulting from over-water trajectories on the resulting long-term atmospheric dispersion and deposition estimates.

In its response to RAI 02.03.05-2, dated February 8, 2010 (ADAMS Accession No. ML093570220), the applicant stated that the majority (approximately 85 percent) of the collective population within 80 kilometers (50 miles) of the site resides in areas where the trajectory would not be over water. Another 13 percent of the collective population within 80 kilometers (50 miles) of the site resides in areas where the trajectory over water is 32 kilometers (20 miles) or less and therefore the deposition rate would not be significantly different than that over land. Less than two percent of the collective population within 80 kilometers (50 miles) resides in areas where the trajectory over water could extend up to the 80-kilometer (50-mile) radius. Therefore the applicant concluded that the potential impact to the collective population would be very small.

The staff reviewed the response to RAI 02.03.05-2 and determined that the question was closed but the issue remained unresolved. The staff subsequently issued RAI 02.03.05-4 stating that it found the response to RAI 02.03.05-2 incomplete. As discussed in the response to RAI 02.03.05-2, the overwater trajectories for the population living within 80 kilometers (50 miles) in the NE, ENE, E, SE, SSE, S and SSW sectors can range from 16 to 80 kilometers (10 to 50 miles). Air trajectories over such extensive water surfaces could affect atmospheric diffusion rates when compared with overland trajectories due to: (1) the generally smoother water surface decreasing the contribution to diffusion by mechanical turbulence and (2) cooler water temperatures (as compared to air temperatures) decreasing the contribution to diffusion from convectional turbulence. The staff asked the applicant to revise FSAR Section 2.3.5 to discuss the impact of changes in surface temperature and roughness resulting from over-water trajectories on the resulting long-term (routine) atmospheric dispersion and deposition estimates.

In its response (ML102180224) to RAI 02.03.05-4 dated July 26, 2010, the applicant stated that air trajectories over large water surfaces could reduce the rate of atmospheric dispersion due to differences in surface roughness and static stability as compared to transport over land. The applicant consequently adjusted the stability class for the direction sectors that are upwind to the water sectors (i.e., SW clockwise to NNE) in the JFDs to the next higher stability class level in order to model the potential decrease in the rate of atmospheric dispersion for over water trajectories; that is, the hours for the upwind sectors originally associated with stability class A were shifted to stability class B, stability class B hours were shifted to stability class C, etc., and the hours in stability class F were added to the hours originally identified in stability class G. The applicant performed this adjustment to both the 1985-1989 JFD and the 2002-2007 JFD and reran the XOQDOQ dispersion model. The applicant subsequently included both sets of revised χ/Q and D/Q values in Revision 4 of the FSAR. The staff considered the stability class adjustment to account for changes in atmospheric dispersion characteristics over water to be reasonable and therefore considers RAI 02.03.05-4 to be resolved.

e. Resulting Relative Concentration and Deposition Factors

FSAR Tables 2.3-307 through 2.3-327 and Tables 2.3-366 through 2.3-377 list the long-term atmospheric dispersion and deposition estimates for the site boundary and special receptors of interest that the applicant derived from the XOQDOQ model. The χ/Q values in these tables reflect several plume radioactive decay and deposition scenarios. Regulatory Position C.3 of RG 1.111 states that radioactive decay and dry deposition should be considered in radiological impact evaluations of potential annual radiation doses to the public that result from routine releases of radioactive materials in gaseous effluents. Regulatory Position C.3.a of RG 1.111 states that an overall half-life of 2.26 days is acceptable for evaluating the radioactive decay of short-lived noble gases, and an overall half-life of 8 days is acceptable for evaluating the radioactive decay for all iodines released into the atmosphere. Definitions for the χ/Q categories listed in the headings of FSAR Tables 2.3-307 through 2.3-327 are as follows:

- No Decay χ/Q values are χ/Q values used to evaluate ground level concentrations of long-lived noble gases, tritium, and carbon-14. The plume is assumed to travel downwind, without undergoing dry deposition or radioactive decay.

- 2.26-Day Decay χ/Q values are χ/Q values used to evaluate ground-level concentrations of short-lived noble gases. The plume is assumed to travel downwind, without undergoing dry deposition, but is decayed, assuming a half-life of 2.26 days, based on the half-life of xenon-133m.

- 8.00-Day Decay χ/Q values are χ/Q values used to evaluate ground level concentrations of radioiodine and particulates. The plume is assumed to travel downwind, with dry deposition, and is decayed, assuming a half-life of 8.00 days based on the half-life of iodine-131.

FSAR Tables 2.3-328 through 2.3-339 and Tables 2.3-366 through 2.3-377 list the applicant's long-term atmospheric dispersion and deposition estimates for all 16 radial sectors from the site boundary to a distance of 80 kilometers (50 miles) from the proposed facility.

The staff performed an independent evaluation of the applicant's XOQDOQ results by executing XOQDOQ with JFDs it generated from the 1985-1989 and 2002-2007 hourly onsite meteorological databases submitted in the supplemental response to RAI 02.03.04-4 and obtaining similar results for the site boundary and special receptors of interest (i.e., most values within ± 10 percent). The applicant presents the higher of either the 1985-1989 or the 2002-2007 χ/Q and D/Q values as site characteristic values in Section 2.0 of the Fermi 3 COL FSAR and used the higher values in its offsite airborne dose evaluation presented in FSAR Section 12.2.2.2. The staff finds the applicant's approach of using the higher (more conservative) of either the 1985-1989 or the 2002-2007 χ/Q and D/Q values in its offsite airborne dose evaluations to be acceptable.

The staff has reviewed the information provided and, for the reasons given above, concludes that the applicant's atmospheric dispersion estimates are acceptable and meet the relevant requirements of 10 CFR 100.21(c)(1).

2.3.5.5 *Post Combined License Activities*

There are no post COL activities associated with this FSAR section.

2.3.5.6 *Conclusion*

The NRC staff has reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

In addition, the staff compared the information in the COL application to the relevant NRC regulations, the guidance in Section 2.3.5 of NUREG–0800, and the applicable NRC regulatory guides. The NRC staff's review finds that the applicant has presented and substantiated information regarding long-term atmospheric dispersion estimates for routine releases. The staff reviewed the information provided and, for the reasons given above, concludes that the applicant's atmospheric dispersion estimates are acceptable and meet the relevant requirements of 10 CFR 100.21(c)(1). Representative atmospheric dispersion and deposition factors have been calculated for 16 radial sectors from the site boundary to a distance of 50 miles (80 kilometers) as well as for specific locations of potential receptors of interest. The characterization of atmospheric dispersion and deposition conditions are appropriate for the evaluation to demonstrate compliance with the numerical guides for doses contained in 10 CFR Part 20, Subpart D and 10 CFR Part 50, Appendix I.

The staff's review confirms that the applicant has adequately addressed the COL license information item in accordance with Section 2.3.5 of NUREG–0800.

2.4 <u>Hydrology</u>

This section of the SER addresses the Fermi 3 COL FSAR, Revision 7, site-specific hydrological site parameters and site characteristics identified in Chapter 5 of Tier 1 and Chapter 2 of Tier 2 of the ESBWR DCD, Revision 10.

2.4.1 Hydrologic Description

2.4.1.1 *Introduction*

The hydrologic description of the nuclear power plant site includes the interface of the plant with the hydrosphere, hydrological causal mechanisms, surface and groundwater uses, hydrologic data, and alternate conceptual models. The review covers the following specific areas: (1) the interface of the plant with the hydrosphere including descriptions of site location, major hydrological features in the site vicinity, surface water and groundwater related characteristics, and the proposed water supply to the plant; (2) hydrological causal mechanisms that may require special plant design bases or operating limitations with regard to floods and water supply requirements; (3) current and likely future surface and groundwater uses by the plant and water users in the vicinity of the site that may impact safety of the plant; (4) available spatial and temporal data relevant for the site review; (5) alternate conceptual models of the hydrology of the site that reasonably bound hydrological conditions at the site; (6) potential effects of seismic and non-seismic data on the postulated design bases and how they relate to the hydrology in the vicinity of the site and the site region; and (7) any additional information requirements prescribed within the "Contents of Application" sections of the applicable Subparts to 10 CFR Part 52.

2.4.1.2 *Summary of Application*

Subsection 2.4.1 of the Fermi 3 COL FSAR, Revision 7, describes the site from the standpoint of hydrologic considerations and provides topographic and regional maps showing proposed changes to the site's natural drainage features and major hydrological features. In addition, in Section 2.4.1, the applicant provides the following:

<u>*COL Item*</u>

- EF3 COL 2.0-12-A Hydrologic Description

  To address this COL item, the applicant described the site and all safety-related elevations, structures, and systems from the standpoint of hydrologic considerations and provided a topographic map of the site that showed proposed changes to natural drainage features.

  The applicant described the location, size, shape, and other hydrologic characteristics of streams, lakes, and shore regions influencing plant citing. Groundwater environments were not discussed in this section. The applicant stated that there are no known present or future water control structures in the vicinity of or at the site.

  The applicant provided a regional map showing major hydrologic features.

2.4.1.3 *Regulatory Basis*

Guidance relevant to the Commission's regulations for the hydrologic descriptions, and the associated acceptance criteria, are in Section 2.4.1 of NUREG-0800. The staff reviewed Section 2.4.1 of the FSAR for conformance with the applicable regulations and considered the corresponding regulatory guidance.

The applicable regulatory requirements are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 52.79(a)(1)(iii), as it relates to the hydrologic characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The following related acceptance criteria are summarized from SRP Section 2.4.1:

- Interface of the Plant with the Hydrosphere: The application should provide a description of hydrology in the vicinity of the site and site regions and of how the plant interfaces with the hydrosphere.

- Hydrological Causal Mechanisms: The application should provide a description of hydrological causal mechanisms that affect the safety of the plant.

- Surface and Ground Water Uses: The application should provide a description of surface and ground water uses in the vicinity of the site that affect the safety-related water supply to the plant.

- Data: The application should provide a complete description of all spatial and temporal datasets used by the applicant in support of its conclusions regarding safety of the plant.

- Alternate Conceptual Models: The application should provide a description of alternate conceptual models of site hydrology.

- Consideration of Other Site-Related Evaluation Criteria: The application should demonstrate that the potential effects of site-related proximity and of seismic and non-seismic information as they relate to hydrologic description in the vicinity of the proposed plant site and site regions are appropriately taken into account.

The description of hydrologic characteristics should correspond to those of the United States Geological Survey (USGS), Natural Resources Conservation Service (NRCS), U.S. Army Corps of Engineers (USACE), or appropriate State and river basin agencies.

In addition, the hydrologic characteristics should be consistent with appropriate sections from: RG 1.27, RG 1.29, "Seismic Design Classification," RG 1.59, "Flood Design Basis for Nuclear Power Plants," as supplemented by best current practices, and RG 1.102, "Flood Protection for Nuclear Power Plants."

2.4.1.4 *Technical Evaluation*

The NRC staff has reviewed Section 2.4.1 of the Fermi 3 COL FSAR, Revision 7. The staff conducted a site visit in accordance with the guidance provided in Section 2.4.1 of NUREG-0800. The staff used information from the site visit, USGS topographic maps, topographic maps of the site provided by the applicant, available references, and independent calculations to verify the hydrologic description provided in Section 2.4.1 of the Fermi 3 FSAR.

COL Item

- EF3 COL 2.0-12-A Hydrologic Description

  To address this COL item, the applicant described the site and all safety-related elevations, structures, and systems from the standpoint of hydrologic considerations and provided a topographic map of the site that showed proposed changes to natural drainage features.

  The applicant described the location, size, shape, and other hydrologic characteristics of streams, lakes, and shore regions influencing plant citing. Groundwater environments were not discussed in this section. The applicant stated that there are no known present or future water control structures in the vicinity of or at the site.

  The applicant provided a regional map showing major hydrologic features.

Site and Facilities

The staff has reviewed the information submitted by the applicant related to the hydrological parameters of the site and facilities. Throughout Section 2.4 of the FSAR, the applicant presented the elevations of various plant and flooding features using four different reference datums. The four datums referenced in the Fermi 3 FSAR include: the North American Vertical Datum of 1988 (NAVD 88), the Fermi plant grade datum (plant), the National Geodetic Vertical Datum of 1929 (NGVD 29), and the International Great Lakes Datum of 1985 (IGLD 85). The staff constructed the following table (Table 2.41-1) displaying elevations of important hydrological features in each of the four datums.

Table 2.4.1-1 Key Site Elevations According to Four Datum Systems

Feature	Elevations by Reference Datum (feet)[a]			
	NAVD 88	Plant	IGLD 85	NGVD 29
Current Fermi plant grade	581.8	583.0	581.5	582.4
Planned Fermi 3 plant grade	588.8	590.0	588.5	589.4
Fermi 3 safety structures	589.3	590.5	589.0	589.9
Lake Erie low water datum	569.5	570.7	569.2	570.1
Elevation of water intake pipe	553.3	554.5	553.0	553.9
100-year lake level calculated by the applicant (FSAR Section 2.4.5)	575.1	576.3	574.8	575.7
100-year lake level calculated by FEMA (2000)	578.2	579.4	577.9	578.8
Average elevation of Lake Erie	571.6	572.8	571.3	572.2
Flood elevation from probable maximum precipitation (PMP) at the Fermi 3 site	584.4	585.6	584.1	585.0
Flood elevation from PMP plus snowmelt at the Fermi 3 site	584.8	586.0	584.5	585.4
Applicant's Flooding Alternative I	579.4	580.6	579.1	580.0
Applicant's Flooding Alternative II	579.2	580.4	578.9	579.8
Applicant's Flooding Alternative III	585.4	586.6	585.1	586.0
Applicant's Flooding Alternative III plus snowmelt and PMF on Swan Creek	585.5	586.7	585.2	586.1
Staff's Flooding Alternative III plus snowmelt and Probable Maximum Flood (PMF) on Swan Creek	586.3	587.5	586.0	586.9

[a] To change feet to meters, multiply the values by 0.3048.
NAVD = North American Vertical Datum
IGLD = International Great Lakes Datum
NGVD = National Geodetic Vertical Datum
FEMA = Federal Emergency Management Agency
PMF = Probable Maximum Flood

The staff uses the NAVD 88 coordinate system throughout this document to describe hydrological features. The applicant's information is presented herein using the datum referenced for that feature in the FSAR that was submitted.

Information Submitted by the Applicant

The applicant described the site hydrology, described the principal plant structures and their design elevations, and presented topographic maps showing changes in site drainage patterns between the existing conditions and the final grade.

According to Subsection 2.4.1.1 of the FSAR, the site is located in Monroe County, Michigan, on the west bank of Lake Erie. The Fermi 3 unit is located approximately 0.40 km (0.25 mi) west of the Lake Erie shoreline. The applicant provided a USGS topographic map with the site boundary delineated. The applicant stated that site elevations range from 577 to 600 ft NGVD 29. The majority of the Fermi plant facility, including the Fermi 2 unit, is located at elevation 583.0 ft plant grade datum, and the Fermi 3 unit is located on an area elevated to 590.0 ft plant grade datum, with safety-related facilities at a minimum of 590.5 ft plant grade datum.

The applicant referenced ESBWR DCD Section 1.2 to describe the seven principal plant structures including the RB/FB, Control Building and Fire Water Service Complex as the only seismic Category 1 structures of Fermi 3. The applicant described that Lake Erie is the primary source of makeup water for the Fermi 3 unit. Potable water needs and makeup demineralizer water is supplied by the Frenchtown Township municipal water supply. A new pump house is planned to be constructed to pump water from Lake Erie for Fermi 3, utilizing the intake bay currently used by Fermi 2. Discharge from Fermi 3 is through a new pipe to Lake Erie.

NRC Staff's Technical Evaluation

The NRC staff checked the referenced USGS Stony Point topographic map and found that elevations within the Fermi Property boundary were less than 575 ft to greater than 595 ft NAVD 88. According to NOAA (NOAA, 2009), the average elevation of Lake Erie is 571.6 ft NAVD 88. The applicant submitted elevation maps of the current plant grade as a response to RAI 2.4.1-1 (ADAMS Accession No. ML100830380). The staff used these maps to verify the elevations of the current Fermi plant facility. The staff has verified the applicant's stated plant grade elevation of 581.8 ft NAVD 88.

Also in RAI 2.4.1-1, the staff requested that the applicant provide proof in the form of a letter or other documentation that the Frenchtown Township municipal water supply is available for Fermi 3 potable water needs and makeup demineralizer water. In their response (ADAMS Accession No. ML100830380), the applicant stated that they have confirmed that the Frenchtown Township service and current utility infrastructure is adequate for the additional Fermi 3 water demand (Detroit Edison 2009b). The staff finds this response acceptable.

Hydrosphere

Information Submitted by the Applicant

The applicant described the local and regional hydrology surrounding the Fermi 3 site. Fermi 3 is contained within the Swan Creek Watershed. Swan Creek is a 106 square mile (mi^2) (about 274 km^2) watershed that drains into Lake Erie approximately 1 mi north of the Fermi Site.

The Fermi property is bordered by Lake Erie along its eastern edge. Lake Erie is a part of the Great Lakes Drainage Basin and is the shallowest and warmest of the Great Lakes with a water surface area of 9,910 mi^2 (25,665 km^2). The applicant stated that the drainage area of Lake Erie is approximately 23,400 mi^2 (60,600 km^2) and it has twelve main tributaries. The main tributaries of Lake Erie nearest to the Fermi site are the River Raisin to the south and the Detroit River to the north. The western basin of Lake Erie borders the Fermi property. The western basin of Lake Erie is very shallow basin with an average depth of 24 ft (7.3 m). A rock barrier is present along the eastern edge of the Fermi site at the shoreline to protect the Fermi site against the high water levels of Lake Erie. The rock barrier crest elevation is at 583.0 ft plant grade datum.

The applicant described the Detroit River as "the largest and most important tributary for the western basin of Lake Erie as it provides approximately 80 percent of Lake Erie's water inflow. The applicant provided a short description of the 126 mi^2 (326 km^2) Stony Creek Watershed, as it is adjacent to the Swan Creek Watershed to the south. The River Raisin Watershed has a drainage area of 1,070 mi^2 (2,770 km^2) and is south of the Stony Creek Watershed. The applicant discussed the River Raisin because it impacts "sediment and other water quality characteristics within the western basin of Lake Erie in the vicinity of the Fermi site." The applicant did not discuss the groundwater environment in the vicinity of the site in Section 2.4.1 but provided detailed information in Section 2.4.12 of the FSAR.

As Lake Erie is the primary source of water for the operation of Fermi 3, the applicant stated that Fermi 3 has been designed to operate at full capacity assuming the lowest recorded water level on Lake Erie at the intake pipe for the plant. The elevation of the base of the intake pump is 553 ft IGLD 85, which the applicant said is 10 feet below the lowest lake level for operation of 563.64 IGLD 85, as discussed in Section 2.4.11 of the FSAR. The applicant described the current and past surface water use of Lake Erie, following SRP Section 2.4.1. Tables 2.4-201 through 2.4-204 present water use information for Lake Erie for the years between 1998 and 2004. Tables 2.4-205 through 2.4-208 present water use information for Monroe County for the years between 2000 and 2006. Table 2.4-209 presents the net basin water supply of Lake Erie by month. Using data from the tables presented, the applicant stated that Monroe County, Michigan uses approximately 1.4 percent of the total water supply for Lake Erie.

NRC Staff's Technical Evaluation

The NRC staff could not verify the boundary of the Swan Creek Watershed with the information provided by the applicant. In response to RAI 2.4.1-1, dated September 18, 2008 (ADAMS Accession No. ML082730763) asking for a detailed topographic map of the Swan Creek Watershed, the applicant submitted the USGS Stony Point quadrangle. The staff reviewed this quadrangle. The mouth of Swan Creek is contained in the Stony Point quadrangle, but the majority of the watershed is not in the quadrangle. Adjacent USGS quadrangles, containing the rest of the Swan Creek Watershed include: Flat Rock, Monroe, Estral Beach, Rockwood, Carlton, Ypsilanti East, Belleville, and Maybee. To verify the watershed boundary, the staff requested that the digital elevation model (DEM) for the Swan Creek watershed be submitted. This was requested as RAI 2.4.1-2. The staff delineated the Swan Creek watershed boundary using the information submitted by the applicant. The watershed boundary submitted by the applicant by letter dated September 18, 2008 (ADAMS Accession No. ML082730763,) was found to be slightly larger than the watershed found by the review team. The entire Fermi site was found by the review team to be included in the Swan Creek Watershed and the total watershed area was calculated to be 101 mi^2.

The watershed area of Swan Creek is listed as 100 mi^2 (259 km^2) on the Michigan Department of Environmental Quality (MDEQ) Flood Discharge Request Record for Swan Creek (MDEQ, 2009). The applicant stated that the watershed area is slightly larger (106 mi^2), which makes an analysis of flooding more conservative. The staff verified the watershed area is accurate.

The staff confirmed that the River Raisin is the largest watershed in the vicinity of the site. The staff evaluated flooding levels on the River Raisin to determine if flooding on the River Raisin could impact the Fermi 3 site. The confluence of the River Raisin with Lake Erie is over six miles south of the location of Fermi 3. A Federal Emergency Management Agency (FEMA) report, "Flood Insurance Study Monroe County, Michigan," (FEMA, 2000) provides flood elevations for the River Raisin approximately three miles inland from the river's confluence with Lake Erie. The 100-year flood elevation for this location on the River Raisin is estimated to be 583.2 ft NAVD 88 considering ice-jam effects and 580.0 NAVD 88 ft without ice-jam impacts. The flood elevations downstream of this point are assumed to be lower. The elevations of the land surface between Fermi 3 and the River Raisin are up to 599.7 ft NAVD 88. Based on review of the topography of the area and the information contained in the local FEMA report (2000), the staff determined that there is no risk of flooding at Fermi 3 due to flooding on the River Raisin because the topography of the area restricts the flooding of the site from adjacent watersheds.

The Detroit River enters Lake Erie more than 6 miles (9.6 km) north of the Fermi 3 site. The USACE (1998) estimated that the 500-year flood elevation at the mouth of the Detroit River was approximately 578.3 ft NAVD 88. The staff has reviewed the topography and has determined that there is no risk of flooding at Fermi 3 due to flooding on the Detroit River because the plant is located at an elevation of 590.5 and in an adjacent watershed.

The applicant did not discuss substantive groundwater issues in Section 2.4.1 of the FSAR, but did address groundwater fully in Section 2.4.12 of the FSAR. The staff's review of the information submitted by the applicant is located in Section 2.4.12, below.

SRP Section 2.4.1 states that flood maps should be provided, showing the areas to be inundated by floods of different magnitudes, with all plant structures and components identified on the maps. The staff identified FEMA maps showing the 100-yr and 500-yr flood plains in the vicinity of the site (FEMA, 2000). The applicant submitted the maps in response to an RAI filed for the Environmental Impact Statement, RAI HY2.3.1-10. The staff verified that the submitted maps were from the *Flood Insurance Study, Monroe County* (FEMA, 2000).

The applicant described the current and past surface water use of Lake Erie. The information about water use in the Lake Erie watershed presented in Tables 2.4-201 through 2.4-204 was verified by the staff using annual reports by the Great Lakes Commission (GLC, 1998; GLC, 1999; GLC, 2000; GLC, 2001; GLC, 2002; GLC, 2003; GLC, 2004). The information presented in Table 2.4-205 about water use in Monroe County from 2000-2006 was reviewed by the staff using sector-specific water use reports presented by the MDEQ (http://www.michigan.gov/deq/0,1607,7-135-3313_3684_45331-72931--,00.html). The staff verified the values presented in Table 2.4-205, however, the values presented for water withdrawn for agricultural irrigation in 2001 were not those found on the MDEQ website. According to the MDEQ, the surface water use was 2.27 million gallons per day (Mgd) and the groundwater use was 0.88 Mgd for agricultural irrigation in 2001. The information presented in Tables 2.4-206 through 2.4-208 could not be verified by the staff. The staff could not find the documents referenced in these tables and could not find other documents containing this information. Additionally, the source information presented in Table 2.4-209 was not clear. In RAI 2.4.1-3, dated March 19, 2010 (ADAMS Accession No. ML100830380), the staff requested the applicant to provide the references used to create Tables 2.4-206 through 2.4-208 related to Monroe County water supply and water use. The staff also requested that the data presented in Table 2.4-209 concerning the water supply of Lake Erie be further explained with detailed documentation of how the values in the table were determined. The response submitted by the applicant contained unpublished Monroe County water use data tables obtained from the MDEQ to produce FSAR Tables 2.4-206 through 2.4-208. DTE stated that this information was sent by the MDEQ in response to a request for data. The applicant also explained the derivation of the Lake Erie water balance values presented in Table 2.4-209. DTE downloaded the monthly hydrologic data from the Great Lakes Environmental Research Laboratory (GLERL) website. The applicant also stated that the data from the Detroit River was no longer available through GLERL, but pointed out that the data could be found through a USACE website. The staff downloaded the data from both websites and verified the values presented in Table 2.4-209. The staff therefore finds the response acceptable.

The applicant did not provide an estimate of future likely water use for Lake Erie in the FSAR. A discussion of future groundwater use was presented in Subsection 2.4.12.2.2 of the FSAR with reference to Table 2.4-277, which presents the estimates of future groundwater use by category through the year 2060. The groundwater use data for the year 2000 in FSAR Table 2.4-205 differed, in some instances, from the groundwater use data presented in Table 2.4-227. The staff requested that the applicant provide additional information on the material contained in the different tables as RAI 2.4.1-4, dated March 19, 2010 (ADAMS Accession No. ML100830380). The applicant responded with a detailed table comparing the sources of information for each category of groundwater use in Monroe County. The applicant selected the most conservative (largest) estimate of water use from all of the referenced sources to perform estimates of future water use. The staff finds this approach acceptable. In the response (ADAMS Accession No. ML100830380, dated March 19, 2010) to RAI 2.4.1-4, the applicant also provided the website address of the data that was used in the tables. The staff downloaded the groundwater use data and verified the values used in the tables. The staff finds the response to RAI 2.4.1-4 acceptable.

The applicant did not describe all of the datasets used in support of its conclusions regarding safety of the plant in this section, as called for in SRP Section 2.4.1. Datasets were described instead in FSAR Section 2.4.2. Lake Erie data was obtained by the applicant from the GLERL. The applicant provided this dataset electronically to the staff in response to RAI 2.4.5-1, dated September 30, 2009 (ADAMS Accession No. ML092790561). Verification of this dataset by the staff is discussed in Section 2.4.5 below.

Alternate conceptual models of site hydrology are provided in Section 2.4.12 of the FSAR and are discussed below in Section 2.4.12 of this SER.

For the reasons given above, the staff concludes that the identification and consideration of the hydrology in the vicinity of the site and site regions are acceptable and meet the requirements of

10 CFR Part 50, 10 CFR 52.79, and 100.20(c), with respect to determining the acceptability of the site for the ESBWR design.

2.4.1.5 *Post Combined License Activities*

There are no post COL activities related to this subsection.

2.4.1.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.1 of NUREG–0800, and other NRC RGs. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed EF3 COL Item 2.0-12-A as it relates to the hydrologic description.

As set forth above, the applicant has presented and substantiated information relative to the hydrologic description in the vicinity of the site and site regions important to the design and siting of this plant. The staff reviewed the available information provided. For the reasons given above, the staff concluded that the identification and consideration of the hydrology in the vicinity of the site and site regions are acceptable and meet the requirements of 10 CFR Part 50, 10 CFR 52.79, and 10 CFR 100.20(c), with respect to determining the acceptability of the site for the ESBWR design.

The staff finds that the applicant has considered the appropriate site phenomena for establishing the design bases for SSCs important to safety. The staff has accepted the methodologies used to determine the hydrologic description in the vicinity of the site and site regions reflected in site characteristics documented in the SER. Accordingly, the staff concludes that the use of these methodologies results in site characteristics containing sufficient margins for the limited accuracy, quantity, and period of time in which the data have been accumulated. The staff concluded that the identified site characteristics meet the requirements of 10 CFR 52.79 and 100.20(c), with respect to establishing the design basis for SSCs important to safety.

2.4.2 <u>Floods</u>

2.4.2.1 *Introduction*

This subsection discusses the historical flooding at the proposed site or in the region of the site. The information summarizes and identifies the individual types of flood-producing phenomena, and combinations of flood-producing phenomena, considered in establishing the flood design bases for safety-related plant features. The discussion also covers the potential effects of local intense precipitation. The flood history and the potential for flooding are reviewed for the sources and events listed below. Factors affecting potential runoff (such as urbanization, forest fire, changes in agricultural use, erosion, and sediment deposition) are considered in the review. In addition to describing flood history, this subsection also determines the local intense precipitation on the site to estimate local flooding. Local intense precipitation is reported as a site characteristic used in site grading design.

2.4.2.2 *Summary of Application*

Section 2.4.2 of the Fermi 3 COL FSAR, Revision 7, addresses site-specific information on flood history at the Fermi 3 site. In addition, the applicant provides the following:

<u>COL Item</u>

- EF3 COL 2.0-13-A Floods

  To address this COL item, the applicant discussed the flood potential from streams, reservoirs, adjacent watersheds, and site drainage and described the effects of local PMP on site drainage systems, including drainage from the roofs of structures. Additionally, the applicant provided a discussion of the effects of snow accumulation on site facilities where such accumulation could coincide with local probable maximum (winter) precipitation and cause flooding or other damage to safety-related facilities.

2.4.2.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the floods, and the associated acceptance criteria, are in Section 2.4.2 of NUREG–0800. The applicable regulatory requirements for identifying floods are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 52.79(a)(1)(iii), as it relates to the hydrologic characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The following related acceptance criteria are summarized from SRP Subsection 2.4.2:

Local Flooding on the Site and Drainage Design: The application should include an estimate of local intense precipitation or local PMP and a determination of the capacity of site drainage facilities (including drainage from the roofs of buildings and site ponding).

- Stream Flooding: The application should include documentation of the potential sources of flood and flood response characteristics.

- Surges: The application should include the complete history of storm surges in the vicinity of the site.

- Seiches: The application should include the complete history of seiches in the vicinity of the site.

- Tsunami: The application should include the complete history of tsunami in the vicinity of the site.

- Seismically Induced Dam Failures (or Breaches): The application should include the flooding hazard at the plant site resulting from seismically induced dam failure upstream of the site location.

- Flooding Caused by Landslides: The application should include the flooding hazard at the plant site from flood waves induced by landslides and backwater effects due to stream blockage from landslides.

- Effects of Ice Formation in Water Bodies: The application should include information concerning potential flooding at the plant site due to flood waves resulting from the collapse of an ice dam or backwater effects due to stream blockage due to an ice dam or an ice jam downstream of the plant site.

- Combined Events Criteria: The application should include information concerning design basis flooding at the plant site, including consideration of appropriate combinations of individual flooding mechanisms in addition to the most severe effects from individual mechanisms themselves.

- Consideration of Other Site-Related Evaluation Criteria: The application should demonstrate that the potential effects of site-related proximity, seismic, and non-seismic information as they relate to hydrologic description in the vicinity of the proposed plant site and site regions are appropriately taken into account.

In addition, the hydrologic characteristics should be consistent with appropriate sections in: RGs 1.27, 1.29, 1.59, as supplemented by best current practices and in RG 1.102.

2.4.2.4 *Technical Evaluation*

The NRC staff reviewed Subsection 2.4.2 of the Fermi 3 COL FSAR, Revision 7, related to flood history, flood design, and the effects of the PMP as follows:

<u>*COL Item*</u>

- EF3 COL 2.0-13-A Floods

  Based on a review of the Fermi Unit 3 site grading plan and the FSAR, the design plant grade elevation is 588.8 ft NAVD 88, with the safety features planned at an elevation of 589.3 ft NAVD 88. The design plant grade is approximately 3.4 ft above the maximum flood level at the site calculated in the FSAR resulting from a probable maximum surge and seiche on Lake Erie corresponding with the 100-year lake level and coincident wave action (elevation 585.4 ft NAVD 88).

The NRC staff's evaluation of COL Item EF3 COL 2.0-13-A is presented below.

Flood History

<u>*Information Submitted by Applicant*</u>

The applicant stated that "Lake Erie is the primary surface-water body to potentially impact Fermi 3." Historical floods on Lake Erie were discussed in Subsection 2.4.2.1 of the FSAR.

The applicant states that Lake Erie water level data is available from 1860 to the present. The response to RAI 2.4.5-1, dated September 30, 2009 (ADAMS Accession No. ML092790561) provided additional explanation of the values presented in Table 2.4-210. Table 2.4-210 of the FSAR provides maximum and minimum water levels recorded at the Fermi Power Plant gaging station on Lake Erie from 1970 through 2007. The applicant also described storm events, some with winds gusting higher than 62 mph that caused peak water levels near the Fermi Site. Peak water levels, up to 0.5 ft above the values in Table 2.4-210, were also presented in this section of the FSAR.

The applicant presented peak flow rates for Swan Creek referencing an MDEQ website as the source of the information. The applicant also provides descriptions of and peak flow rates for the adjacent Stony Creek, the River Raisin, and the Detroit River.

NRC Staff's Technical Evaluation

RAI 2.4.2-1, dated September 30, 2009 (ADAMS Accession No. ML092790561) included a request for records of water levels for Lake Erie from 1860 to present. The historical records prior to 1970 were not provided or discussed in the FSAR. In the response to RAI 2.4.2-1 (ADAMS Accession No. ML092790561, dated September 30, 2009), the applicant provided a table of average monthly water level observations for Lake Erie from 1918 to 2007 downloaded from the USACE website. The staff verified the data presented in the table by checking the referenced USACE website. The applicant compared the average monthly water levels from 1970 through 2007 to the water levels observed over the entire period of record, and found that the period from 1970 through 2007 included the highest water levels from this dataset. The averages of the monthly water levels for the period from 1970 through 2007 were also higher than the averages for the entire period of record, 1918 through 2007. The staff checked the referenced data and confirmed the conclusion that the period between 1970 and 2007 represents a conservative period to evaluate characteristic water levels for Lake Erie.

The staff requested an explanation of the values presented in Table 2.4-210 in RAI 2.4.5-1, dated September 30, 2009 (ADAMS Accession No. ML092790561). The applicant responded that the values represent the maximum and minimum hourly observations of water levels on Lake Erie measured each year at the Fermi Site gage (ID 9063090). The applicant also submitted the hourly water level observations at the Fermi Site gage (in addition to 12 other Lake Erie gages) between 1966 and 2007. This data for the Fermi Site gage (ID 9063090) was submitted to the NRC staff in Microsoft Excel format as a response to RAI 2.4.5-1 requesting data used to develop the 100-year water level for Lake Erie. The staff used this data to verify the information presented in the Table 2.4-210. The staff found that the values presented in Table 2.4-210 did not correspond in to the yearly maximum or minimum values of the hourly observations presented in the Microsoft Excel file for the years between 1970 and 1996 (e.g., 1987 maximum lake level in the excel file is 576.04 ft IGLD 85 not 574.39 IGLD 85 as presented in Table 2.4-210). The values of maximum and minimum water elevations presented in the table for the years from 1997 to 2007 correspond with the data contained in the Microsoft Excel file. The staff requested further explanation of the values presented in Table 2.4-210 in RAI 2.4.5-9, dated May 7, 2010 (ADAMS Accession No. ML101320136). An updated table was submitted as part of the response to RAI 2.4.5-9, correcting the values in Table 2.4-210 for the years 1970 through 1996 to be the yearly maximum or minimum values of the hourly lake level data. The staff finds the response acceptable.

To verify the information presented about flow in Swan Creek, the staff performed a search of USGS gaging stations. The staff identified measurements taken from 12 locations in the upper watershed of Swan Creek, but data were limited to between one and four measurements per site. Data for 12 of the periods between 1971 and 1991 but could not be used to describe peak flows on the watershed. The data were also insufficient to describe statistically the properties of the discharge from the Swan Creek Watersheds. Therefore, staff reviewed the Monroe County FEMA report, which provided estimates of the 10, 2, 1, 0.5 and 0.2 percent Swan Creek peak flow rates based on data available for the other streams in the region (FEMA, 2000). The applicant reports these flow rates in the FSAR and references a MDEQ webpage as the source. However, in the response to RAI 2.4.3-1, dated September 30, 2009 (ADAMS Accession No. ML092790561), the applicant referenced the FEMA report for the peak flow data which is a more accurate representation of the source of the data. Peak flow rates are also presented for the adjacent Stony Creek watershed and the largest watershed in the region, River Raisin.

Flood Design Considerations

Information Submitted by the Applicant

The applicant discussed the analysis and results of combined events in general in Subsection 2.4.2.2 of the FSAR and in detail in Subsection 2.4.3.3 of the FSAR. The applicant stated in Subsection 2.4.2.2 of the FSAR that the flooding possibilities applicable to the Fermi site include: the local PMP runoff, the PMF of streams and rivers, probable maximum surge and seiche flooding, and flooding due to ice effects. However, the applicant did not consider flooding due to ice effects on Swan Creek. In Subsection 2.4.3 of the FSAR, the applicant stated that snowmelt and ice effects are of minimal impact "due to the relatively flat topography of the area, seasonal Lake Erie water level data, and the historical climatology of the region."

The applicant submitted a revised analysis of the PMF including snowmelt runoff at both the local Fermi 3 site and within the Swan Creek Watershed with the response to RAI 2.4.2-1, dated September 30, 2009 (ADAMS Accession No. ML092790561). This analysis revised the flood information previously submitted by the applicant and is discussed further in Subsections 2.4.2.3 and 2.4.3.3, herein.

The three alternative flooding combinations considered by the applicant follow the guidelines of the *American National Standard for Determining Design Basis Flooding at Power Reactor Sites, ANSI/ANS-2.8-1992* (American Nuclear Society, 1992). Each of the alternatives considered has three stated combinations of events that could cause the highest flood level at the site. Alternative I included: 1) one-half PMF or 500-year flood, whichever is less; 2) surge and seiche from the worst regional hurricane or windstorm with wind wave activity; and 3) 100-year or maximum controlled level of water body, whichever is less. Alternative II examined: 1) the PMF within the Swan Creek Watershed; 2) 25-year surge and seiche with wind wave activity; and 3) 100-year or maximum controlled level of water body, whichever is less. Finally, Alternative III considered: 1) 25-year flood within the Swan Creek Watershed; 2) probable maximum surge and seiche with wind wave activity; and 3) 100-year or maximum controlled level of water body, whichever is less.

The applicant states that the most severe flooding combination of events results from a potential high surge from Lake Erie as considered in Alternative III. DCD Tier 1, Chapter 5, Table 5.1-1 requires that the maximum flood level be 1.0 ft below the design plant grade elevation. Based on a review of the Fermi 3 grading plan, the design plant grade elevation is 589.3 ft NAVD 88. The DCD maximum flood level corresponds to an elevation of 588.3 ft NAVD 88. The flood level calculated by the applicant for Alternative III is at 585.4 ft NAVD 88. The applicant also submitted a revised calculation of the PMF in the response to RAI 2.4.2-1, dated September 30, 2009 (ADAMS Accession No. ML092790561) that considers 1) the PMF on Swan Creek, 2) probable maximum snowmelt, 3) probable maximum surge and seiche on Lake Erie, and 4) 100-year elevation of Lake Erie. The flood level calculated by the applicant for this scenario is 585.5 ft NAVD 88, making it the highest elevation flood calculated for the site.

NRC Staff's Technical Evaluation

The NRC staff reviewed the application and verified information discussed in this section.

The staff checked the referenced ANSI/ANS-2.8-1992 guidelines to determine if the applicant's combinations meet the standards. The standards that the applicant referenced are for a *Streamside Location* (Section 9.2.3.2 of ANSI/ANS-2.8-1992). The staff verified that the applicant used the guidance properly in the determination of the highest possible flood level at a streamside location. The ANSI/ANS-2.8-1992 guidelines also include specifications for calculating floods at shoreline locations. The guidance suggests that floods may result from 1) the probable maximum surge and seiche and 2) the 100-year lake level. These floods were considered by the applicant as a part of Alternative III.

In order to verify the analysis and Alternative III, the staff independently calculated a maximum flood level at the site resulting from 25-year flood on Swan Creek, 100-year FEMA flood level on Lake Erie, and maximum surge on Lake Erie to be 585.4 ft NAVD 88, as discussed below. This provides additional assurance that the combination of events was correctly addressed in the application.

ANSI/ANS-2.8-1992 also provides guidance on determining the largest possible precipitation flood at the plant site. Three alternatives are provided that could produce the worst flooding at the site. Alternative I combines 1) mean monthly (base) flow; 2) median soil moisture; 3) antecedent (or subsequent) rain equal to 40 percent of the PMP or 500-year rain, whichever is less; 4) the PMP; and 5) the 2-year wind speed applied in the critical direction. Alternative II includes 1) mean monthly (base) flow; 2) probable maximum snowpack; 3) coincident snow season PMP; and 4) the 2-year wind speed applied in the critical direction. Alternative III combines 1) mean monthly (base) flow; 2) 100-year snowpack; 3) coincident snow season PMP; and 4) 2-year wind speed applied in the critical direction.

The staff compared the applicant's analysis of plant site flooding against the three Alternatives presented in ANSI/ANS-2.8-1992. The applicant calculated a combination of Alternatives II and III in response to RAI 2.4.2-1, dated September 30, 2009 (ADAMS Accession No. ML092790561). The applicant calculated the flood resulting from 1) the probable maximum snowpack, 2) the PMP, and 3) the 2-year wind speed. The applicant also assumed that the temperature was equal to the 100-year recurrence dew point temperature for April, 69.1 degrees Fahrenheit. The staff considers this to be a conservative assumption for the snowmelt calculation. The flood elevation associated with this combination of events was determined by the staff to be 584.8 ft NAVD 88, the same value as calculated by the applicant. The staff considers the applicant's analysis to be conservative as the PMP and the probable maximum snowmelt are considered in the same case.

Based on a review of the DCD, staff confirms that regulatory treatment of non-safety system (RTNSS) structures that meet Criterion B (i.e., for actions required beyond 72 hours and seismic events) are required to perform reliably in the event of hazards such as external flooding considering the PMF, PMP, seiche and other pertinent hydrologic factors. Staff performed a detailed review of all RTNSS features in Chapter 19 of this SER and Chapter 22 of the ESBWR FSER.

Effects of Local Intense Precipitation

Information Submitted by the Applicant

The applicant discussed the existing drainage patterns on the site shown on Figure 2.4-214 of the FSAR. Of the six areas described to handle existing storm discharge only one, the drainage outfall pipe, is called out on Figure 2.4-214. The remaining outlets were not called out on the map.

A map showing the final grade drainage areas and patterns was provided in the FSAR as Figure 2.4-215. The drainage area for the Fermi 3 final grade is less than 1 mi^2. The applicant described the runoff from the Fermi 3 final grade as primarily flowing into onsite drop inlets that discharge to the outfall pipe that drains into an overflow canal which then enters the North Lagoon. The applicant stated that the storm water may also "possibly flow toward two lagoons (North Lagoon and South Lagoon)." Flow from the North Lagoon reportedly flows to Swan Creek and flow from the South Lagoon flows directly to Lake Erie. A map showing the drainage of the Fermi 3 final grade assuming that all onsite drop inlets and drains blocked was provided in the FSAR as Figure 2.4-217.

The applicant calculated the discharge from the existing site sub-basins that are shown on Figure 2.4-214. Table 2.4-212 presents the discharge from the 22 sub-basins for the 10, 25, 50, and 100-year recurrence intervals. Table 2.4-213 presents the discharge from the sub-basins on final grade of the Fermi 3 (shown in Figure 2.4-215) for the 10, 25, 50, and 100-year recurrence intervals. An updated version of Table 2.4-213 was included with the response to RAI 2.4.2-1. The applicant used the rational method to calculate the runoff amounts for both the existing and final grade sub-basins. Table 2.4-214 presents total discharges for the 10, 25, 50, and 100-year recurrence intervals for both the existing condition and the final grade. An updated version of Table 2.4-214 was also presented with the response to RAI 2.4.2-1. The applicant compared the runoff from the existing condition to the final grade and estimated that runoff would be increased by 44 percent for the 10-year storm for the final grade and 88 percent for the 100-year storm.

The applicant calculated the PMF at the site using the rational method to determine peak runoff rates from the PMP. The applicant calculated the PMP for a 1 mi^2 area using the methods outlined in NOAA Hydro-Meteorological Report (HMR) 51 and HMR-52, as clarified by RAI 2.4.2-2, dated November 20, 2009 (ADAMS Accession No. ML092750405). The calculated PMP depths for storms lasting 12 hours or less are presented in Table 2.4-211. The investigated PMP is 69.6 inches per hour, which is the intensity that lasts for duration of 5 minutes. As a basis for selecting the 5-minute PMP duration, the applicant stated that this duration is shorter than the time of concentration and provides a more conservative estimate of runoff using the rational method. Time of concentration values for each of the final grade sub-basin areas are presented in Table 2.4-213.

In response to RAI 2.4.2-1, the applicant described calculation of the time of concentration for each of the individual Fermi 3 sub-basins, provided the equations used to calculate time of concentration, and presented a table with input values used in the equations. The equations used to calculate the time of concentration were from the USDA's *Urban Hydrology for Small Watershed, Technical Release 55* (TR-55) (USDA, 1986).

The applicant used the rational method to determine PMF from the PMP assuming all the storm drains at the site were blocked. The runoff coefficient was conservatively set to 1.0 representing completely impervious soil/concrete or saturated antecedent conditions. The applicant assumed the area of runoff included the Fermi 3 nuclear island, an area where the SSCs are located (18.1 acres) plus the area located to the southwest, termed N3 in the FSAR (see Figure 2.4-217 of the FSAR). This area is approximately 25.96 acres and is assumed to contribute to the site runoff because there may be backwater effects from this area to prevent water from draining from the Fermi 3 nuclear island.

The applicant calculated a peak flow of 3,066 cubic feet per second (cfs) resulting from the PMP over Fermi 3 safety-related area of 18.09 acres and the adjacent drainage area to the west and south of the Fermi 3 nuclear island of 25.96 acres, for a total of 44.05 acres. The adjacent area was included to address the effects of a backwater scenario due to the water running off the steeper sides of the nuclear island with the safety structures and onto the lesser sloped adjacent area. For this scenario, the runoff was assumed to drain off the slopes of the Fermi 3 final grade because the storm drains at the site are assumed to be blocked.

The applicant then used Manning's equation to predict a runoff depth of 2.55 ft resulting from the peak flow rate of 3,066 cfs. The applicant assumed a channel width of 75 ft, vertical sides, a slope of 0.006 ft/ft (the slope of the area adjacent to the Fermi 3 nuclear island), and a roughness coefficient of 0.013.

In response to a subsection of RAI 2.4.2-1, the applicant conducted an analysis of the impact of snowmelt in addition to the PMF at the site. The applicant revised the analysis to address snow pack and assumed an initial snowpack covering the entire site with no significant variation in snow temperature or snow depth. The applicant then calculated snowmelt as a function of wind velocity, rainfall rate, air temperature, and a wind coefficient using equation 5-19 presented in the USACE document, *Runoff from Snowmelt* (USACE, 1998). The applicant assumed the PMP rain on snow event would occur in April, as relatively high temperatures occurred historically after freezing during the month of April. The applicant used the observed dew point temperatures as representative of air temperature during a PMP rain on snow event. The wind velocity and temperature were derived from historical data from the Detroit Metropolitan Airport meteorological station. The applicant analyzed 34 years of data (1961-1995) for the month of April to determine the 2-year occurrence wind speed, 32.5 mph, and the 100-year occurrence dew point temperature, 69.1 degrees Fahrenheit. The applicant selected the highest hourly dew point temperature and the highest hourly wind speed from each April on record. The applicant stated an extreme frequency analysis was done with the resultant data, but did not describe the methodology taken to determine the values. The applicant assumed these values were constant through the entire storm.

For the 5-minute storm duration, the applicant calculated the snowmelt to be 1.54 inches. This runoff from snowmelt was then added on to the 5-minute precipitation value of 69.6 inches/hour, to produce an equivalent rainfall intensity of 88.1 inches/hour. The rational method was used to calculate a PMF runoff of 3,880 cfs from the 44.05 acre area including the Fermi nuclear island and the area to the south and west of the island. Using the same assumptions about the channel, the applicant used Manning's equation to calculate a flow depth of 2.97 ft resulting from the runoff.

RAI 2.4.2-1 requested information related to the potential erosion of the slopes of the Fermi 3 site. The applicant's response stated that erosion protection measures such as mulching, seeding, sodding, and other will be incorporated in the design of the slopes. The applicant stated that erosion protection measures will be taken following guidelines in *The Guidebook of Best Management Practices for Michigan Watersheds* (MDEQ, 1998). The applicant also stated that very little runoff is expected to occur on the slopes. The runoff from the Fermi 3 nuclear island will be routed to a stormwater collection system, so the only expected runoff on the slopes is what results from direct precipitation onto the slopes. The applicant stated that this runoff will be at low velocities and therefore will not cause erosion.

The applicant has made a commitment (COM 2.4-002) in FSAR Subsection 2.4.2.2 stating that a detailed design will incorporate best industry practices included in "The Guidebook of Best Management Practices for Michigan Watersheds

> **[START COM FSAR-2.4-002]** Detailed design will incorporate best industry practices included in "The Guidebook of Best Management Practices for Michigan Watersheds" to provide added erosion protection to the slopes, even though they are receiving very little runoff. These practices include mulching, seeding, sodding, soil management, trees, shrubs, and ground covers. To be conservative, erosion protection methods selected will be based on runoff velocities for a local PMP condition not taking credit for the storm water drains. Where necessary, erosion protection will be provided for breaking waves during a postulated surge/seiche event. **[END COM FSAR-2.4-002]**

NRC Staff's Technical Evaluation

The NRC staff reviewed the information submitted by the applicant concerning the flooding caused by the PMP at the site and verified that information by comparing it to results using the rational method. RAI 2.4.2-1 requested significant additional information about the calculation of the PMP and the local runoff resulting from the PMP. The staff verified from the literature that the 5-minute PMP duration provides a more conservative estimate of runoff using the rational method (Pilgrim and Cordery, 1993). The time of concentration is a key parameter in completing the rational method and is the time it takes for flow to travel from the top of the watershed to the downstream end where flow is measured (Lettenmaier and Wood, 1993). The staff checked the TR-55 reference and confirmed that the equations from TR-55 were appropriate to calculate the time of concentration. The staff also checked the values presented for input into the equations and confirmed the values were appropriate (USDA, 1986; US Weather Bureau, 1961; Engman, 1986). The staff independently confirmed that the time of concentration values presented in Table 2.4-213 were correct. Thus, the staff verified the applicant's calculation of time of concentration, as presented in the response to RAI 2.4.2-1, to be acceptable.

The staff independently developed rainfall intensities. First, the staff independently determined the 60-minute, 1 mi^2 PMP to be 17.3 inches from Figure 24 in HMR-52 (NOAA, 1982). The 5-minute, 1 mi^2 PMP was determined independently by the staff to be 5.8 inches using Figure 36 of HMR-52 (NOAA, 1982). The 5-minute PMP value of 5.8 inches corresponds to a rainfall intensity of 69.6 inches/hour. This verifies the applicant's calculation of the 5-minute, 1 mi^2 PMP that was presented in the response to RAI 2.4.2-1. The staff verified the value of PMP presented by the applicant.

The applicant used the rational method to determine PMF from the PMP assuming all storm drains are blocked. The staff considers this method of calculation to be conservative, as the

Rational Method captures a snapshot in time of the worst potential precipitation of almost 6 inches in a 5 minute window. Also, the applicant assumed no infiltration or other losses of the PMP, which is a conservative assumption. The applicant assumed the area of runoff included the Fermi 3 nuclear island (18.1 acres) plus the area located to the southwest, termed N3 in the FSAR (see Figure 2.4-217 of the FSAR). This area is approximately 25.96 acres and is assumed to contribute to the site runoff because there may be backwater effects from this area to prevent water from draining from the Fermi 3 nuclear island. The staff confirmed that the runoff from this total area of 44.05 acres resulting from the 5-minute PMP is calculated to be 3,066 cfs.

To calculate the depth of flow potentially resulting from the peak runoff rates, the applicant used the Manning's equation. The staff evaluated the inputs to the equation. The Manning's roughness coefficient used for the analysis is appropriate for concrete or bare soil (Engman, 1986). The staff finds this value appropriate for roughness at the Fermi 3 site. The width of 75 feet is arbitrary, as there is currently no channel into which the flow is directed. The staff performed the calculation to determine the depth of flow using the applicant's stated assumptions and found a flow depth of 2.57 ft. This verified the applicant's calculation. The staff finds this analysis of runoff depth acceptable because the assumption of a 75 ft channel is conservative.

The staff reviewed the applicant's analysis of PMF plus snowmelt runoff when all storm drains were blocked as presented in the response to RAI 2.4.2-1. The staff verified the equation for snowmelt runoff by checking the applicant's reference (USACE, 1998). The equation used by the applicant is conservative because it assumes a constant snowpack that does not decrease during the PMF. Input values to the equation included wind velocity, air temperature, rainfall rate and a wind coefficient. The staff verified that the wind coefficient of 1 used by the applicant is a conservative assumption (USACE, 1998). The resulting snowmelt would have been reduced if the value was assumed to be lower than 1. The rainfall rate that the applicant used was the same as was used for the PMF calculation, 69.6 in/hour. The staff obtained Detroit Metro Airport climate data from the NCDC to verify the applicant's wind velocity and air temperature assumptions. The staff obtained average daily dew point temperature and average daily wind speed information from 1984 through 2009. For a conservative analysis the staff chose the highest wind speed and dew point temperature for the month of April from each of the 25 years on record. Both datasets were found to be normally distributed using the EPA's ProUCL software (USEPA, 2007). For each of the resultant datasets, a normal cumulative distribution function of the values was examined to determine the recurrence interval of the applicant's selected values. The staff found that the average daily wind speed of 32.5 mph (assumed by the applicant for snowmelt calculations) occurred less frequently than the 100-year wind speed. Thus, the staff verified that this is a conservative value for wind speed during the PMF with snowmelt. For the daily dew point temperature, the staff also found the value of 69.1 degrees Fahrenheit (assumed by the applicant for snowmelt calculations) occurred less frequently than the 100-year value for the month of April. The staff's calculations verified that the applicant selected a conservative value of dew point temperature for the calculation of snowmelt.

For the 5-minute storm duration, the staff verified that the snowmelt was calculated to be 1.54 inches using the applicant's conservative assumptions. The staff verified that the snowmelt added to the 5-minute precipitation value of 69.6 inches/hour produced an equivalent rainfall intensity of 88.1 inches/hour. The PMF runoff of 3,880 cfs was then calculated by the staff using the rational method. Using the same assumptions about the channel, the staff verified the flow depth calculation using Manning's equation. A flow depth of 2.97 ft was calculated by the staff, verifying the applicant's calculation. The flood elevation associated with this runoff depth was determined by the staff to be 584.8 ft NAVD 88, the same value as calculated by the applicant.

In the FSAR, the applicant did not discuss any erosion protection measures or the potential erosional impacts of PMP flooding on the slopes of the Fermi 3 elevated area containing the safety structures. RAI 2.4.2-1 requested information related to the potential erosion of the slopes of the Fermi 3 site. The applicant stated that the slopes are 8 percent and thus the staff does believe that erosion protection measures, such as described in *The Guidebook of Best Management Practices for Michigan Watersheds* (MDEQ, 1998) should be taken to prevent erosion on the slopes. Additionally, these erosion protection measures should be monitored and maintained to ensure that they are functioning properly. Additionally, NRC guidelines NUREG-1623 provide guidance on designing erosion protection along slopes that may be helpful to the applicant. In RAI 2.4.2-4, the staff requested additional information on the specific erosion protection measures to be used for the slopes of the Fermi 3 elevated area. The staff requested that (1) the applicant calculate the potential maximum velocity of runoff from the 8 percent slopes during the PMP at the site and (2) the applicant provide detailed information on specific erosion protection measures designed to resist erosion under the maximum predicted water velocities. The applicant used Manning's equation to calculate the potential velocities of water running down the slopes during the local PMF assuming all the drains are blocked. The maximum velocity calculated by the applicant was 5.64 ft per second (fps) and thus the applicant used this velocity as the design velocity to determine proper erosion protection measures for the slopes of the nuclear island. The applicant stated that grass cover established by sod or a riprap cover with a median diameter of 3 inches would comply with the requirements in *The Guidebook of Best Management Practices for Michigan Watersheds* (MDEQ, 1998). The staff checked the applicant's calculations and finds this response to be conservative and acceptable in determining erosion protection measures for the local PMP on the slopes of the nuclear island.

In the FSAR, the applicant did not consider potential impacts of PMP flooding at the Fermi 3 site on the adjacent Fermi 2 site. RAI 2.4.2-3, dated November 20, 2009 (ADAMS Accession No. ML093280179) requested an analysis of potential impacts of the PMP flood at the Fermi 3 site on the Fermi 2 safety facilities, assuming all runoff drop inlets are blocked (i.e., the worst case scenario). In the response, the applicant calculated the maximum additional depth of water at Fermi 2 to be 4 inches during the PMP flood. The Fermi 2 UFSAR (Detroit Edison, 2009a) states that the Fermi 2 safety structures are water tight to a minimum of 586.8 ft NAVD 88. The staff determined that there would be no impact to the Fermi 2 safety structures from the local PMP flooding at Fermi 3.

The applicant discussed predevelopment and final Fermi 3 plant site runoff for storms smaller than the PMP. The information presented concerning the 10-year through 100-year rainfall intensities and resulting runoff for the existing drainage and the final grade drainage (presented in Table 2.4-212, 2.4-213 and 2.4-214) was not considered to be essential to the staff's review of safety-related features, and this information was not reviewed by the staff. For the reasons given above, the staff concluded that the identification and consideration of the floods at the site and in the surrounding area are acceptable and meet the requirements of 10 CFR 52.79(a)(31) and 10 CFR 100.20(c), with respect to determining the acceptability of the site for the ESBWR design.

2.4.2.5 Post Combined License Activities

The applicant idenfies the following commitment:

- **Commitment (COM 2.4-002)** – Detailed design will incorporate best industry practices included in "The Guidebook of Best Management Practices for Michigan Watersheds" to provide added erosion protection to the slopes, even though they are receiving very little runoff. These practices include mulching, seeding, sodding, soil management, trees, shrubs, and ground covers. To be conservative, erosion protection methods selected will be based on runoff velocities for a local PMP condition not taking credit for the storm water drains. Where necessary, erosion protection will be provided for breaking waves during a postulated surge/seiche event.

2.4.2.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.2 of NUREG–0800, and other NRC RGs. The staff's review concluded that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed EF3 COL Item 2.0-13-A as it relates to floods.

As set forth above, the applicant has presented and substantiated information relative to the floods important to the design and siting of this plant. The staff reviewed the available information provided. For the reasons given above, the staff concludes that the identification and consideration of the floods at the site and in the surrounding area are acceptable and meet the requirements of 10 CFR 52.79(a)(31) and 100.20(c), with respect to determining the acceptability of the site for the ESBWR design.

The staff finds that the applicant has considered the appropriate site phenomena in establishing the design bases for SSCs important to safety. The staff accepts the methodologies used to determine the locally intense precipitation flood event. Accordingly, the staff concludes that the use of these methodologies results in design bases containing a sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. The staff concludes that the identified design bases meet the requirements of 10 CFR 100.20(c) with respect to establishing the design basis for SSCs important to safety.

2.4.3 Probable Maximum Flood on Streams and Rivers

2.4.3.1 *Introduction*

The PMF on streams and rivers is used to determine the extent of any flood protection required for those safety-related SSCs necessary to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition. The specific areas of review are as follows: (1) design basis for flooding in streams and rivers, (2) design basis for site drainage, (3) consideration of other site-related evaluation criteria, and (4) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.4.3.2 *Summary of Application*

Section 2.4.3 of the Fermi 3 COL FSAR, Revision 7, addresses the need for information on site specific PMF on streams and rivers. In addition, the applicant provides the following:

<u>*COL Item*</u>

- EF3 COL 2.0-14-A Probable Maximum Flood

  To address this COL item, the applicant discussed considerations of storm configuration, maximized precipitation amounts, time distributions, orographic effects, storm centering, seasonal effects, antecedent storm sequences, antecedent snowpack, and a snowmelt model in defining the PMP. The applicant described the absorption capability of the basin, including consideration of initial losses and infiltration rates as well as the hydrologic response characteristics of the watershed to precipitation and provided verification from synthetic procedures.

In addition, the applicant presented the controlling PMF runoff hydrograph at the plant site that would result from rainfall and described the translation of the estimated peak PMP discharge to elevation using cross-section and profile data, standard step methods, roughness coefficients, verification, and estimates of PMF water surface profiles. Finally, the applicant discussed setup, maximum wave heights, run-up, and resultant static and dynamic effects of wave action on each safety-related facility from wind-generated activity that may occur coincidentally with the peak maximum flood water level.

2.4.3.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the PMF on streams and rivers, and the associated acceptance criteria, are in Section 2.4.3 of NUREG–0800. The applicable regulatory requirements for identifying PMF on streams and rivers are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirements to consider physical site characteristics in site evaluations are specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), sets forth the criteria to determine the citing factors for plant design bases with respect to seismically induced floods and water waves at the site.

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The related acceptance criteria are:

- Design Bases for Flooding in Streams and Rivers: To meet the requirements of 10 CFR Part 100, estimates of the following characteristics are needed, and should be based on conservative assumptions of hydrometeorologic characteristics in the drainage area: (a) the area of the watershed used to estimate flooding in streams and rivers, (b) the total depth of PMP and the PMP hyetograph, (c) the maximum PMF water surface elevation in streams and rivers with coincident wind-waves, and (d) hydraulic characteristics that describe dynamic effects of PMF on SSC important to safety. If a potential hazard to SSC important to safety exists, the applicant should document and justify the design bases of affected facilities.

- Design Bases for Site Drainage: To meet the requirements of 10 CFR Part 100, estimates of the following characteristics are needed: the runoff from the immediate site area and the drainage from areas adjacent to the site, including the roofs of safety-related structures. Flood response characteristics should be identified to estimate flooding adjacent to and on the plant site. The effects of erosion and sedimentation during the flooding should be identified and their effects on SSC important to safety should be determined. If a potential hazard to SSC important to safety exists, the applicant should document and justify the design bases of affected facilities.

- Consideration of Other Site-Related Evaluation Criteria: To meet the requirements of 10 CFR Part 100 information about the potential effects of site-related proximity, seismic, and non-seismic information as they relate to flooding in streams and rivers and local flooding adjacent to and on the plant site is needed.

In addition, the hydrologic characteristics should be consistent with appropriate sections from RGs:

- RG 1.27, describes the applicable UHS capabilities.

- RG 1.29, identifies seismic design bases for SSC important to safety.

- RG 1.59, as supplemented by current best practices provides guidance for developing the hydrometeorological design bases.

- RG 1.102, describes acceptable flood protection to prevent the safety-related facilities from being adversely affected.

2.4.3.4 *Technical Evaluation*

The NRC staff reviewed Subsection 2.4.3 of the Fermi 3 COL FSAR.

<u>COL Item</u>

- EF3 COL 2.0-14-A Probable Maximum Flood

  To address this COL item, the applicant discussed considerations of storm configuration, maximized precipitation amounts, time distributions, orographic effects, storm centering, seasonal effects, antecedent storm sequences, antecedent snowpack, and a snowmelt model in defining the PMP. The applicant described the absorption capability of the basin, including consideration of initial losses and infiltration rates as well as the hydrologic response characteristics of the watershed to precipitation and provided verification from synthetic procedures.

  In addition, the applicant presented the controlling PMF runoff hydrograph at the plant site that would result from rainfall and described the translation of the estimated peak PMP discharge to elevation using cross-section and profile data, standard step methods, roughness coefficients, verification, and estimates of PMF water surface profiles. Finally, the applicant discussed setup, maximum wave heights, run-up, and resultant static and dynamic effects of wave action on each safety-related facility from wind-generated activity that may occur coincidentally with the peak maximum flood water level.

2.4.3.4.1 Probable Maximum Precipitation

<u>Information Submitted by the Applicant</u>

In Subsection 2.4.3.1 of the FSAR, the applicant calculated the PMP over the entire Swan Creek Watershed. In the response to RAI 2.4.3-1, dated September 30, 2009 (ADAMS Accession No. ML092790561), the applicant stated that the PMP was calculated using HMR-51. The applicant estimated a storm depth of 31.4 inches over a 72-hour period as the PMP. The applicant presented the distribution of rainfall during the 72-hour period in Table 2.4-216 of the FSAR and referenced the ANSI/ANS-2.8-1992 for this calculation. The applicant stated that an antecedent condition was assumed, but no further explanation is provided.

In response to RAI 2.4.2-1, dated September 30, 2009 (ADAMS Accession No. ML092790561), the applicant performed an analysis of snowmelt impacts in addition to the PMP in the Swan Creek Watershed. For this calculation, the applicant used the HMR-52 software program (USACE, 1984) to determine the PMP for the Swan Creek Watershed. The HMR-52 software determines the size of the storm and spatially orients the storm within the watershed to determine the worst possible scenario for the PMP. The applicant performed this storm orientation with the probable maximum storm in the Swan Creek Watershed. The applicant determined that a storm size of 100 mi^2 with an orientation of 311 degrees produced the largest precipitation values. Other inputs required for using the HMR-52 software include delineation of the watershed boundary, depth-area-duration data and the ratio of the 1-hour to 6-hour storm, as illustrated in Figure 39 of HMR-52 (NOAA, 1982). The applicant derived the depth-area-duration data from HMR-51 (NOAA, 1978). The applicant stated that the value of the ratio of the 1-hour to the 6-hour storm was 0.302.

Snowmelt resulting from rain on snow was calculated using the *Runoff from Snowmelt* guidance provided by the USACE (1998). The applicant used a lumped model approach assuming that all the parameters are constant across the watershed to simplify the problem. The applicant then calculated snowmelt as a function of wind velocity, rainfall rate, air temperature, and a wind coefficient using equation 5-19 of the USACE guidance. The applicant assumed the PMP rain on snow event would occur in April because, historically, relatively high temperatures have occurred after freezing during the month of April. The applicant used the observed dew point temperatures as representative of air temperature during a PMP rain on snow event. The wind velocity and temperature were derived from historical data from the Detroit Metropolitan Airport meteorological station. The applicant analyzed 34 years of data (1961-1995) for the month of April to determine the 2-year occurrence wind speed, 32.5 mph, and the 100-year occurrence dew point temperature, 69.1 degrees Fahrenheit. The applicant selected the highest hourly dew point temperature and the highest hourly wind speed from each April on record. The applicant stated an extreme frequency analysis was done with the resultant data, but did not describe the methodology taken to determine the values. The applicant assumed these values were constant through the entire storm.

NRC Staff's Technical Evaluation

The NRC staff checked the applicant's PMP calculation that was based on the HMR-51 and HMR-52 reports (NOAA, 1978; NOAA, 1982). First, the staff used the method described in HMR-51 to determine the PMP depth at the site. The staff found values of PMP depth corresponding to the location of Fermi 3 in Figure 18 through Figure 47 of HMR-51 (NOAA, 1978). Information developed by staff for standard increments and basin size is found below in Table 2.4.3-1 below.

Table 2.4.3-1. Depth-area-duration Tables for the Fermi site.

	Storm Depth (inches) per Storm Duration (hours)				
Basin Size (square miles)	6 hours	12 hours	24 hours	48 hours	72 hours
10	25.5	28.75	30.5	32.9	34.9
200	17.8	21.2	22.7	25.6	27.5
1000	12.9	15.6	17.4	20	21.95
5000	7.8	10.6	12.4	14.85	16.6
10000	6	8.5	10	13	14.7
20000	4.2	6.7	8.3	10.9	12.4
To convert square-miles to square-kilometers multiply the numbers by 2.59. To convert inches to centimeters multiply the numbers by 2.54.					

Smooth depth-area-duration curves were then graphed on semi-log paper. This graph was used to find the PMP depths for the 100 mi^2 Swan Creek Watershed. The staff determined that the 72-hour PMP depth for Swan Creek is 29.3 inches. The staff then used the USACE computer program HMR-52 to determine the probable maximum storm in Swan Creek Watershed. The HMR-52 software calculated the 72-hour PMP to be 28.9 inches.

The HMR-52 software requires several inputs including: points outlining the watershed, the ratio of the 1-hour to the 6-hour storm, the position of the maximum 6-hour rainfall increment, the temporal distribution of the PMP over the entire storm, the storm area, the storm center, the depth-area-duration information derived from HMR-51, and the preferred storm orientation information from HMR-51 (NOAA, 1978; USACE, 1984). The staff determined that the 1 to 6-hour ratio for the 20,000 mi^2 storm at the Fermi site was 0.302 by checking Figure 39 of HMR-52 (NOAA, 1982). The staff set the position of the maximum 6-hour precipitation increment to the 7th increment, following the ANSI/ANS-2.8-1992 guidance. The staff also followed the ANSI/ANS-2.8-1992 guidance to set the distribution of the PMP over the entire storm. The storm area size and the storm orientation were set as variables, so the HMR-52 program could change these parameters to maximize the probable maximum storm. The preferred storm orientation listed in HMR-51 of 245 degrees was also input into HMR-52. The staff ran the HMR-52 model to determine the PMP for Swan Creek. The resultant storm size was 100 mi^2 and the storm orientation was 309 degrees, the same storm properties that the applicant determined. The HMR-52 software calculated the 72-hour PMP to be 28.9 inches. The 12 rainfall intervals, 6 hours each, were calculated by the HMR-52 model. The intervals were reordered based on guidance from ANS 2.8 -1992. The information is tabulated below.

Table 2.4.3-2. Rainfall Distribution of Probable Maximum Storm for the Swan Creek Watershed

6-Hour Interval	Rainfall Depth (inch)	Order of Interval in Storm
1	19.76	7
2	2.70	6
3	1.50	8
4	1.04	5
5	0.80	9
6	0.65	4
7	0.55	10
8	0.47	3
9	0.42	11
10	0.37	2
11	0.34	12
12	0.31	1
To convert inches to centimeters multiply the numbers by 2.54.		

Table 2.4.3-2 can be directly compared to FSAR Tables 2.4-216 and 2.4-217 to see that the applicant's calculated probable maximum storm is larger and therefore more conservative than the staff calculated storm. The staff finds the applicant's calculation of PMP to be acceptable, because the applicant's PMP is higher (more conservative) than the value calculated by the staff.

The staff also checked the applicant's calculation of PMP with snowmelt, as submitted in the response to RAI 2.4.2-1, dated September 30, 2009 (ADAMS Accession No. ML092790561). First, the applicant used the USACE HMR-52 software to define the PMP, similar to the method described by the staff, above. Second, the applicant calculated snowmelt for each time interval during the storm. The values for rainfall and snowmelt were combined for each time interval to become a total value of effective precipitation on the watershed.

The applicant's input and output values for the HMR-52 program were very similar to the staff's. Both the staff and the applicant used a value of 0.302 for the ratio of the 1 to 6 hour storm. The staff found a maximum storm orientation of 309 degrees and the applicant found a maximum storm orientation of 311 degrees. The depth-area-duration curves used by the applicant were slightly larger overall than those used by the staff, and thus the applicant's analysis was more conservative. Therefore, the applicant's input values were found to be acceptable. The applicant calculated a PMP of 28.9 from the HMR-52 software, the same value determined by the staff's calculation.

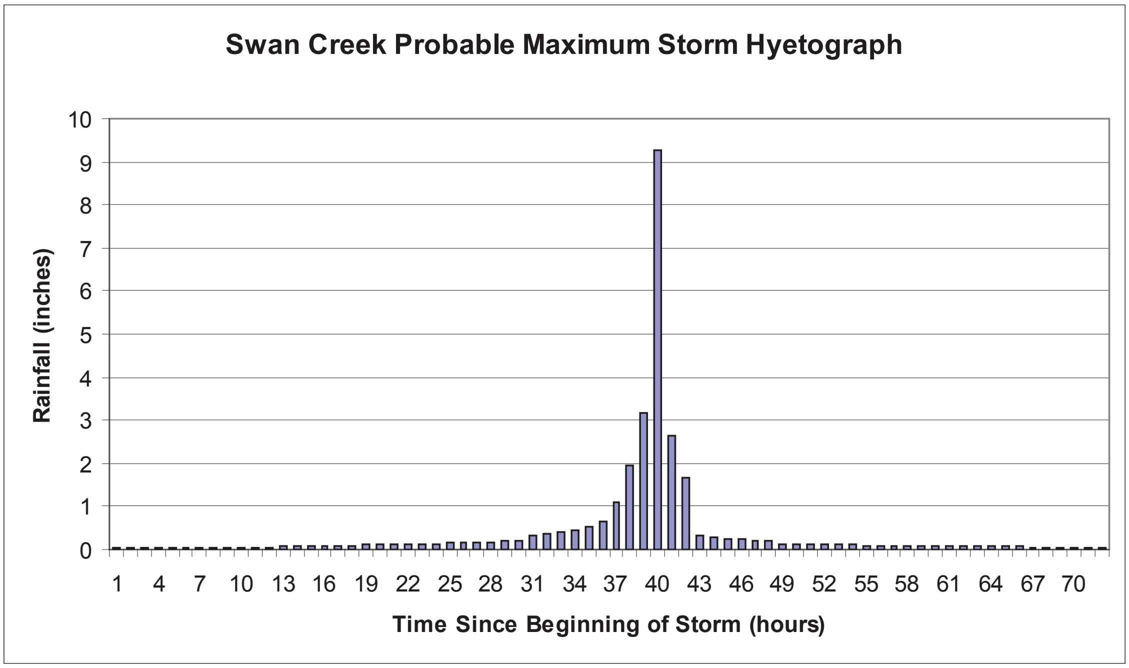


Figure 2.4.3-1. Hourly Distribution of the Probable Maximum Precipitation for the Swan Creek Watershed

The hourly distribution of the probable maximum storm was also calculated by HMR-52. The probable maximum storm for the Swan Creek Watershed shown in Figure 2.4.3-1 above can be directly compared to Figure 2.4-XX-2 submitted by the applicant with the response to RAI 2.4.2-1, dated September 30, 2009 (ADAMS Accession No. ML092790561). The staff finds the applicant's calculation of PMP from HMR-52 to be acceptable, because the applicant's PMP is the same as the value independently calculated by the staff.

The applicant calculated snowmelt for each time step using Eequation 5-19 from the USACE manual *Runoff from Snowmelt* (USACE, 1998). A full discussion of the verification of the snowmelt calculations is presented in SER Subsection 2.4.2.4 above. The staff verified the results of the snowmelt calculations and independently calculated the same cumulative rain and snowmelt total of 70.3 inches over 72-hours.

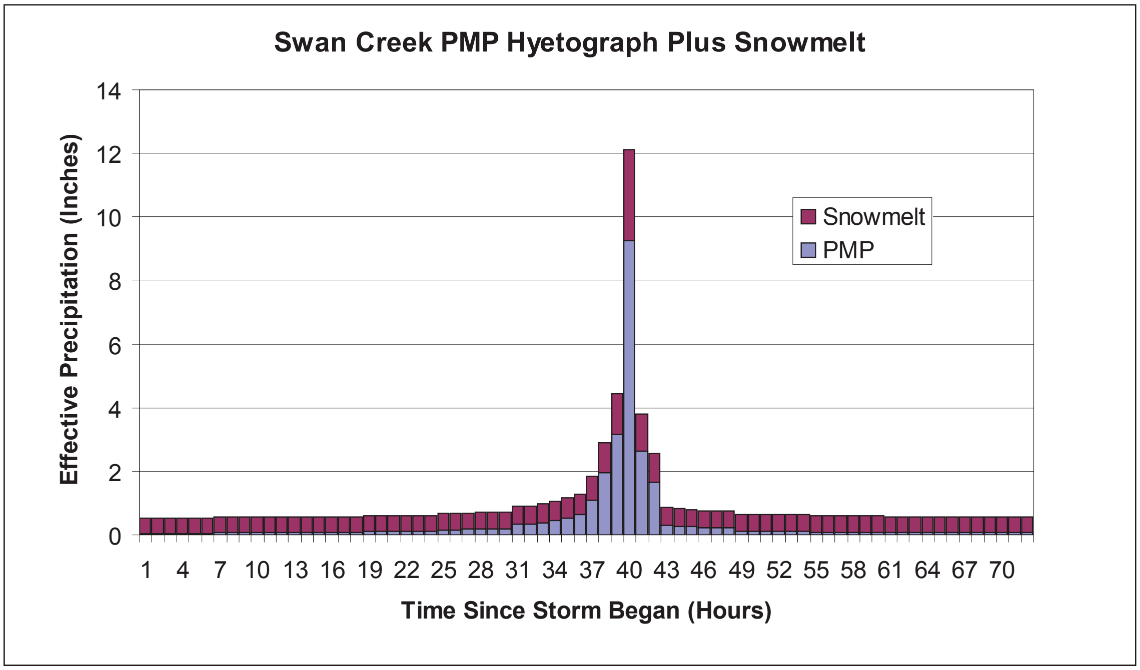


Figure 2.4.3-2. Hourly Distribution of the Probable Maximum Storm with Snowmelt for the Swan Creek Watershed

The staff-calculated PMP with snowmelt for the Swan Creek Watershed shown in Figure 2.4.3-1 above can be directly compared to Figure 2.4-XX-3 submitted by the applicant with the response to RAI 2.4.2-1, dated September 30, 2009 (ADAMS Accession No. ML092790561). The staff finds the applicant's calculation of PMP with snowmelt to be acceptable, because the applicant's PMP is the same as the value calculated by the staff.

Precipitation Losses

Information Submitted by the Applicant

In Subsection 2.4.3.2 of the FSAR, and in the response to RAI 2.4.2-1 and RAI 2.4.3-1, dated September 30, 2009 (ADAMS Accession No. ML092790561) the applicant describes precipitation losses for the Swan Creek Watershed and how they were calculated. In the response to RAI 2.4.2-1, the applicant calculated initial losses using the NRCS default equation and a curve number of 98. The curve number of 98 was used to represent saturated conditions. The response to RAI 2.4.3-1 provided a different analysis of losses using curve numbers representative of different land use types to a stated composite curve number of 84.25. However, after discussing the calculation of this curve number, the applicant stated these losses were "not applied to the resultant hydrograph."

NRC Staff's Technical Evaluation

The NRC staff reviewed the information submitted by the applicant. A curve number of 98 is considered by the staff to be a conservative value because it assumes that the watershed is completely saturated from antecedent storm conditions. This assumption means that very little precipitation loss occurs and that almost all of the PMP is transmitted through the watershed. Using the NRCS default equation and a curve number of 98, the staff calculated an initial loss of

0.04 inches across the watershed. The staff finds the applicant used conservative assumptions for precipitation losses in the calculation of the PMF on Swan Creek.

Runoff and Stream Course Models

Information Submitted by the Applicant

In Subsection 2.4.3.3 of the FSAR, the applicant used the NRCS synthetic unit hydrograph method to transform the rainfall into runoff within the Swan Creek Watershed. The applicant provided the ordinates of the hydrograph in Table 2.4-218 of the FSAR. The applicant presented a graph of the 6-hour unit hydrograph for Swan Creek Watershed in Figure 2.4-219 of the FSAR. The applicant stated that the peak flow for the 6-hour, 1-inch storm was 4,690 cfs.

The applicant used the NRCS unit hydrograph method to transform the PMP into the PMF runoff from the Swan Creek Watershed. To transform rainfall into runoff using this method, an estimate of the basin lag time is required. The basin lag was calculated based on the time of concentration for the watershed. The applicant used the Kirpich equation to calculate the time of concentration for the basin. In the response to RAI 2.4.2-1, dated September 30, 2009 (ADAMS Accession No. ML092790561), the applicant stated that the time of concentration was calculated to be 16.4 hours. The applicant provided an equation using the time of concentration to determine the basin lag of 9.84 hours (590 minutes).

An additional analysis of the PMF on the Swan Creek Watershed was submitted in response to RAI 2.4.2-1, which included analysis of the impacts of snowmelt. The applicant used the NRCS (also called the SCS) unit hydrograph method within the Hydological Engineering Centers Hydrological Modeling System (HEC-HMS) 3.1.0 rainfall-runoff model software package (USACE, 2006) to generate runoff in Swan Creek resulting from the PMP with snowmelt.

NRC Staff's Technical Evaluation

The NRC staff reviewed the information submitted by the applicant concerning the selection of runoff and stream course models. The NRC staff independently calculated the unit hydrograph for the Swan Creek watershed resulting from the 1 inch of rainfall falling over a 6-hour period and verified the applicant's results. The staff independently calculated the time of concentration to be 12.6 hours using the Kirpich equation, assuming a maximum travel length of 18 miles. The staff verified the Kirpich equation in the literature (Pilgrim and Cordery, 1993). The staff calculated a basin lag of 7.6 hours (455 minutes) using the equation provided by the applicant. The equation that the applicant presented for basin lag was found by the staff in TR-55 (NRCS, 1986) and verified. The staff also used two alternative equations to calculate the time of concentration and basin lag to determine if the equation that the applicant chose provided a conservative result. There are several methods available in the literature to determine the time of concentration of a watershed. Each watershed generates runoff uniquely, according to its features, such as slope and preciousness. Thus, the staff wanted to verify that the most conservative method was used to determine runoff in the Swan Creek Watershed. The staff used the Snyder method to calculate basin lag of 9 hours (550 minutes) and used the method presented in TR-55 to calculate a time of concentration of 11.5 hours and a basin lag of 413 minutes (Pilgrim and Cordery, 1993; NRCS, 1986).

The NRC staff checked the applicant's calculation of the 6-hour, 1 inch unit hydrograph for the Swan Creek Watershed by performing a unit hydrograph simulation in HEC-HMS. The staff used a basin lag of 413 minutes, the most conservative of the values found from the above analysis. The staff assumed no initial loss of rainfall to infiltration and used a curve number of 98. The staff calculated the peak runoff to be 4,300 cfs. The staff considers the applicant's calculation to be conservative because the runoff calculated by the applicant was higher than that calculated by the staff.

Probable Maximum Flood Flow

Information Submitted by the Applicant

In Subsection 2.4.3.4 of the FSAR the applicant used the NRCS synthetic unit hydrograph method to transform the rainfall into runoff within the Swan Creek Watershed. The applicant calculated a PMF peak flow of 113,000 cfs resulting from the PMP.

A modified analysis of the PMF was submitted in response to RAI 2.4.2-1, dated September 30, 2009 (ADAMS Accession No. ML092790561), which included analysis of the impacts of snowmelt on the PMF. The applicant used a curve number of 98 for the loss estimate in HEC-HMS to represent the saturated ground conditions. The applicant used 1-hour time steps for the calculation of flood discharge. The applicant calculated a PMF peak runoff of 168,000 cfs from the PMP with snowmelt. The RAI response also updated the analysis of water surface elevations using Hydrological Engineering Centers River Analysis System (HEC-RAS), as discussed in Section 2.4.3.5 below.

NRC Staff's Technical Evaluation

The NRC staff reviewed the information submitted by the applicant concerning the flow resulting from the PMF. The NRC staff independently calculated the PMF for Swan Creek using the SCS unit hydrograph method in HEC-HMS 3.1.0. The staff obtained a value of 134,000 cfs, which is approximately 18 percent higher than the value presented by the applicant. Though these (134,000 and 168,000 cfs) values (and the snowmelt values discussed below) are of an unreasonably large magnitude for Swan Creek, they result in highly conservative estimates using the applied methodology and are therefore useful for evaluation purposes. The staff used the smallest and most conservative time of concentration value calculated by the three methods presented above, 413 minutes. The staff also assumed a constant baseflow equivalent to the mean monthly flow for the month of April presented in Table 2-215 of the FSAR of 120 cfs.

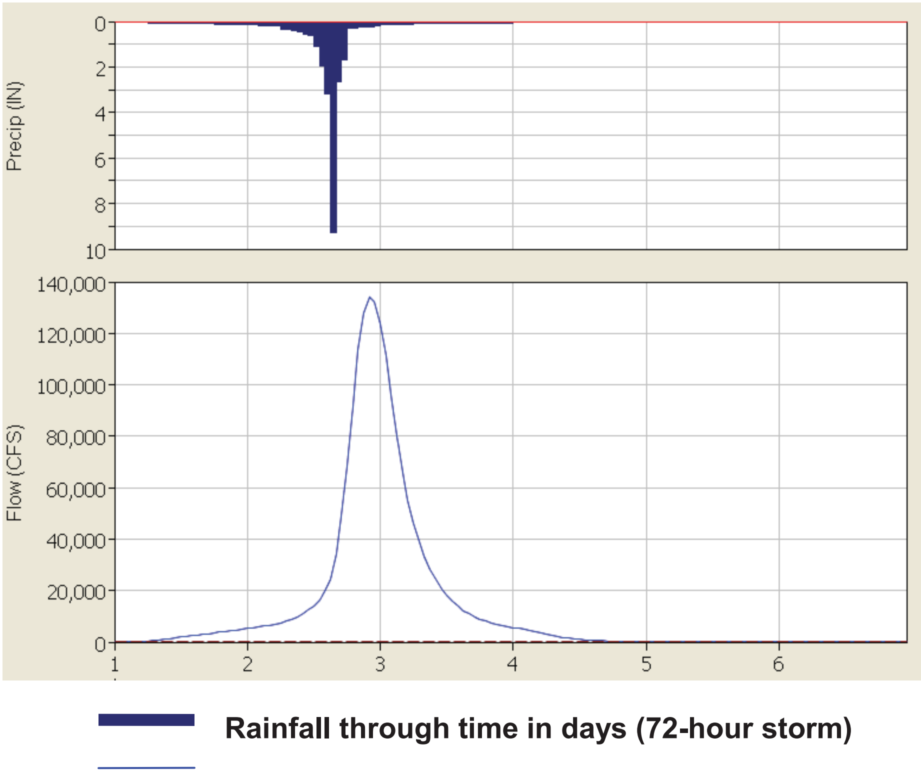
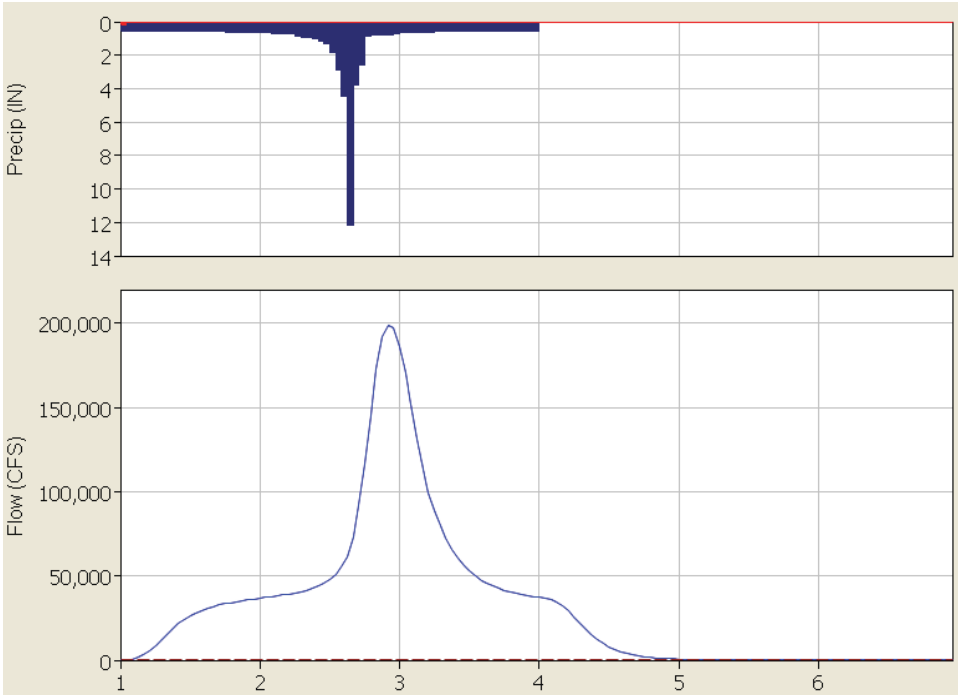


Figure 2.4.3-3. Probable Maximum Flood Runoff using HEC-HMS 3.1.0 Rainfall-runoff Model

In Figure 2.4.3-3, the staff developed flood hydrographs based on the parameters discussed above. By developing an independent hydrograph, Figure 2.4.3-3 can be directly compared with Figure 2.4-219 of the FSAR to examine the PMF runoff calculated by the staff versus the PMF runoff calculated by the applicant.

The NRC staff independently calculated the PMF with snowmelt for Swan Creek and obtained a value of 199,000 cfs, which is approximately 18 percent higher than the value presented in the response to RAI 2.4.2-1, dated September 30, 2009 (ADAMS Accession No. ML092790561).



Rainfall plus snowmelt through time in days (72-hour storm)

Runoff through time in days

Figure 2.4.3-4. Probable Maximum Flood with Snowmelt Runoff using HEC-HMS 3.1.0 Rainfall-Runoff Model

In Figure 2.4.3-4, the staff independently developed a flood hydrograph that include snowmelt. The staff hydrograph in Figure 2.4.3-4 can be directly compared with Figure 2.4-2-XX-4 of the response to RAI 2.4.2-1, dated September 30, 2009 (ADAMS Accession No. ML092790561) to examine the runoff from the PMF plus snowmelt calculated by the staff versus the PMF plus snowmelt runoff calculated by the applicant.

The runoff amounts for both the PMF and the PMF with snowmelt calculated by the staff are 18 percent larger than the applicant's calculated values. Although the precipitation inputs developed by staff are higher than the applicants, the resultant water surface elevations are not significantly impacted. Therefore, the staff finds the analysis performed by the applicant to be acceptable because the water levels determined by HEC-RAS from the NRC staff-calculated peak runoff do not vary significantly from the water levels calculated by the applicant (discussed in the following section).

Water Level Determination

Information Submitted by the Applicant

In Subsection 2.4.3.5 of the FSAR, the applicant used HEC-RAS Version 4.0.0 (USACE, 2008) to determine water surface profiles on Swan Creek resulting from the three possible maximum flooding scenarios: Alternative I, Alternative II, and Alternative III (see Section 2.4.2.4.2 above). The 500-year and 25-year flood levels on Swan Creek were derived from the *FEMA Flood Insurance Study for Monroe County* (FEMA, 2000). According to the response to RAI 2.4.3-1, dated September 30, 2009 (ADAMS Accession No. ML092790561), the applicant created geometric cross-sections across Swan Creek using a 10-meter resolution DEM. The applicant created 8 cross-sections to represent approximately 11,000 feet of the downstream end of the Swan Creek channel. The applicant submitted input and output files to the NRC staff as a part of the response to RAI 2.4.1-1. The staff reviewed these files to examine the applicant's approach in detail. The applicant used a Manning's roughness coefficient of 0.02 for the channel and a value of 0.06 for the floodplain. The applicant assumed a constant water surface elevation in Lake Erie as the downstream boundary condition and a normal depth slope of 0.001 ft/ft as an upstream boundary condition. Each of the flooding alternatives has a different downstream elevation of Lake Erie and contributing flow from Swan Creek. The applicant provided detail on the derivation of the elevation of Lake Erie for each of the alternatives. Alternative I used the 100-year elevation of Lake Erie, 575.1 ft NAVD 88, combined with the estimate of the 100-year surge of 4.0 ft as presented in Table 2.4-222 of the FSAR. Alternative II used the 100-year elevation of Lake Erie, 575.1 ft NAVD 88, combined with the estimate of the 33-year surge of 3.2 ft as presented in Table 2.4-222 of the FSAR. Alternative III used the 100-year elevation of Lake Erie, 575.1 ft NAVD 88, combined with the estimate of probable maximum surge height of 10.3 ft. Table 2.4.3-3 summarizes the applicant's HEC-RAS inputs and the results.

Table 2.4.3-3. The Applicant's Inputs to HEC-RAS and Resulting Flood Elevations at the Fermi Site

Combined Events	**Input Parameters**		**Results**
Flood Scenario	**Flow in Swan Creek (cfs)**	**Calculated Lake Elevation (ft NAVD 88)**	**Resulting Fermi Flood Elevation (ft NAVD 88)**
Alternative I: • 500-yr flood in Swan Creek (5000 cfs) • Largest observed surge in Lake Erie (4.0 ft) • 100-year elevation of Lake Erie (575.1 ft NAVD)	5,000	579.1	**579.4**

Alternative II: • PMF in Swan Creek (113,200 cfs) • 25-year surge in Lake Erie (3.2 ft) • 100-year elevation of Lake Erie (575.1 ft NAVD)	113,200	578.3	**579.1**
Alternative III: • 25-year flood in Swan Creek (3100 cfs) • Probable maximum surge or seiche in Lake Erie (10.3 ft) • 100-year elevation of Lake Erie (575.1 ft NAVD)	3,100	585.4	**585.4**
Sensitivity due to Snowmelt Alternative: • PMF in Swan Creek plus snowmelt runoff (168,000 cfs) • Probable maximum surge and seiche in Lake Erie (10.3 ft) • 100-year elevation of Lake Erie (575.1 ft NAVD)	168,000	585.4	**585.5**
cfs = cubic-foot per second NAVD = North American Vertical Datum PMF = probable maximum flood	To convert feet to meters, multiply by 0.3048 To convert cfs to cubic-meter per second, divide by 35.315		

Table 2.4-219 of the FSAR presents the detailed HEC-RAS simulation results of flooding Alternative II, which included the PMF on Swan Creek. The applicant determined the flood elevation for the Fermi site to be the water elevation at the cross section approximately 1,900 feet upstream from Lake Erie. Detailed HEC-RAS results for Alternative I and Alternative III were presented in FSAR Tables 2.4-220 and 2.4-221, respectively. The flood elevations at Fermi 3 for Alternative I and Alternative III were constant at the downstream cross-sections of Swan Creek, according to the information in these tables.

NRC Staff's Technical Evaluation

The NRC staff reviewed the information submitted by the applicant. The staff finds the applicant's use of HEC-RAS 4.0.0 to be acceptable for estimating water levels in Swan Creek because the staff verified the geometric cross-sections in the HEC-RAS model of Swan Creek by comparing them with the USGS Stony Point topographic map. However, to fully verify the cross-sections, the staff compared them to the 10-m DEM requested by the staff as RAI 2.4.1-3, dated March 19, 2010 (ADAMS Accession No. ML100830380). The review team extracted cross sections from the DEM submitted by the applicant and evaluated the cross sections in comparison to those submitted by the applicant. This confirmed that the appropriate cross-sections were used in the applicant's model.

The staff verified that the Manning's coefficient values assumed for Swan Creek are conservative by varying the coefficient values and performing simulations. Reasonable values for the Manning's coefficient could range between 0.015 and 0.04 for Swan Creek (Shen and Julien, 1993; FEMA, 2000). Fermi flood elevations were the largest when a Manning's n value of 0.04 was assumed for Swan Creek. Therefore, the staff chose the value of 0.04 for Manning's n to compute the most conservative water levels resulting from the flooding alternatives.

The staff reviewed the *FEMA Flood Insurance Study for Monroe County* (2000), particularly the document's discussion of the Swan Creek Watershed. The staff verified that the 25-year flood is estimated to be 3,100 cfs and the 500-year flood level is estimated to be 5,000 cfs (FEMA, 2000). FEMA determined the flood levels for the Swan Creek watershed by plotting flood levels for streams in the region that have been monitored. The calculated flood levels for Swan Creek are then based on its size in comparison with the size of the monitored watersheds.

The staff reviewed the applicant's calculation of the water level for Lake Erie for each flooding alternative. For Alternative I, the applicant stated that a surge of 4.0 feet was assumed. The applicant used the 100-year recurrence interval surge for the month of December of 4.0 ft to estimate the "surge and seiche resulting from the worst regional hurricane or windstorm with wind-wave activity," as required by the ANSI/ANS-2.8-1992. The staff verified the height of the surge by checking the USACE website that the applicant referenced for the value (USACE, 2009). However, the applicant states in Section 2.4.5.2.2.3 of the FSAR that the maximum rise observed as a result of a seiche was 6.3 ft. In RAI 2.4.3-2, dated January 29, 2010 (ADAMS Accession No. ML092870355), the NRC staff requested that the applicant provide a rationale for choosing the 100-year surge as predicted by the USACE for flooding Alternative I rather than using the maximum recorded seiche at the site of 6.3 ft. The response included a calculation of flooding Alternative I using the maximum recorded seiche at the site. The flooding height was calculated to be 581.7 ft NAVD 88, which is lower than the flooding level of Alternative III. Thus, Alternative I, even with the maximum recorded seiche, would not produce the PMF.

For Alternative II, the applicant stated that a surge of 3.2 feet was assumed, based on the 33-year surge elevation as estimated by the USACE (2009). The staff verified the height of the surge by checking the applicant's reference. For Alternative III, the applicant stated that a surge of 10.3 feet was assumed, based on the calculation of probable maximum surge as discussed further below. However, upon review of the applicant's information submitted in Subsection 2.4.5 of the FSAR, a surge height plus wave action of 12.37 ft at the site was calculated by the applicant with the STWAVE model. This issue is discussed in greater detail in Subsection 2.4.5.

The verification of the Lake Erie elevation for each of the flooding alternatives is discussed below in Section 2.4.5. The verification of the calculation of the 100-year elevation of Lake Erie, the probable maximum surge and seiche, and the maximum observed surge elevation are discussed in Section 2.4.5, below.

Table 2.4.3-4 presents the staff's inputs and outputs of the HEC-RAS model.

Table 2.4.3-4. The Staff's Inputs to HEC-RAS and Resulting Flood Elevations at the Fermi Site

Combined Events	**Input Parameters**		**Results**
Flood Scenario	**Flow in Swan Creek (cfs)**	**Calculated Lake Elevation (ft NAVD 88)**	**Resulting Fermi Flood Elevation (ft NAVD 88)**
Alternative I: • 500-yr flood in Swan Creek (5000 cfs) • Largest observed surge in Lake Erie (4.0 ft) • 100-year elevation of Lake Erie (575.1 ft NAVD)	5,000	579.1	**579.1**
Alternative II: • PMF in Swan Creek (134,000 cfs) • 25-year surge in Lake Erie (3.2 ft) • 100-year elevation of Lake Erie (575.1 ft NAVD)	134,000	578.3	**581.5**
Alternative III: • 25-year flood in Swan Creek (3100 cfs) • Probable maximum surge or seiche in Lake Erie (10.3 ft)	3,100	585.4	**585.4**

• 100-year elevation of Lake Erie (575.1 ft NAVD)			
Sensitivity due to Snowmelt Alternative: • PMF in Swan Creek plus snowmelt runoff (199,000 cfs) • Probable maximum surge and seiche in Lake Erie (10.3 ft) • 100-year elevation of Lake Erie (575.1 ft NAVD)	199,000	585.4	**586.3**
cfs = cubic-foot per second NAVD = North American Vertical Datum PMF = probable maximum flood	To convert feet to meters, multiply by 0.3048 To convert cfs to cubic-meter per second, divide it by 35.315		

The highest flood level calculated by the staff is 586.3 ft NAVD 88 and resulted from the PMF plus snowmelt on Swan Creek coincident with the probable maximum surge and seiche in Lake Erie. However, this alternative was performed as a sensitivity analysis to determine the impact of a snowpack at the site. The ANSI/ANS-2.8-1992 guidelines state that the three alternatives are adequate for determining the maximum water level at the site. The staff finds that the maximum water level resulting from flooding is 585.4 ft NAVD 88 in Alternative III, which is 0.1 ft below the applicant's maximum water level is acceptable.

Coincident Wind Wave Activity

Information Submitted by the Applicant

In Subsection 2.4.3.6 of the FSAR, the applicant calculated the potential for wind-wave activity occurring with flooding Alternative III in Section 2.4.5 of the FSAR. The applicant stated that the wave run-up resulting from the probable maximum windstorm winds on Lake Erie was calculated with the Automated Coastal Engineering System (ACES) model. In Section 2.4.5 of the FSAR, the applicant calculated the wave run-up estimated to occur on top of the probable maximum surge in Lake Erie of 585.4 ft NAVD 88. The applicant stated that the breaking wave was calculated to be 9.48 ft at the toe of the seawall and 2.23 ft on the toe of the Fermi 3 nuclear island/berm. If waves run up to the slope of berm, the highest run-up level was found to be 3.01 ft.

NRC Staff's Technical Evaluation

The NRC staff reviewed the applicant's calculation of wave run-up presented in Section 2.4.5 of the FSAR. The staff requested additional information about the applicant's calculation of wave run-up in RAI 2.4.5-3, received November 20, 2009 (ADAMS Accession No. ML093280179), which is discussed below in Section 2.4.5.

Using the values presented by the applicant, the staff calculated the maximum elevation that waves would break to be 587.7 ft NAVD 88 at the toe of the berm and run up to be 588.41 ft along the slope of the Fermi 3 nuclear island/berm, caused by a combination of the probable maximum surge, wind set-up, and wave run-up. These elevations are 1.4 ft and 0.9 ft below the elevation of the Fermi 3 safety structures, respectively.

Additionally, in RAI 2.4.3-3, dated January 29, 2010 (ADAMS Accession No. ML092870355), the NRC staff requested that the applicant provide additional information on wind-wave activity coincident with a flood under Alternatives I and II. According to Subsection of 9.2.3.2 of the ANSI/ANS 2.8-1992, all alternatives need to be evaluated with wind-wave activity. The applicant calculated the wave runup for Alternative I to be 0.4 ft below the top of the seawall at the edge of Lake Erie, but the wave runup on the Fermi 2 plant grade was not calculated. The applicant stated that there would be some water splashing up on the Fermi 2 plant grade, but the runup would be much lower than the height of the Fermi 3 safety structures. The wave runup for Alternative II was calculated by the applicant to be 3.6 ft above the top of the seawall, so at an elevation of 585.4 ft NAVD 88, which is 3.9 ft below the elevation of the Fermi 3 safety structures. The applicant did not address potential impacts from the wind wave activity on the slopes of the nuclear island. To address this, the NRC staff transmitted RAI 2.4.2-5, dated May 7, 2010 (ADAMS Accession No. ML101320136) requesting that the applicant (1) evaluate potential erosion on the slopes of the nuclear island caused by wind wave activity and (2) describe the erosion protection measures that will be taken to prevent erosion on the slopes of the nuclear island. In the response to RAI 2.4.2-5, Detroit Edison provided an analysis of potential erosion on the slopes of the Fermi 3 nuclear island from wave run-up. The analysis showed that slopes would be protected from wave run-up velocities during the PMF event, using the slope protection methods discussed in the answer to RAI 2.4.2-4 (grassed slopes or rip-rap with a D50 of 0.25 ft). The applicant estimated that velocities of run-up wave along the slope and breaking waves hitting the slope prior to breaking are approximately 3.4 ft per second and 3.7 ft per second, respectively. Both velocities are below the permissible velocities for the erosion protection methods discussed in RAI 2.4.2-4. As the applicant indicated, however, the wave action on the slope of the Fermi 3 nuclear island could provide additional forces that result in erosion. To ensure no damage or displacement of the rip-rap on the slopes, the applicant found that a D50 of 0.5 ft would need to be used. The staff finds this analysis to be conservative and acceptable.

For the reasons given above, the staff concludes that the identification and consideration of the PMF on streams and rivers at the site and in the surrounding area are acceptable and meet the requirements of 10 CFR 52.79 and 10 CFR 100.20(c), with respect to determining the acceptability of the site for the ESBWR design.

2.4.3.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.4.3.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.3 of NUREG–0800, and other NRC RGs. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed COL Item EF3 2.0-12-A as it relates to probable maximum floods.

As set forth above, the applicant has presented and substantiated information relative to the probable maximum flooding on streams and rivers important to the design and siting of this plant. The staff reviewed the available information provided. For the reasons given above, the staff concludes that the identification and consideration of the probable maximum flooding on streams and rivers at the site and in the surrounding area are acceptable and meet the requirements of 10 CFR 52.79 and 10 CFR 100.20(c), with respect to determining the acceptability of the site for the ESBWR design.

The staff finds that the applicant has considered the appropriate site phenomena in establishing the design bases for SSCs important to safety. The staff accepts the methodologies used to determine the probable maximum flooding on streams and rivers. Accordingly, the staff concludes that the use of these methodologies results in design bases containing a sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. The staff concludes that the identified design bases meet the requirements of 10 CFR 100.20(c) with respect to establishing the design basis for SSCs important to safety.

2.4.4 Potential Dam Failures

2.4.4.1 *Introduction*

The potential dam failures are addressed to ensure that any potential hazard to the safety-related facilities due to the failure of onsite, upstream, and downstream water control structures is considered in the plant design. The specific areas of review are as follows: (1) flood waves resulting from a dam breach or failure, including those due to hydrologic failure as a result of overtopping for any reason, routed to the site and the resulting highest water surface elevation that may result in the flooding of SSCs important to safety; (2) successive failures of several dams in the path to the plant site caused by the failure of an upstream dam due to plausible reasons, such as a PMF, landslide-induced severe flood, earthquakes, or volcanic activity and the effect of the highest water surface elevation at the site under the cascading failure conditions; (3) dynamic effects of dam failure-induced flood waves on SSCs important to safety; (4) failure of a dam downstream of the plant site that may affect the availability of a safety-related water supply to the plant; (5) effects of sediment deposition or erosion during dam failure-induced flood waves that may result in blockage or loss of function of SSCs important to safety; (6) failure of onsite water control or storage structures such as levees, dikes, and any engineered water storage facilities that are located above site grade and may induce flooding at the site; (7) the potential effects of seismic and non-seismic data on the postulated design bases and how they relate to dam failures in the vicinity of the site and the site region; and (8) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.4.4.2 *Summary of Application*

Section 2.4.4 of the Fermi 3 COL FSAR, Revision 7, addresses the needs for site specific information on potential dam failures. In addition, in FSAR Section 2.4.4, the applicant provides the following:

<u>*COL Item*</u>

- EF3 COL 2.0-15-A Potential Dam Failures

  To address this COL item, the applicant stated that there were no known dams on adjacent water bodies that would impact the Fermi 3 Site.

2.4.4.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the potential dam failures, and the associated acceptance criteria, are in Section 2.4.4 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), sets forth the criteria to determine the citing factors for plant design bases with respect to seismically induced floods and water waves at the site.

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The following related acceptance criteria are summarized from SRP Section 2.4.4:

- Flood Waves from Severe Breaching of an Upstream Dam: To meet the requirements of 10 CFR Part 100 and 10 CFR 100.23(d), estimates of the following characteristics are needed, and should be based on conservative assumptions of hydrometeorological, geological, and seismic characteristics in the drainage area: (a) modes of assumed dam breaches or failures, (b) consideration of flood control reservoirs at full pool level, and (c) conservatism of coincident flow rates and water surface elevations.

- Domino-Type or Cascading Dam Failures: To meet the requirements of 10 CFR Part 100 and 10 CFR 100.23(d), an appropriate configuration of the cascade of dam failures and its potential to produce the largest flood adjacent to the plant site is needed.

- Dynamic Effects on Structures: To meet the requirements of 10 CFR Part 100, an estimate of dynamic effects of flood waves, such as velocities and momentum fluxes, on SSC important to safety is needed.

- Loss of Water Supply Due to Failure of a Downstream Dam: To meet the requirements of 10 CFR Part 100 and 10 CFR 100.23(d), an assessment regarding loss of safety-related water supply to the plant caused by failure of a downstream dam is needed.

- Effects of Sediment Deposition and Erosion: To meet the requirements of 10 CFR Part 100 and 10 CFR 100.23(d), an assessment is needed regarding loss of functionality of safety-related water supply to the plant caused by blockages due to sediment deposition or erosion during the dam failure-induced flood event.

- Failure of Onsite Water Control or Storage Structures: To meet the requirements of 10 CFR Part 100, an assessment is needed regarding the failure of any onsite water control or storage structures that may cause flooding of SSC important to safety.

- Consideration of Other Site-Related Evaluation Criteria: The potential effects of site-related proximity, seismic, and non-seismic information as they relate to flooding due to upstream dam failures and loss of safety-related water supply due to blockages and failures of downstream dam failures adjacent to and on the plant site and site regions are needed to meet the requirements of 10 CFR Part 100.

In addition, the hydrologic characteristics should be consistent with appropriate sections from: RGs 1.27, 1.29, 1.59, as supplemented by best current practices, and RG 1.102.

2.4.4.4 *Technical Evaluation*

NRC staff reviewed Section 2.4.4 of the Fermi 3 COL FSAR related to potential dam failures and their effects on the Fermi site as follows:

<u>*COL Item*</u>

- EF3 COL 2.0-15-A Potential Dam Failures

  To address this COL item, the applicant stated that there were no known dams on adjacent water bodies that would impact the Fermi 3 Site.

The staff reviewed FSAR Section 2.4.4, Potential Dam Failures. In Section 2.4.3.4 of the FSAR, the second paragraph states that “There are no dams existing within the Swan Creek watershed ...” In response to this statement, the NRC staff requested the applicant to provide additional information on the justification for the statement regarding dams in the watershed through RAI 2.4.4-1, dated September 30, 2009 (ADAMS Accession No. ML092790561). The RAI specified that the applicant should demonstrate that a reasonable search of records or applicable databases has been conducted to support its conclusion. In response to RAI 2.4.4-1, the applicant referenced the USACE National Inventory of Dams database. The staff checked the National Inventory of Dams on October 21, 2009 and verified that there are no dams within the Swan Creek Watershed (USACE, 2007). The staff verified that the information in the dam inventory and finds that there is no risk of flooding due to a potential dam failure. For the reasons given above, the staff concludes that the identification and consideration of the effects of dam failures at the site and in the surrounding area are acceptable and meet the requirements of 10 CFR 52.79, 100.23(d), and 100.20(c).

2.4.4.5 *Post Combined License Activities*

There are no post COL activities related to this subsection.

2.4.4.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.4 of NUREG–0800, and other NRC RGs. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed COL Item EF3 2.0-15-A as it relates to potential dam failures.

As set forth above, the applicant has presented and substantiated information relative to the effects of dam failures important to the design and citing of this plant. The staff reviewed the available information provided. For the reasons given above, the staff concludes that the identification and consideration of the effects of dam failures at the site and in the surrounding area are acceptable and meet the requirements of 10 CFR 52.79, 100.23(d), and 100.20(c).

The staff finds that the applicant has considered the appropriate site phenomena in establishing the design bases for SSCs important to safety. The staff accepts the methodologies used to determine the effects of dam failures reflected in the site characteristics. Accordingly, the staff concludes that the use of these methodologies results in design bases containing a sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. The staff concludes that the identified design bases meet the requirements of 10 CFR 100.23(d) and 10 CFR 100.20(c), with respect to establishing the design basis for SSCs important to safety.

2.4.5 Probable Maximum Surge and Seiche Flooding

2.4.5.1 *Introduction*

The probable maximum surge and seiche flooding are addressed to ensure that any potential hazard to the safety-related facilities due to the effects of probable maximum surge and seiche is considered in plant design. The specific areas of review are as follows: (1) probable maximum hurricane (PMH) that causes the probable maximum surge as it approaches the site along a critical path at an optimum rate of movement; (2) probable maximum wind storm (PMWS) from a hypothetical extratropical cyclone or a moving squall line that approaches the site along a critical path at an optimum rate of movement; (3) a seiche near the site, and the potential for seiche wave oscillations at the natural periodicity of a water body that may affect flood water surface elevations near the site or cause a low water surface elevation affecting safety-related water supplies; (4) wind-induced wave run-up under a PMH or PMWS winds; (5) effects of sediment erosion and deposition during a storm surge and seiche-induced waves that may result in blockage or loss of function of SSCs important to safety; (6) the potential effects of seismic and non-seismic information on the postulated design bases and how they relate to a surge and seiche in the vicinity of the site and the site region; (7) any additional information requirements prescribed in the “Contents of Application” sections of the applicable subparts to 10 CFR Part 52.

2.4.5.2 *Summary of Application*

Section 2.4.5 of the Fermi 3 COL FSAR, Revision 7, addresses probable maximum surge and seiche flooding. In addition, in FSAR Section 2.4.5, the applicant provides the following:

<u>*COL Item*</u>

- EF3 COL 2.0-16-A Probable Maximum Surge and Seiche Flooding

  The applicant discussed criteria of combined events that cause flood induced by probable maximum surge and seiche along the shore of the Lake Erie and presented the determination of probable maximum meteorological winds and associated parameters.

  The applicant provided historical data related to surges and seiches for the area of Lake Erie in the vicinity of the site and discussed the wind-generated wave activity that can occur independently or coincidentally with a surge or seiche.

  The applicant discussed the possibility of oscillations of waves at natural periodicity, such as lake reflection and harbor resonance phenomena, and any resulting effects at the site.

  The applicant discussed the location of, and design criteria for, any special facilities for the protection of intake, effluent, and other safety-related facilities against surges, seiches, and wave action.

2.4.5.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the probable maximum surge and seiche flooding, and the associated acceptance criteria, are in Section 2.4.5 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), sets forth the criteria to determine the citing factors for plant design bases with respect to seismically induced floods and water waves the site.

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The following related acceptance criteria are summarized from SRP Subsection 2.4.5:

- Probable Maximum Hurricane: To meet the requirements of 10 CFR Part 100, estimates of the probable maximum hurricane and the probable maximum storm surge, i.e., the storm surge induced by the PMH, are needed.

- Probable Maximum Wind Storm: To meet the requirements of 10 CFR Part 100, estimates of the PMWS and the storm surge induced by the PMWS are needed.

- Seiche and Resonance: To meet the requirements of 10 CFR Part 100, estimates of seiche and resonance in water bodies induced by meteorological causes, tsunamis, and seismic causes are needed.

- Wave Run-up: To meet the requirements of 10 CFR Part 100, an estimate of wind-induced wave run-up under PMH or PMWS winds is needed.

- Effects of Sediment Erosion and Deposition: To meet the requirements of 10 CFR Part 100, an assessment of loss of functionality of safety-related water supply to the plant caused by blockages due to sediment deposition or erosion during the storm surge or seiche is needed.

- Consideration of Other Site-Related Evaluation Criteria: The potential effects of site-related proximity, seismic, and non-seismic information as they relate to flooding and loss of safety-related water supply due to surge and seiche adjacent to the plant site and site regions are needed to meet the requirements of 10 CFR Part 100.

In addition, the hydrologic characteristics should be consistent with appropriate sections from: RGs 1.27, 1.29, 1.59, as supplemented by best current practices and RG 1.102.

2.4.5.4 *Technical Evaluation*

The staff reviewed Section 2.0 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the ESBWR DCD and the information in the Fermi 3 COL FSAR appropriately represents the complete scope of information relating to this review topic. The staff's review confirms that the information contained in the application and the information incorporated by reference address the relevant information related to this section.

The staff reviewed the information in the Fermi 3 COL FSAR, Revision 7, as follows:

<u>COL Item</u>

- EF3 COL 2.0-16-A Probable Maximum Surge and Seiche Flooding

In FSAR Section 2.4.5, the applicant states:

> The analyses discussed in this section are based on ANSI/ANS-2.8-1992 (Reference 2.4-248). ANSI/ANS-2.8-1992, Section 9.2.3, describes the combined events criteria for an enclosed body of water, which is appropriate for analyzing postulated flooding at the Fermi 3 power reactor site due to wind and wave conditions in Lake Erie. Specifically, ANSI/ANS-2.8-1992, Section 9.2.3.1, states that the following combination of flood causing events provides an adequate design base for shore locations.
>
> 1. Probable maximum surge and seiche with wind-wave activity.
> 2. 100-year or maximum controlled level in water body, whichever is less.

The staff's evaluations of the information in this FSAR section are provided below:

Probable Maximum Winds and Associated Meteorological Parameters

In Subsection 2.4.5.1 of the FSAR, the applicant discussed meteorological winds and parameters for the probable maximum windstorm (PMWS). The applicant stated, "According to Section 7.2.2 of ANSI/ANS-2.8-1992, for the area of the Great Lakes in the vicinity of the site, the probable maximum surge and seiche is calculated from the PMWS." The applicant implied that the other events, such as probable maximum hurricane (PMH) and moving squall line are not required for this area.

The applicant referenced Subsection 7.2.2.1 of ANSI/ANS-2.8-1992 to provide a set of parameters associated with PMWS in the area of Great Lakes as follows: (1) set maximum over-water wind speed at ~ 160 km/hr (100 mph); (2) set lowest pressure within the PMWS to ~950 mbar; (3) apply a most critical, constant translational speed during the life of the PMWS; (4) assume that wind speeds over water vary diurnally from 1.3 (day) to 1.6 (night) times the overland speed; and (5) assume that winds blow 10 degrees across the isobars over the water body.

According to Section 7 of ANSI/ANS-2.8-1992, probable maximum winds and parameters should be presented with three metrological events, respectively: (1) PMH, (2) PMWS, and (3) moving squall line. The NRC staff checked region of occurrence for each event as described in the Subsections of 7.2.1.1, 7.2.2.1, and 7.2.3.1 of ANSI/ANS-2.8-1992. The staff verified that the Fermi 3 site area is beyond influence of PMH, which is within 200 miles from the U.S. coastline. The moving squall line in western Lake Erie, however, was not discussed by the applicant, even though it is significant in Lake Michigan. RAI 2.4.5-5, dated November 20, 2009 (ADAMS Accession No. ML092870355) the NRC staff requested that the applicant provide an evaluation to justify or an analysis to demonstrate that the surge calculated for moving squall line does not result in the most severe flood condition in this area.

In response to RAI 2.4.5-5, dated November 20, 2009 (ADAMS Accession No. ML092870355), applicant provided additional analysis based on several references listed in ANSI/ANS-2.8-1992 standards (Detroit Edison, 2010a). The main results from the previous studies are as follows: (1) most of moving squall lines in the Great Lakes region move in a northwest to southwest direction, and (2) the highest storm surge induced by squall lines was predicted at South Haven along the Lake Michigan with propagation speed of 60 knots. Though the Fermi site is sheltered from the predominant direction of squalls in the region, a worst-case scenario was analyzed with assumptions of an 8-mbar pressure jump and a 65-knot speed. The maximum surge would be 5.6 ft under the worst-case scenario at Fermi site. The surge level induced by moving squall lines under the worst-case scenario is much smaller than the maximum surge height of 10.3 ft derived from analysis of storm surge induced by PMWS. Therefore, the staff considers RAI 2.4.5-5 closed.

According to Subsection 7.2.2.3.1 of ANSI/ANS-2.8-1992, the set of parameters used by the applicant are recommended for the Great Lakes region, in lieu of detailed meteorological study for the area. Therefore, it is acceptable for the applicant to use these parameters for surge calculation.

Surge and Seiche

Information Submitted by the Applicant,

In Subsection 2.4.5.2 of the FSAR the applicant discussed the determination of the maximum postulated still-water level at the site. It assumes a predicted storm surge developed on the Lake Erie 100-year lake level. As indicated in the Subsection of 2.4.3 of the FSAR, the applicant found that this probable maximum storm surge water level is a key element in flooding Alternative III, which determines the plant design elevation basis.

The applicant discussed the historical lake level data, their sources, and the method to establish the Lake Erie 100-year water level. The applicant concluded that the 100-year lake level is 5.64 ft above the chart datum (or low water datum) for Lake Erie. This lake level corresponds to 575.1 ft (175.3 m) NAVD 88.

The applicant indicated that the surge analysis was guided by USACE's Coastal Engineering Manual (CEM). A method developed by Bretschneider (1966) was used by the applicant for wave setup to generate storm surge. The Bretschneider method assumes wind setup in a rectangular basin of constant depth with a non-exposed bottom and a perimeter wall. The applicant did not discuss in details how to apply this method to derive storm surge level in the Lake Erie.

As a part of RAI 2.4.1-1, dated July 29, 2009 (ADAMS Accession No. ML100830380), the staff requested additional data packages that support the applicant's calculations. In response to RAI 2.4.1-1, the applicant provided data packages including wave calculations. The calculation file consisted of bathymetric data evaluation, tables for calculating stresses and surge height using the Bretschneider method, and input/output files for the STWAVE model and the ACES model. The derivation and selection of parameters, however, was not discussed for the Bretschneider equation, especially the key parameters fetch length and water depth.

In Subsection 2.4.5.2 of the FSAR regarding surge analysis, the applicant mainly described STWAVE, a numerical model requiring input of bathymetric soundings for Lake Erie and discussed a general model setup for wind wave generation. The results of STWAVE model, however, were not used for surge prediction in this section but in the following section regarding wave run-up (2.4.5.3).

The applicant discussed the bathymetric data for Lake Erie and described its sources and input format for the STWAVE model. However, the bathymetric data were also not used for the surge prediction discussed in Subsection 2.4.5.2 of the FSAR.

The applicant concluded that the maximum probable storm surge (10.3 ft) predicted by the Bretschneider method developed on the 100-year lake level (575.1 ft NAVD 88) defines the maximum postulated still-water level on Lake Erie (585.4 ft NAVD 88).

The applicant discussed the historical records of seiche in Lake Erie and identified maximum recorded rise was 1.9 m (6.3 ft) and the maximum recorded fall was 2.7 m (8.9 ft) for the period of 1941-1981. The applicant concluded that the level of the rise due to seiche is significantly less than the calculated surge height.

NRC Staff's Technical Evaluation

The NRC staff verified the approach to determine the maximum postulated still-water level at the site area boundary by combining the storm surge with antecedent water level (Lake Erie 100-year lake level), according to the Subsection 2.4.5 of the SRP and Section 7 of ANSI/ANS-2.8-1992.

The staff verified the applicant's calculation of the 100-year Lake Erie water elevation. The staff independently checked the calculation of the average lake elevation from the 13 gaging stations on Lake Erie for each hourly interval. The staff then used the Log Pearson Type III distribution to calculate the 100-year lake elevation. The staff calculated a value of 574.7 ft NAVD 88 for the 100-year Lake Erie water elevation. This value is lower than the value calculated by the applicant of 575.1 ft NAVD 88, making the applicant's assumption more conservative. Therefore, the staff finds the applicants value to be acceptable, and RAI 2.4.1-1 is closed.

In the FSAR Subsection of 2.4.5.2, the applicant presented a result of 10.3 ft estimated for the probable maximum surge for Lake Erie using the Bretschneider method. The applicant, however, did not provide any discussion on the method, assumptions, parameter selection, and derivation in this section. Instead, the applicant mainly discussed the STWAVE model, which was not used by the applicant for predicting probable maximum surge and its elevation but was used to calculated wave action in the following section (2.4.5.3). According to the Section 7.3 of ANSI/ANS-2.8-1992, any "method used for surge or seiche level determination should be addressed." In RAI 2.4.5-6, dated January 29, 2010 (ADAMS Accession No. ML092870355) the NRC staff requested that the applicant provide: (1) descriptions of the assumptions of the Bretschneider method used for calculating wind setup under the PMWS, (2) rationale of choosing the Bretschneider method as a conservative approach to predict the probable maximum surge for Lake Erie compared to other commonly used methods, (3) details of the derivation of the key parameters of fetch length and water depth used in the Bretschneider method, and (4) a copy of the reference.

In response to RAI 2.4.5-6, the applicant provided detailed descriptions on the Bretschneider method and its application to calculate the surge under the PMWS condition. Two other methods, Zeider Zee and Sibul methods, were reviewed by the applicant. The applicant indicates that Zeider Zee method was mainly developed for a long and narrow water body at a depth deeper than Lake Erie and Sibul method predicts less surge height. To improve its application of the Bretschneider method, the applicant incorporated variation of lake depth by segmenting the lake along its length. The staff verified the information in the RAI response by performing confirmatory calculations. Based on the information provided in the response and a literature review, the staff finds the Bretschneider method is conservative and acceptable for the surge calculation.

In applying the Bretschneider method, the key parameters that affect storm surge are the fetch length, water depth, and coefficients under the PMWS condition. The fetch length was estimated by the longest straight line from the Fermi 3 site across Lake Erie to the east coast of the lake. The staff verified its distance of 154,781 m along the straight line. Lake Erie is divided evenly by 10 segments to account for variations of the lake depth, and the average depth for each segment was used for the calculation. The coefficients used for the Bretschneider equation are derived by the Corps of Engineers based on studies conducted at Lake Okeechobee. These coefficients are applicable because they were derived from a lake with similar characteristics. Therefore, the results are acceptable and RAI 2.4.5-6 is closed.

The applicant discussed the calculation of surge smaller than the probable maximum surge in FSAR Subsection 2.4.3.3 for calculation of the flooding alternatives. For Alternative I, the applicant stated that a surge of 4.0 feet was assumed. The applicant used the 100-year recurrence interval surge of 4.0 ft for the month of December to estimate the "surge and seiche resulting from the worst regional hurricane or windstorm" as required by ANSI/ANS-2.8-1992. The staff verified the height of the surge by checking the value on the USACE website that the applicant referenced (USACE, 2009). However, the applicant states in Section 2.4.5.2.2.3 of the FSAR that the maximum rise observed as a result of a seiche was 6.3 ft. Therefore, in RAI 2.4.3-2, dated January 29, 2010 (ADAMS Accession No. ML092870355), the staff requested that the applicant provide a rationale for choosing the 100-year surge as predicted by the USACE rather than using the maximum recorded seiche for flooding Alternative I. The response included a calculation of flooding Alternative I using the maximum recorded seiche at the site. The flooding height was calculated to be 581.7 ft NAVD 88, which is lower than the flooding level of Alternative III. Thus, Alternative I, even with the maximum recorded seiche, would not produce the PMF. For Alternative II, the applicant stated that a surge of 3.2 feet was assumed, based on the 33-year surge elevation as estimated by the USACE (2009). The staff verified the height of the surge by checking the applicant's reference.

The staff verified the bathymetric data for Lake Erie submitted by the applicant to be accurate and that the data were converted to a format and used in the STWAVE model appropriately. This information is used by the staff and the applicant to model parameters in the FSAR Subsection 2.4.5.3.

The NRC staff has reviewed the historical data for seiche in Lake Erie and confirms its effect is less than impact of surge under PMWS in the site area. The staff concludes that the information was accurate and applicable to the site.

Wave Action

Information Submitted by the Applicant

In Subsection 2.4.5.3 of the FSAR, the applicant discussed the wave action from the PMWS winds including wind-induced wave (surge) and wave run-up. The applicant used a two dimensional, steady-state finite-difference model STWAVE to determine the wind-induced wave and its characteristics (wave height and period) at a selected point, which is located at the beginning of the nearshore. As the wave moves across the shore profile, the wave run-up was calculated by using the ACES model to predict the highest wave run-up and overtopping rates on an impermeable structure. The breaking waves and their heights were also predicted by using the ACES model at the points along the shore profile. The applicant states that the calculation assumes the maximum water level combining 100-year lake level and increased wave height due to surge and seiche.

In the wave calculation submitted by the applicant as a part of the response to RAI 2.4.1-1, dated July 29, 2009 (ADAMS Accession No. ML100830380), the applicant discussed the model setup for STWAVE, which included three input files specifying bathymetric grid data, wind parameters, peak frequency, water level correction, incident wave spectrum, and observation points. In the model simulation, Lake Erie is considered as an enclosed water body. A zero incident wave spectrum was assigned to the shoreline. A constant wind speed and direction were assigned to each simulation. The applicant performed 15 simulations with various wind directions from -42^o to 42^o where 0^o is a wind pointed directly to the west toward the site. The model output file presents the parameters of the generated wave at selected 197 observation points. The applicant states that "Several points that were closest to the shore were examined to determine the highest waves generated." Based on the selected point that was located about 61 m (200 ft) from shore at a depth of 1 m (3.3 ft) chart datum, the highest waves were 3.77 m (12.37 ft) high with a peak spectral period of 11.1 seconds.

For wave run-up on an impermeable embankment, the applicant's analysis is based on general assumptions as follows: (1) waves are monochromatic, normally incident to the structure, and unbroken in the vicinity of the structure toe; (2) waves are specified at the structure location; (3) all structure types are considered to be impermeable; (4) for sloped structures the crest of the structure must be above the still-water level; (5) for vertical and composite structures, partial and complete submersion for the structure is considered; (6) run-up estimates on sloped structures require the assumption of infinite structure height and a simple plane slope; and (7) the expressions for the transmission by overtopping use the actual finite structure height.

The applicant presented the ACES model inputs including wave type, breaking criteria, wave height, wave period, structure slope, structure height, slope type, and roughness coefficient. The model outputs from the ACES model were presented. The applicant's simulations using the ACES model provided the following results: (1) a 0.49 ft wave increase when the generated wave moves through the nearshore area, and (2) the non-breaking wave at the toe of the berm can generate a wave run-up on the slope to a height of 3.0 ft, and overtopping rate of 0.16 ft^2/s.

For the breaking waves across the shore profile, the maximum wave height was calculated by the modified 1951 Miche criterion. The applicant presented results showing that the height of the breaking wave is 2.89 m (9.47 ft) at seawall and 0.68 m (2.23 ft) at the berm. However, the FSAR Table 2.4-224 shows inconsistent values for wave height in meters and feet.

Based on the results above, the applicant concluded that the wave run-up and breaking wave could not directly impact Fermi 3.

NRC Staff's Technical Evaluation

The NRC staff reviewed the approaches, methodology, and selected models and formulas used by the applicant for simulating wave set up, transmission, run-up, and break across the defined shore profile.

The NRC staff reviewed the input files for the STWAVE model and independently ran all simulations using the given input files and examined all output files, including the wave parameters at 197 locations. Results for wave heights at 197 locations range from 0 m to 5.16 m (16.93 ft). However, the applicant indicated that the wave height predicted by STWAVE at the selected point (200 ft from the shore) is 3.77 m (12.37 ft). In order to clarify the difference between staff and applicant calculated wave heights, the staff requested, in RAI 2.4.5-3, dated November 20, 2009 (ADAMS Accession No. ML093280179), that the applicant provide a plan-view figure detailing the spatially distributed results of the STWAVE simulation from which the storm surge height of 3.77 m (12.37 ft) was derived and to note the locations of Fermi 3 and the point/model cell chosen to determine the storm surge height presented in the response. The response to RAI 2.4.5-3, dated November 20, 2009 (ADAMS Accession No. ML093280179) did not provide all of the necessary details; therefore the staff requested that the applicant provide a map showing the distribution of the wave height overlain on the contours of the bathymetric map in RAI 2.4.5-7. The applicant's response to RAI 2.4.5-7**,** dated January 29, 2010 (ADAMS Accession No. ML092870355) provided additional insight to review the surges generated by the STWAVE model and examine the relationship between water depth and wave height.

In the responses to RAI 2.4.5-3 and RAI 2.4.5-7, the staff verified the results derived by the applicant by modeling the entire area of Lake Erie using the model grid of 100 m using STWAVE. The resulting distribution of wave heights is shown in Figure 2.4.5-1.

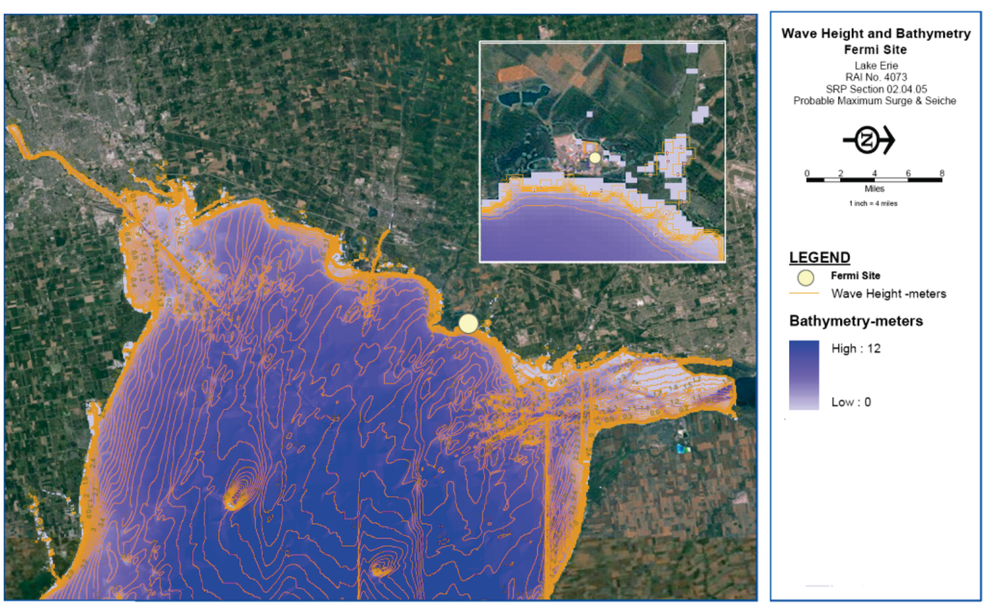


Figure 2.4.5-1. Wave Height and Bathymetry of the Western Lake Erie Derived by STWAVE

The STWAVE data points near the Fermi 3 are shown in Figure 2.4.5-2. The wave periods at all these points are 11.1 seconds. The wave height at the point near Fermi 3 is 3.7 m. The wave parameters selected by the applicant using STWAVE are conservative based on the staff's independent verification using additional data received in RAI responses. These parameters, including wave period and distribution of wave height, were used for further calculation of wave action across the shore.

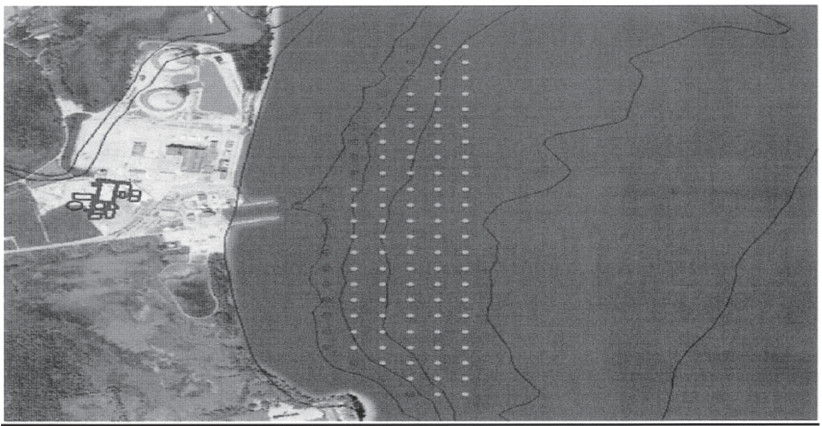


Figure 2.4.5-2. STWAVE Data Points Near Fermi 3

The NRC staff reviewed all of the inputs for simulations using the ACES model and equations 4 and 5 presented in Section 2.4.5.3.2 of the FSAR. To better examine the results, the staff summarized all elevations and the derived depths in Table 2.4.5-1 as shown in the shore profile in Figure 2.4.5-3

Table 2.4.5-1. Summary of Elevations, Water Depths, and Breaking Wave/Run-up Across the Shore Profile

Shore Profile Location	Elevation (ft)		100-year Lake Level (ft, NAVD 88)	Surge Height (ft)	Probable Maximum Surge Water Level (ft, NAVD 88)	Water Depth (ft)	Breaking Wave (ft)	Wave Run-up (ft)
	Plant Grade Datum	NAVD 88						
STWAVE Point	567.4	566.2	575.1	10.3	585.4	19.2	--	--
Nearshore	567.4 to 570.7	566.2 to 569.5	575.1	10.3	585.4	19.2 to 15.9	--	--
Chart Datum (low water datum)	570.7	569.5	575.1	10.3	585.4	15.9	--	--
Seawall	570.7 to 583	569.5-581.8	575.1	10.3	585.4	15.9 to 3.65	9.47	--
Onshore (Fermi 2 Plant Grade)	583 (flat)	581.8 (flat)	575.1	10.3	585.4	3.65	2.23	--
Toe of Berm to Fermi 3 Plant Grade	583 to 590.5	581.8 to 589.3	575.1	10.3	585.4	3.65 ft at toes of berm and 3.9 below Plant Grade	2.23	3.01
To covert feet to meters multiply the numbers by 0.3048					NAVD= North American Vertical Datum			

In summary, the applicant used the STWAVE model to perform wave set-up, which is developed on a maximum still lake level combining the 100-year lake level and probable surge level derived by the Bretschneider method. The results of STWAVE were used to estimate wave breaking and run-up. According to Chapter 4 of the Coastal Engineering Manual, the wave breaking and run-up mainly depended on the total water depth, which is sum of wave set-up and still water depth. The applicant, however, did not provide a discussion on the change in total water depth due to the wave set-up across the shore. Therefore, the staff requested that the applicant use graphs to illustrate the shore profile (from an STWAVE point to the Fermi 3 safety structures), wave characteristics across the shore (maximum still water level, wave length, wave height, breaking wave, run-up, etc.), their relationship, and quantitative information that supports conclusion of no impact to Fermi 3 safety structures. RAI 2.4.5-8, dated January 29, 2010 (ADAMS Accession No. ML092870355) was issued to the applicant.

In response to RAI 2.4.5-8 the applicant provided the information regarding the cross section from the STWAVE point to the Fermi 3 safety structures and the calculated the wave characteristics across the shore (Figure 2.4.5-3). The staff verified that all information is correct by checking the cross section data to that information used in the model. The shore profile data were used in the model input for the calculation of the breaking wave and wave run-up.

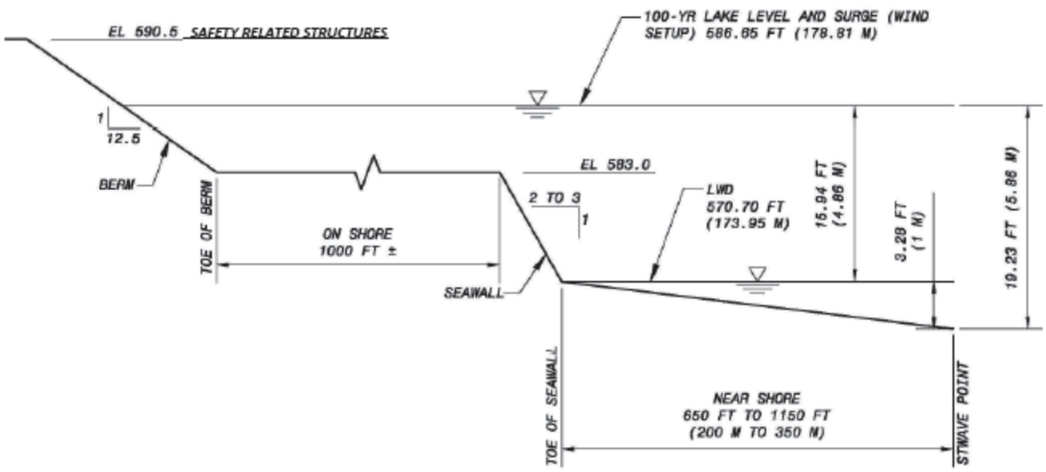


Figure 2.4.5-3. Cross Section from the STWAVE Point to the Fermi 3 Safety-Related Structure

The breaking wave was calculated using the ACES model at two points: the toe of seawall at a water depth of 15.9 ft and the toe of the berm at a depth of 3.65 ft. The wave characteristics were predicted by the model as shown in Figure 2.4.5-4, assuming a constant wave period as incoming wave at 11.1 second. The staff confirms that this assumption is conservative because a possible decreasing period of waves through the shore profile would result in a smaller wave length and height. In response to RAI 2.4.5-8 the applicant also corrected wave heights in the Table 2.4.224 of the FSAR. Based on a breaking wave calculated at the toe of the berm, the breaking wave developed on the probable maximum surge (585.4 ft NAVD 88) resulted in a water level of 587.6 ft NAVD 88, which is 1.7 ft below the nominal Fermi 3 plant grade of safety-related structures (589.3 ft NAVD 88). Thus, no breaking waves would impact safety-related structures.

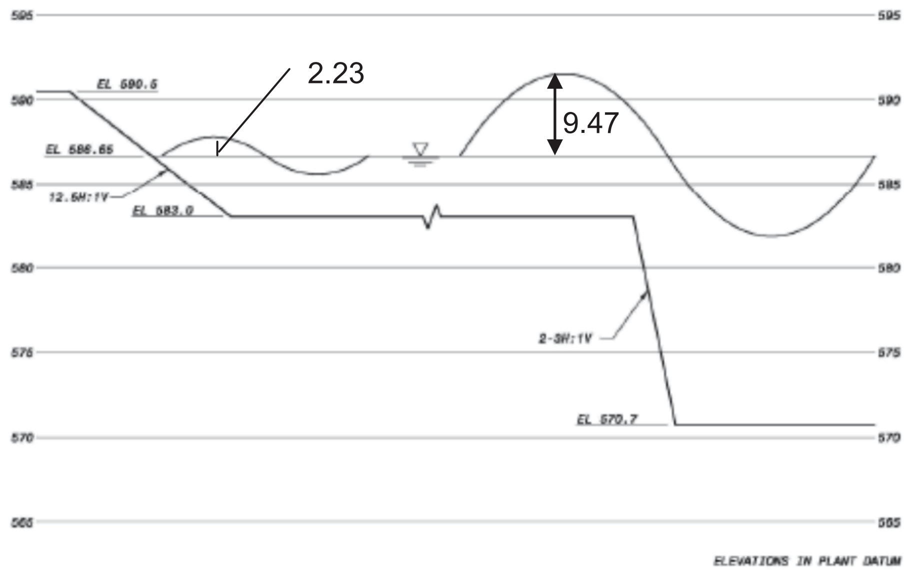


Figure 2.4.5-4. Characteristics of Breaking Waves at the Toes of the Seawall and Berm (Vertical Exaggeration, ~10:1; Elevation in Plant Datum).

The wave run-up was also calculated by the applicant using the ACES model to estimate the potential wave run-up developed on the slope of berm. The result of 3.01 ft of wave run-up is verified by the staff by independently running the model and comparing results. The potential highest level of wave run-up would be 588.41 ft (NAVD 88) based on the wave run-up developed on the probable maximum surge (585.4 ft NAVD 88). The highest level of the wave run-up is 0.9 ft below the nominal Fermi 3 plant grade of safety-related structures (589.3 ft NAVD 88). In response to RAI 2.4.5-8 the applicant showed wave characteristics of the potentially highest wave run-up on the shore cross section, demonstrating that no water would wash on to the nuclear island impacting the safety-related structures. The staff finds the conclusion acceptable because it meets the requirements of 10 CFR Part 100, 10 CFR 100.23(d), and 10 CFR 52.79(a)(1)(iii).

To ensure all information on methods, assumptions, and calculations is included the FSAR related to DTE responses to RAI 2.4.5-5, RAI 2.4.5-6, RAI 2.4.5-7, and RAI 2.4.5-8, the staff requested an update to the relevant sections in the FSAR. The staff reviewed DTE responses and finds the correction and updates to the FSAR to be acceptable because they meet the requirements of 10 CFR Part 100, 10 CFR 100.23(d), and 10 CFR 52.79(a)(1)(iii).

Resonance

Information Submitted by the Applicant

In Subsection 2.4.5.4 of the FSAR, the applicant states that the Fermi site's location next to the open water of Lake Erie "results in a natural period of oscillation of the flooded area that is much greater than that of the incident shallow-water storm waves. Consequently, resonance is not a problem at the site during PMWS occurrence."

NRC Staff's Technical Evaluation

The NRC staff reviewed this section and finds that the resonance in the enclosed water bodies induced by meteorological causes, tsunamis, and seismic causes were not well addressed. In RAI 2.4.5-4, dated November 20, 2009 (ADAMS Accession No. ML093280179), the staff requested that the applicant provide the quantitative basis and methodology for determining the natural period of oscillation of the flooded area and the incident shallow-water storm waves.

In response to RAI 2.4.5-4, the applicant estimated the first six modes of oscillation, which range from 29 to 124 seconds. The peak spectral period of the incoming waves is 11.1 seconds near Fermi 3, derived from the STWAVE model for the Lake Erie. The period of the incoming wave is much less than the period of oscillation. The staff verified the applicant's conclusion that resonance is not a problem at the site during PMWS occurrence.

Sedimentation and Erosion

Information Submitted by the Applicant

In Subsection 2.4.5.5, the applicant states that "Fermi 3 does not rely on Lake Erie for a safety-related water source. Therefore, the loss of functionality of a safety-related water supply to Fermi 3 caused by blockages due to sediment deposition or erosion during a storm surge or seiche event is not a concern."

NRC Staff's Technical Evaluation

The NRC staff finds that sedimentation and erosion are not problems at the site because safety related water would not be impacted and therefore the requirements of 10 CFR Part 100, 10 CFR 100.23(d), and 52.79(a)(1)(iii) are met.

Protective Structures

Information Submitted by the Applicant

On the basis of the wave run-up analysis presented in Subsection 2.4.5.6 of the FSAR, the applicant concluded that the waves under PMWS will not overtop the berm to adversely impact Fermi 3. Therefore, additional structures are not needed.

NRC Staff's Technical Evaluation

After the NRC staff reviewed the section and subsequent RAIs (RAI 2.4.5-3, RAI 2.4.5-6, RAI 2.4.5-7, RAI 2.4.5-8, and RAI 2.4.5-10), the wave run-up analysis was verified and found to be acceptable. As discussed in 2.4.5.3, the potential wave run-up (3.01 ft) developed on the probable maximum surge (585.4 ft NAVD 88) could result in a run-up level of 588.41 ft NAVD 88, which is 0.9 ft below the elevation of the safety structures. The waves under PMWS, therefore, would not overtop the berm and adversely impact Fermi 3.

For the reasons given above, the staff concludes that the identification and consideration of the probable maximum storm surge and its wave actions at the site and in the surrounding area are acceptable and meet the requirements of 10 CFR 52.79(a)(31) and 10 CFR 100.20(c), with respect to determining the acceptability of the site for the ESBWR design.

2.4.5.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.4.5.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.5 of NUREG–0800, and other NRC RGs. The staff's review concluded that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed COL Item EF3 2.0-16-A as it relates to probable maximum surge and seiche flooding.

As set forth above, the applicant has presented and substantiated information relative to the probable maximum storm surge and its wave actions important to the design and siting of this plant. The staff has reviewed the available information provided. For the reasons given above, the staff concludes that the identification and consideration of the probable maximum storm surge and its wave actions at the site and in the surrounding area are acceptable and meet the requirements of 10 CFR 52.79(a)(31) and 10 CFR 100.20(c), with respect to determining the acceptability of the site for the ESBWR design.

The staff finds that the applicant has considered the appropriate site phenomena in establishing the design bases for SSCs important to safety. The staff accepts the methodologies used to determine the probable maximum storm surge and its wave actions. Accordingly, the staff concludes that the use of these methodologies results in design bases containing a sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. The staff concludes that the identified design bases meet the requirements of 10 CFR 100.20(c) with respect to establishing the design basis for SSCs important to safety.

2.4.6 Probable Maximum Tsunami Hazards

2.4.6.1 *Introduction*

The probable maximum tsunami (PMT) hazards are addressed to ensure that any potential tsunami hazards to the SSCs important to safety are considered in plant design. The specific areas of review are as follows: (1) historical tsunami data, including paleo tsunami mappings and interpretations, regional records and eyewitness reports, and more recently available tide gauge and real-time bottom pressure gauge data; (2) PMT that may pose hazards to the site; (3) tsunami wave propagation models and model parameters used to simulate the tsunami wave propagation from the source toward the site; (4) extent and duration of wave run-up during the inundation phase of the PMT event; (5) static and dynamic force metrics including the inundation and drawdown depths, current speed, acceleration, inertial component, and momentum flux that quantify the forces on any safety-related SSCs that may be exposed to the tsunami waves; (6) debris and water-borne projectiles that accompany tsunami currents and may impact safety-related SSCs; (7) effects of sediment erosion and deposition caused by tsunami waves that may result in blockage or loss of function of safety-related SSCs;

(8) potential effects of seismic and non-seismic information on the postulated design bases and how they relate to tsunami in the vicinity of the site and the site region; (9) any additional information requirements prescribed in the “Contents of Application” sections of the applicable subparts to 10 CFR Part 52.

2.4.6.2 *Summary of Application*

Subsection 2.4.6 of the Fermi 3 COL FSAR, Revision 7, addresses PMT hazards. In addition, in Section 2.4.6, the applicant provides the following:

<u>COL Item</u>

- EF3 COL 2.0-17-A Probable Maximum Tsunami Hazards

  To address this COL item, the applicant stated that there is no tsunami hazard in the vicinity of the Fermi 3 site.

2.4.6.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the PMT hazards, and the associated acceptance criteria, are in Section 2.4.6 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), sets forth the criteria to determine the siting factors for plant design bases with respect to seismically induced floods and water waves at the site.

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding areas and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The following related acceptance criteria are summarized from SRP Subsection 2.4.6:

- Historical Tsunami Data: The application should provide a complete description of historical tsunami data near the proposed plant site.

- Probable Maximum Tsunami: The application should provide an assessment of the PMT for the proposed site.

- Tsunami Propagation Models: The application should provide a description of the tsunami wave propagation models used in the applicant’s SAR.

- Wave Runup, Inundation, and Drawdown: The application should provide the extents and durations of inundation and drawdown near the proposed site.

- Hydrostatic and Hydrodynamic Forces. The application should provide a set of metrics that describes the hydrostatic and hydrodynamic forces caused by the PMT on the safety-related SSC.

- Debris and Water-Borne Projectiles. The application should provide an assessment of the debris and water-borne projectiles that may accompany PMT currents.

- Effects of Sediment Erosion and Deposition. The application should provide an assessment of the effects of sediment erosion and deposition near the proposed locations of safety-related SSC.

- Consideration of Other Site-Related Evaluation Criteria. The application should provide an evaluation of the potential effects of site-related proximity, seismic, and non-seismic information as they affect tsunamis near the plant site and site regions.

In addition, the hydrologic characteristics should be consistent with appropriate sections from: RGs 1.27, 1.29, 1.59, as supplemented by best current practices, and 1.102.

2.4.6.4 *Technical Evaluation*

The staff reviewed the information in Section 2.4.6 of the Fermi 3 COL FSAR, Revision 7, as follows:

<u>*COL Item*</u>

- EF3 COL 2.0-17-A Probable Maximum Tsunami Hazards

  To address this COL item, the applicant stated that there is no tsunami hazard in the vicinity of the Fermi 3 site.

<u>*Information Submitted by the Applicant*</u>

The applicant states that "Based on the history of the area, local seismic disturbances would result only in minor excitations in the lake. No tsunami has been recorded in Lake Erie; the only remotely similar phenomena observed have been low-amplitude seiches resulting from sudden barometric pressure differences." The applicant concluded that there are no potential tsunamis or tsunami-like waves which could affect safety-related structures or components at Fermi 3.

NRC Staff's Technical Evaluation

To verify applicant's conclusion, the NRC staff searched tsunami database (National Geophysical Data Center, NOAA) and found two historical events: one in the northern end of Lake Erie and the other near the Detroit River. The staff requested that the applicant conduct a thorough search for historical tsunamis in the area providing an evaluation to support the applicant's conclusion in RAI 2.4.6-1.

In response to RAI 2.4.6-1, dated January 29, 2010 (ADAMS Accession No. ML100330612), the applicant provided additional information regarding historic records in the area, indicating that the recorded historical events were only minor disturbances or seiches and no actual tsunamis are evident. The applicant's review of historic data is complete and accurate, and the response is deemed acceptable because it meets the requirements of 10 CFR Part 100, 10 CFR 100.23(d), and 10 CFR 52.79(a)(1)(iii).

2.4.6.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.4.6.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.6 of NUREG–0800, and other NRC RGs. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed COL Item EF3 2.0-17-A as it relates to probable maximum tsunami hazards.

As set forth above, the applicant has presented and substantiated information relative to PMT important to the design and siting of this plant. The staff reviewed the available information provided. For the reasons given above, the staff concludes that the identification and consideration of the tsunamis at the site and in the surrounding area are acceptable and meet the requirements of 10 CFR 52.79(a)(31) and 10 CFR 100.20(c), with respect to determining the acceptability of the site for the ESBWR design.

The staff finds that the applicant has considered the appropriate site phenomena in establishing the design bases for SSCs important to safety. The staff accepts the methodologies used to determine the presence of tsunami. Accordingly, the staff concludes that the use of these methodologies results in design bases containing a sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. The staff concludes that the identified design bases meet the requirements of 10 CFR 100.20(c) with respect to establishing the design basis for SSCs important to safety.

2.4.7 Ice Effects

The emergency cooling system for Fermi 3 is provided by the UHS which does not rely on water sources external to the plant and is not affected by ice conditions.

2.4.7.1 *Introduction*

The ice effects are addressed to ensure that safety-related facilities and water supply are not affected by ice-induced hazards. The specific areas of review are as follows: (1) regional history and types of historical ice accumulations (i.e., ice jams, wind-driven ice ridges, floes, frazil ice formation, etc.); (2) potential effects of ice-induced, high- or low-flow levels on safety-related facilities and water supplies; (3) potential effects of a surface ice-sheet to reduce the volume of available liquid water in safety-related water reservoirs; (4) potential effects of ice to produce forces on, or cause blockage of, safety-related facilities; (5) potential effects of seismic and non-seismic data on the postulated worst-case icing scenario for the proposed plant site; (6) any additional information requirements prescribed in the “Contents of Application” sections of the applicable subparts to 10 CFR Part 52.

2.4.7.2 *Summary of Application*

Section 2.4.7 of the Fermi 3 COL FSAR, Revision 7, addresses ice effects. In addition, in Section 2.4.7, the applicant provides the following:

COL Item

- EF3 COL 2.0-18-A Ice Effects

  To address this COL item, the applicant stated that there are no expected ice effects to safety-related facilities at the site of Fermi 3.

2.4.7.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the ice effects, and the associated acceptance criteria, are in Section 2.4.7 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 52.79(a)(1)(iii), as it relates to the hydrologic characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The following related acceptance criteria are summarized from SRP Subsection 2.4.7:

- Historical Ice Accumulation: The application should include a complete history of ice formation at and in the vicinity of the site.

- High and Low Water Levels: The application should include estimates of water levels resulting from potential ice flooding or low flows.

- Ice Sheet Formation: The application should include estimates of the most severe ice sheet formation in water storage reservoirs.

- Ice-induced Forces and Blockages: The application should provide estimates of the most severe ice-induced forces on safety-related SSC.

- Consideration of Other Site-Related Evaluation Criteria: The application should demonstrate that the potential effects of site-related proximity, seismic, and non-seismic information as they relate to worst-case icing scenarios adjacent to and on the plant site and site regions are appropriately take into account.

In addition, the hydrologic characteristics should be consistent with appropriate sections from: RGs 1.27, 1.29, 1.59, as supplemented by best current practices, and 1.102.

2.4.7.4 *Technical Evaluation*

The staff reviewed the information in Section 2.4.7 of the Fermi 3 COL FSAR, Revision 7, as follows:

COL Item

- EF3 COL 2.0-18-A Ice Effects

  To address this COL item, the applicant stated that there are no expected ice effects to safety-related facilities at the site of Fermi 3.

No discussion was presented on ice effects in the FSAR. The staff issued RAI 2.4.3-1 requesting for information to support the conclusion that there would be no impacts to Fermi 3 safety-related features due to ice effects. In the response to RAI 2.4.3-1, dated September 30, 2009 (ADAMS Accession No. ML092790561), the applicant cited checking the USACE ice jam database for historical occurrences of ice jams on Swan Creek. The applicant found no historic ice jams on Swan Creek in the ice jam database. Also, in the response to RAI 2.4.9-1, the applicant stated that no ice jams were observed on Swan Creek over the period from 1957 to the present, during which time the applicant managed the Fermi site.

To verify the applicant’s response, the staff performed a search of the USACE ice jam database and found no evidence of an historical ice jam on Swan Creek (USACE, 2010). However, in the description of the ice jam database, the USACE stated that the historical records of ice jams are primarily limited to waterways that have USGS gaging stations (USACE, 2010). There have never been continuously recording USGS gaging stations on Swan Creek, so the likelihood of an historical ice jam being recorded on Swan Creek is low. However, the applicant stated that there have been no ice jams on Swan Creek since 1957. The gaging station on the River Raisin to the south has recorded several ice jams since that time, and records of this flooding are found both on the ice jam database and in local media sources. No personal accounts or media accounts of flooding in Swan Creek due to ice jams were found. Therefore, the staff finds that the applicant’s answer is acceptable in that ice jams are not likely to contribute to flooding in Swan Creek.

2.4.7.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.4.7.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.7 of NUREG–0800, and other NRC RGs. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed COL Item EF3 2.0-18-A as it relates ice effects.

As set forth above, the applicant has presented and substantiated information relative to the ice effects important to the design and citing of this plant. The staff has reviewed the available information provided and, for the reasons given above, concludes that the identification and consideration of the potential for ice flooding, ice blockage of water intakes, ice forces on structures, and the minimum low water levels (from upstream ice blockage) are acceptable and meet the requirements of 10 CFR 52.79(a)(1)(iii) and 10 CFR 100.20(c), with respect to determining the acceptability of the site.

The staff finds that the applicant has considered the appropriate site phenomena for establishing the design bases for SSCs important to safety. The staff has generally accepted the methodologies used to determine the potential for ice formation and blockage reflected in these site characteristics. Accordingly, the staff concludes that the use of these methodologies results in site characteristics containing margin sufficient for the limited accuracy, quantity, and period of time in which the data have been accumulated.

2.4.8 Cooling Water Canals and Reservoirs

2.4.8.1 *Introduction*

The cooling water canals and reservoirs used to transport and impound water supplied to the SSCs important to safety are reviewed to verify their hydraulic design basis. The specific areas of review are as follows: (1) design bases postulated and used by the applicant to protect structures such as riprap, inasmuch as they apply to safety-related water supply; (2) design bases of canals pertaining to capacity, protection against wind waves, erosion, sedimentation, and freeboard and the ability to withstand a PMF (surges, etc.), inasmuch as they apply to a safety-related water supply; (3) design bases of reservoirs pertaining to capacity, PMF design basis, wind wave and run-up protection, discharge facilities (e.g., low-level outlet, spillways, etc.), outlet protection, freeboard, and erosion and sedimentation processes inasmuch as they apply to a safety-related water supply; (4) potential effects of seismic and non-seismic information on the postulated hydraulic design bases of canals and reservoirs for the proposed plant site; and (5) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.4.8.2 *Summary of Application*

Section 2.4.8 of the Fermi 3 COL FSAR, Revision 7, addresses the use of cooling water canals and reservoirs. In addition, in Section 2.4.8, the applicant provides the following:

<u>COL Item</u>

- EF3 COL 2.0-19-A Cooling Water Canals and Reservoirs

  To address this COL item, the applicant describes in the FSAR that no cooling water canals or reservoirs are used for safety related features by Fermi 3. The staff confirmed that Fermi 3 does not use cooling water canals or reservoirs for plant safety.

2.4.8.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the cooling water canals and reservoirs, and the associated acceptance criteria, are in Section 2.4.8 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d) sets forth the criteria to determine the citing factors for plant design bases with respect to seismically induced floods and water waves the site.

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The following related acceptance criteria are summarized from SRP Subsection 2.4.8:

- Hydraulic Design Bases for Protection of Structures: To meet the requirements of 10 CFR Part 100, a complete description of the hydraulic design bases for protection of structures is needed.

- Hydraulic Design Bases of Canals: To meet the requirements of 10 CFR Part 100, a complete description of the hydraulic design bases related to the capacity, protection against wind waves, erosion, sedimentation, and freeboard, and the ability to withstand a PMF, surges, etc., is needed.

- Hydraulic Design Bases of Reservoirs: To meet the requirements of 10 CFR Part 100, a complete description of the design bases of safety-related reservoirs related to their capacity, PMF design basis, wind wave and run-up protection, discharge facilities (e.g., low-level outlet, spillways, etc.), outlet protection, freeboard, and erosion and sedimentation processes is needed.

- Consideration of Other Site-Related Evaluation Criteria: To meet the requirements of 10 CFR Part 100, a complete description of the potential effects of site-related proximity, seismic, and non-seismic information on the postulated design bases of safety-related canals and reservoirs is needed.

In addition, the hydrologic characteristics should be consistent with appropriate sections from: RGs 1.27, 1.29, 1.59, as supplemented by best current practices, RG 1.102, and RG 1.125, "Physical Models for Design and Operation of Hydraulic Structures and Systems for Nuclear Power Plants."

2.4.8.4 *Technical Evaluation*

The staff reviewed the information in Section 2.4.8 of the Fermi 3 COL FSAR, Revision 7, as follows:

<u>*COL Items*</u>

- EF3 COL 2.0-19-A Cooling Water Canals and Reservoirs

  Cooling Water Canals and Reservoirs to address this COL item, the applicant describes in the FSAR that no cooling water canals or reservoirs are used for safety related features by Fermi 3. The staff confirmed that Fermi 3 does not use cooling water canals or reservoirs for plant safety.

The NRC staff reviewed Subsection 2.4.8 of the Fermi 3 COL FSAR. The staff has confirmed that the information in the application addresses the relevant information related to this subsection is sufficient and appropriate.

The applicant describes in the FSAR that no cooling water canals or reservoirs are used for safety-related features by Fermi 3. The staff confirmed that Fermi 3 does not use cooling water canals or reservoirs for plant safety.

The staff has reviewed the available information provided and for the reasons given above, concludes that the identification and consideration of the design bases of canals and reservoirs is acceptable and meets the requirements of 10 CFR 100.20(c), with respect to determining the acceptability of the site.

2.4.8.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.4.8.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.8 of NUREG–0800, and other NRC RGs. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed COL Item EF3 2.0-19-A as it cooling water canals and reservoirs.

As set forth above, the applicant has presented and substantiated information relative to the design bases of canals and reservoirs important to the design and citing of this plant. The staff has reviewed the available information provided and for the reasons given above, concludes that the identification and consideration of the design bases of canals and reservoirs is acceptable and meets the requirements of 10 CFR 52.79(a)(1)(iii), 10 CFR 100.20(c), and 10 CFR 100.23(d), with respect to determining the acceptability of the site.

2.4.9 Channel Diversions

No safety-related systems, structures, or components are impacted. The water supply for Fermi 3 is not obtained from channels; therefore, this section is not applicable from a water supply perspective.

2.4.9.1 *Introduction*

Plant and essential water supplies used to transport and impound water supplies were evaluated to ensure that they will not be adversely affected by stream or channel diversions. The review includes stream channel diversions away from the site (which may lead to a loss of safety-related water) and stream channel diversions toward the site (which may lead to flooding). In addition, in such an event, the applicant needs to show that alternate water supplies are available to safety-related equipment. The specific areas of review are as follows: (1) historical channel migration phenomena including cutoffs, subsidence, and uplift; (2) regional topographic evidence that suggests a future channel diversion may or may not occur (used in conjunction with evidence of historical diversions); (3) thermal causes of channel diversion, such as ice jams, which may result from downstream ice blockages that may lead to flooding from backwater or upstream ice blockages that can divert the flow of water away from the intake; (4) potential for forces on safety-related facilities or the blockage of water supplies resulting from channel migration-induced flooding (flooding not addressed by hydrometeorological-induced flooding scenarios in other sections); (5) potential of channel diversion from human-induced causes (i.e., land-use changes, diking, channelization, armoring, or failure of structures); (6) alternate water sources and operating procedures; (7) potential effects of seismic and non-seismic information on the postulated worst-case channel diversion scenario for the proposed plant site; (8) any additional information requirement prescribed in the “Contents of Application” sections of the applicable subparts to 10 CFR Part 52.

2.4.9.2 *Summary of Application*

Section 2.4.9 of the Fermi 3 COL FSAR, Revision 7, addresses channel diversions. In addition, in FSAR Section 2.4.9, the applicant provides the following:

<u>COL Items</u>

- EF3 COL 2.0-20-A Channel Diversions

  To address this COL item, the applicant stated that there is no potential for upstream diversion or rerouting of the source of cooling water with respect to seismic, topographical, geologic, and thermal evidence in the region. Fermi 3 does not rely on channels for water supply, so this section is not applicable.

2.4.9.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the channel diversions, and the associated acceptance criteria, are in Section 2.4.9 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d) sets forth the criteria to determine the citing factors for plant design bases with respect to seismically induced floods and water waves the site.

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The following related acceptance criteria are summarized from SRP Subsection 2.4.9:

- Historical Channel Diversions: To meet the requirements of 10 CFR Part 100, a complete history of channel diversions at and in the vicinity of the site is needed.

- Regional Topographic Evidence: To meet the requirements of 10 CFR Part 100, a description of regional topographic evidence as it relates to channel diversions is needed.

- Ice Causes: To meet the requirements of 10 CFR Part 100, estimates of the most severe ice-induced channel diversion are needed.

- Flooding of Site Due to Channel Diversions: To meet the requirements of 10 CFR Part 100, estimates of the most severe channel diversion induced forces on SSC important to safety are needed.

- Human-Induced Causes of Channel Diversion: To meet the requirements of 10 CFR Part 100, an assessment of the potential for human-induced channel diversions, in the vicinity of the site (e.g., land-use changes, diking, channelization, armoring or failure of such structures) is needed.

- Alternate Water Sources: To meet the requirements of 10 CFR Part 100, assessments of alternate water sources and operating procedures are needed.

- Consideration of Other Site-Related Evaluation Criteria: To meet the requirements of 10 CFR Part 100, a description of the potential effects of site-related proximity, seismic, and non-seismic information on the postulated worst-case channel diversion scenario for the proposed plant site is needed.

In addition, the hydrologic characteristics should be consistent with appropriate sections from: RGs 1.27, 1.29, 1.59, as supplemented by best current practices and 1.102.

2.4.9.4 *Technical Evaluation*

The staff reviewed the information in Section 2.4.9 of the Fermi 3 COL FSAR, Revision 7, as follows:

<u>*COL Item*</u>

- EF3 COL 2.0-20-A Channel Diversions

  To address this COL item, the applicant stated that there is no potential for upstream diversion or rerouting of the source of cooling water with respect to seismic, topographical, geologic, and thermal evidence in the region. Fermi 3 does not rely on channels for water supply, so this section is not applicable.

The NRC staff reviewed the information submitted by the applicant related to potential channel diversions at the Fermi 3 site.

In the FSAR, the applicant stated that this section is not applicable to Fermi 3, as Fermi 3 does not rely on channels for water supply. The staff issued RAI 2.4.9-1 requesting information supporting the conclusion that a diversion along Swan Creek from an ice jam, a landslide, or another mechanism is unlikely. In the response to RAI 2.4.9-1, dated September 30, 2009 (ADAMS Accession No. ML092790561), the applicant provided a discussion supporting the conclusion that a diversion along Swan Creek is unlikely. The applicant stated that the geology and topography of the Swan Creek watershed are not conducive to large scale landslides that could cause a channel diversion. First, the applicant described the geology as being a sequence of bedrock overlain by glacial till deposits overlain by lacustrine deposits. Then the applicant stated that the deposits increase in strength with depth and that the topography of the watershed is not steep, making the chances of a large area landslide caused by a failing lower layer small. The applicant stated that the banks of Swan Creek do experience small failures, but they would not be of large enough size to divert Swan Creek. Then the applicant referred to FSAR Section 2.4.7 and the response to RAI 2.4.3-1 (ADAMS Accession No. ML092790561, dated September 30, 2009) to support the conclusion that it is unlikely that an ice jam would occur on Swan Creek and cause a diversion. The applicant also stated that no manmade or natural diversions were observed over the period from 1957 to the present, during which time the applicant managed the Fermi site. The staff found the applicant’s response acceptable.

2.4.9.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.4.9.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.9 of NUREG–0800, and other NRC RGs. The staff’s review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed COL Item EF3 2.0-20-A as it relates to channel diversions.

As set forth above, the applicant has presented and substantiated information relative to the channel diversion effects important to the design and citing of this plant. The staff has reviewed the available information provided and for the reasons given above, concludes that the identification and consideration of the potential for channel diversion is acceptable and meets the requirements of 10 CFR 52.79(a)(1)(iii), 10 CFR 100.20(c), and 10 CFR 100.23(d), with respect to determining the acceptability of the site.

2.4.10 Flooding Protection Requirements

2.4.10.1 *Introduction*

The flooding protection requirements address the locations and elevations of safety-related facilities and those of structures and components required for protection of safety-related facilities. These requirements are then compared with design-basis flood conditions to determine whether flood effects need to be considered in the plant's design or in emergency procedures. The specific areas of review are as follows: (1) safety-related facilities exposed to flooding; (2) type of flood protection (e.g., "hardened facilities," sandbags, flood doors, bulkheads, etc.) provided to the SSCs exposed to floods; (3) emergency procedures needed to implement flood protection activities and warning times available for their implementation reviewed by the organization responsible for reviewing issues related to plant emergency procedures; (4) potential effects of seismic and non-seismic information on the postulated flooding protection for the proposed plant site; and (5) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.4.10.2 *Summary of Application*

Subsection 2.4.10 of the Fermi 3 COL FSAR, Revision 7, addresses the site specific information on flooding protection requirements. In addition, in FSAR Section 2.4.9, the applicant provides the following:

<u>*COL Item*</u>

- EF3 COL 2.0-21-A Flooding Protection Requirements

  To address this COL item, the applicant stated that the safety-related features of the Fermi 3 plant are designed to be above the probable maximum flood elevation and thus no flooding protection is required.

2.4.10.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the flooding protection requirements, and the associated acceptance criteria, are in Section 2.4.10 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), sets forth the criteria to determine the citing factors for plant design bases with respect to seismically induced floods and water waves at the site.

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The following related acceptance criteria are summarized from SRP Subsection 2.4.10:

- Safety-related Facilities Exposed to Flooding: To meet the requirements of 10 CFR Part 100, identification of all SSC exposed to flooding is needed.

- Type of Flood Protection: To meet the requirements of 10 CFR Part 100, an evaluation of the applicant's proposed flood protection measures is needed.

- Emergency Procedures: To meet the requirements of 10 CFR Part 100, a listing of proposed emergency procedures is needed.

- Consideration of Other Site-Related Evaluation Criteria: To meet the requirements of 10 CFR Part 100, an assessment regarding the potential effects of site-related proximity, seismic, and non-seismic information on the postulated flooding protection is needed.

In addition, the hydrologic characteristics should be consistent with appropriate sections from: RGs 1.29, 1.59, as supplemented by best current practices, and RG 1.102.

2.4.10.4 *Technical Evaluation*

The staff reviewed the information in Section 2.4.10 of the Fermi 3 COL FSAR, Revision 7, as follows:

COL Item

- EF3 COL 2.0-21-A Flooding Protection Requirements

  To address this COL item, the applicant stated that the safety-related features of the Fermi 3 plant are designed to be above the probable maximum flood elevation and thus no flooding protection is required.

The NRC staff reviewed Subsection 2.4.10 of the Fermi 3 COL FSAR. The elevation of the design plant grade for Unit 3 is 589.3 ft NAVD 88. The NRC staff confirms that this elevation is 3.9 ft above the maximum flood level at the site determined by Alternative III, which is the worst scenario among Alternatives I, II, and III specified by the ANSI/ANS-2.8-1992 guidelines. The Alternative III includes 25-year flood in Swan Creek, probable maximum surge and seiche in Lake Erie, and 100-year elevation of Lake Erie. The staff verified analysis of wave actions caused by the probable maximum storm surge developed on the 100-year lake level and finds that the highest levels of wave breaking and run-up are below the design plant grade.

2.4.10.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.4.10.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.10 of NUREG–0800, and other NRC RGs. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed COL Item EF3 2.0-21-A as it relates to flooding protection requirements.

As set forth above, the applicant has presented and substantiated information relative to the flood protection measures important to the design and siting of this plant. The staff has reviewed the available information provided and for the reasons given above, concludes that the identification and consideration of the flood protection measures is acceptable and meets the requirements of 10 CFR 52.79(a)(1)(iii), 100.20(c), and 100.23(d), with respect to determining the acceptability of the site.

2.4.11 Low Water Considerations

2.4.11.1 *Introduction*

The low water considerations address natural events that may reduce or limit the available safety-related cooling water supply. The applicant ensures that an adequate water supply will exist to shut down the plant under conditions requiring safety-related cooling. The specific areas of review are as follows: (1) worst drought considered reasonably possible in the region; (2) effects of low water surface elevations caused by various hydrometeorological events and a potential blockage of intakes by sediment, debris, littoral drift, and ice because they can affect the safety-related water supply; (3) effects on the intake structure and pump design bases in relation to the events described in FSAR Sections 2.4.7, 2.4.8, 2.4.9, and 2.4.11, which consider the range of water supply required by the plant (including minimum operating and shutdown flows during anticipated operational occurrences and emergency conditions) compared with availability (considering the capability of the UHS to provide adequate cooling water under conditions requiring safety-related cooling); (4) use limitations imposed or under discussion by Federal, State, or local agencies authorizing the use of the water; (5) potential effects of seismic and non-seismic information on the postulated worst-case low water scenario for the proposed plant site; and (6) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.4.11.2 *Summary of Application*

Subsection 2.4.11 of the Fermi 3 COL FSAR, Revision 7, addresses the impacts of low water on water supply. In addition, in FSAR Section 2.4.11, the applicant provides the following:

COL Item

- EF3 COL 2.0-22-A Low Water Considerations

  To address this COL item, the applicant described that the no external water sources are relied upon for operation of the UHS, therefore low water levels in Lake Erie and Swan Creek are not critical to the operation safety related features of Fermi 3.

2.4.11.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for low water considerations, and the associated acceptance criteria, are in Section 2.4.11 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), sets forth the criteria to determine the citing factors for plant design bases with respect to seismically induced floods and water waves at the site.

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The following related acceptance criteria are summarized from SRP Section 2.4.11:

- Low Water from Drought: To meet the requirements of 10 CFR Part 100, a complete history of low water conditions at and in the vicinity of the site is needed.

- Low Water from Other Phenomena: To meet the requirements of 10 CFR Part 100, a complete history of low water conditions, caused by phenomena other than a drought, at and in the vicinity of the site is needed.

- Effect of Low Water on Safety-Related Water Supply: To meet the requirements of 10 CFR Part 100, a thorough description of all safety-related water supply requirements and the effects of the most severe low water event reasonably possible at or in the vicinity of the site is needed.

- Water Use Limits: To meet the requirements of 10 CFR Part 100, a thorough description of water use and discharge limitations (both physical and legal), already in effect or under discussion by responsible Federal, regional, State, or local authorities, that may affect water supply at the plant that have been considered and are substantiated by reference to reports of the appropriate agencies is needed.

- Consideration of Other Site-Related Evaluation Criteria: To meet the requirements of 10 CFR Part 100, the applicant should provide an assessment of the potential effects of site-related proximity, seismic, and non-seismic information on the postulated worst-case low-flow scenario for the proposed plant site.

In addition, the hydrologic characteristics should be consistent with appropriate sections from: RGs 1.27 and 1.29.

2.4.11.4 *Technical Evaluation*

The staff reviewed the information in Section 2.4.11 of the Fermi 3 COL FSAR, Revision 7, as follows:

<u>*COL Item*</u>

- EF3 COL 2.0-22-A Low Water Considerations

  To address this COL item, the applicant described that the no external water sources are relied upon for operation of the UHS, therefore low water levels in Lake Erie and Swan Creek are not critical to the operation safety related features of Fermi 3.

The NRC staff reviewed Subsection 2.4.11 of the Fermi 3 COL FSAR. The applicant stated that no external water sources are used for safety-related cooling of Fermi 3. Low water elevations in Lake Erie or Swan Creek pose no safety-related risk to Fermi 3.

The applicant stated that Lake Erie provides the make-up cooling water for Fermi 3. The lowest recorded water level at the Fermi gage was 563.9 ft NAVD 88. The invert elevation of the pump suction at the water intake for the Fermi 2 plant is at 553.3 ft NAVD 88, which is 10 feet below the lowest recorded elevation of Lake Erie at the Fermi gage. The applicant then stated that low lake levels would not impact pump suction, due to the depth at which the pump suction occurs.

The NRC staff reviewed the lake level data at the Fermi gage submitted by the applicant in response to RAI 2.4.5-1 dated September 30, 2009 (ADAMS Accession No. ML092790561). The staff confirmed that the lowest water elevation at the Fermi gage was 563.9 ft NAVD 88. The staff therefore finds the applicant has addressed low water considerations at Fermi 3 because low water level elevation will not impact safety-related functions.

The staff's review confirms that the information in the application addresses the relevant information related to this subsection.

2.4.11.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.4.11.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.11 of NUREG–0800, and other NRC RGs. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed COL Item EF3 2.0-22-A as it relates to low water considerations.

As set forth above, the applicant has presented and substantiated information relative to the low water effects important to the design and siting of this plant. The staff has reviewed the available information provided and for the reasons given above, concludes that the identification and consideration of the potential for low water conditions is acceptable and meets the requirements of 10 CFR 52.79(a)(1)(iii), 10 CFR 100.20(c), and 10 CFR 100.23(d), with respect to determining the acceptability of the site.

2.4.12 Groundwater

2.4.12.1 *Introduction*

The groundwater description includes the hydrogeological characteristics of the site, and the evaluation includes the effects of groundwater on plant foundations and the reliability of safety-related water supply and dewatering systems. The specific areas of review are as follows: (1) identification of the aquifers, types of onsite groundwater use, sources of recharge, present withdrawals and known and likely future withdrawals, flow rates, travel time, gradients (and other properties that affect the movement of accidental contaminants in groundwater), groundwater levels beneath the site, seasonal and climatic fluctuations, monitoring and protection requirements, and manmade changes that have the potential to cause long-term changes in local groundwater regime; (2) effects of groundwater levels and other hydrodynamic effects of groundwater on design bases of plant foundations and other SSCs important to safety; (3) reliability of groundwater resources and related systems used to supply safety-related water to the plant; (4) reliability of dewatering systems to maintain groundwater conditions within the plant's design bases; (5) potential effects of seismic and non-seismic information on the postulated worst-case groundwater conditions for the proposed plant site; and (6) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.4.12.2 *Summary of Application*

Subsection 2.4.12 of the Fermi 3 COL FSAR, Revision 7, addresses the groundwater in terms of impacts on structures and water supply. In addition, in FSAR Section 2.4.12, the applicant provides the following:

<u>*COL Item*</u>

- EF3 COL 2.0-23-A Groundwater

  To address this COL item, the applicant described the regional and local ground water aquifers, formations, sources, and sinks. The Fermi site does not use groundwater for any purposes, and Fermi 3 does not require a dewatering system.

The applicant described the present and projected future regional water use, relying on reports and databases of the USGS, the USEPA, and the State of Michigan. The applicant provided discussion and illustrations of water levels and flow directions both regionally (bedrock aquifer) and on site (bedrock and overburden aquifers).

2.4.12.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the groundwater, and the associated acceptance criteria, are in Section 2.4.12 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), sets forth the criteria to determine the citing factors for plant design bases with respect to seismically induced floods and water waves at the site.

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The following related acceptance criteria are summarized from SRP Section 2.4.12:

- Local and Regional Groundwater Characteristics and Use: To meet the requirements of 10 CFR 50.55a, 10 CFR 100.20(c)(3), 10 CFR 100.23(d), and 10 CFR 100.20(c), a complete description of regional and local groundwater aquifers, sources, and sinks, local and regional groundwater use, present and known and likely future withdrawals, regional flow rates, travel time, gradients, and velocities, subsurface properties that affect movement of contaminants in the groundwater, groundwater levels including their seasonal and climatic fluctuations, groundwater monitoring and protection requirements, and any man-made changes with a potential to affect regional groundwater characteristics over a long period of time is needed.

- Effects on Plant Foundations and other Safety-Related Structures, Systems, and Components: To meet the requirements of 10 CFR 50.55a, 100.20(c)(3), 100.23(d), and 100.20(c), a complete description of the effects of groundwater levels and other hydrodynamic effects on the design bases of plant foundations and other SSC important to safety is needed.

- Reliability of Groundwater Resources and Systems Used for Safety-Related Purposes: To meet the requirements of 10 CFR 50.55a, 100.20(c)(3), 100.23(d), and 100.20(c), a complete description of all SSC important to safety that depend on groundwater is needed.

- Reliability of Dewatering Systems: To meet the requirements of 10 CFR 50.55a, 100.20(c)(3), 100.23(d), and 100.20(c), a complete description of the site dewatering system, including its reliability to maintain the groundwater conditions within the groundwater design bases of SSC important to safety is needed.

- Consideration of Other Site-Related Evaluation Criteria: To meet the requirements of 10 CFR 50.55a, 100.20(c)(3), 100.23(d), and 100.20(c), the applicant's assessment of the potential effects of site-related proximity, seismic, and non-seismic information on the postulated worst-case scenario related to groundwater effects for the proposed plant site is needed.

In addition, the hydrologic characteristics should be consistent with appropriate sections from RG 1.27.

2.4.12.4 *Technical Evaluation*

The NRC staff reviewed Section 2.4.12 of the Fermi 3 COL FSAR and participated in site visits. The staff's review confirms that the information contained in the application and incorporated by reference addresses the relevant information related to this subsection.

COL Item

- EF3 COL 2.0-23-A Groundwater

  To address this COL item, the applicant described the regional and local ground water aquifers, formations, sources, and sinks. The Fermi site does not use groundwater for any purposes, and Fermi 3 does not require a dewatering system.

The applicant described the present and projected future regional water use, relying on reports and databases of the USGS, the USEPA, and the State of Michigan. The applicant provided discussion and illustrations of water levels and flow directions both regionally (bedrock aquifer) and on site (bedrock and overburden aquifers).

Description and Onsite Use

Information Submitted by the Applicant

The applicant described the hydrogeologic setting based on USGS reports pertinent to the site location and on their own site subsurface investigation. This study included 28 additional monitoring wells installed in the unconsolidated materials and the bedrock. The unconsolidated materials comprise rock fill, lacustrine deposits of peaty silt and clay, and two clayey glacial till units. The uppermost bedrock is the dolomitic Bass Islands Group aquifer (Bass Islands Dolomite).

Fermi 3 does not use groundwater, as the plant obtains potable water from Frenchtown Township, which has an intake in Lake Erie. Following the construction phase, no permanent dewatering system is needed at Fermi 3.

NRC Staff's Technical Evaluation

The NRC staff reviewed the information provided in the FSAR and has determined it to be complete in terms of description of local and regional hydrogeology and its description of the lack of onsite groundwater use.

Sources

Information Submitted by the Applicant

The applicant described present groundwater use in the region, including quarry dewatering, private wells, community water systems, non-community systems, and a municipal system. The locations of these users are presented. Irrigation is mentioned but no details are included. Groundwater flow directions in the overburden and the Bass Islands Dolomite are illustrated in a series of maps. For the overburden materials, these maps and discussion describe perched groundwater in some southern monitoring wells attributed to the effect of clay fill materials. As the applicant states in Section 2.5.4, the existing fill will be removed and replaced with engineered granular fill with a hydraulic conductivity consistent with that of the existing engineered fill used for the adjacent units.

For the bedrock, the applicant describes a change in flow directions in the Bass Islands Dolomite from pre-development flow to the east (toward Lake Erie) to varied flow directions due to the effects of quarry dewatering in Monroe County. The distribution of hydraulic conductivity values in the overburden and bedrock aquifers was illustrated and qualified in terms of heterogeneities. Hydraulic conductivity measured by slug tests ranged from 9.9E-6 to 5.8E-3 cm/s (0.028 to 16.5 ft/d) for quaternary deposits, 1.3E-5 to 1.6E-5 cm/s (0.036 to 0.046 ft/d) for clay fill, and 0.089 to 0.63 cm/s (251 to 1,776 ft/d) for rock fill. Hydraulic conductivity of the bedrock measured by packer tests ranged from 5.3E-5 to 1.4E-2 (0.15 to 40.07 ft/d).

In a response to RAI 2.4.13-6, dated September 1, 2009 (ADAMS Accession No. ML092470230), the applicant provided information on the porosity of the bedrock based on independent regional reports. MRCSP (2007) described the porosity of the Bass Island Dolomite. Dunning et al. (2004) analyzed groundwater flow in a Midwestern carbonate aquifer with similar porosity, and determined an effective porosity of 1 percent. On the basis of the information sources, and to be conservative in the calculations, the applicant initially selected an effective porosity of 1 percent. However, in a later response to RAI 2.4.13-11 and RAI 2.4.13-12, dated October 19, 2010 (ADAMS Accession No. ML102940218), the applicant provided a summary of a revised determination of site-specific bedrock porosity based on a method relying on hydraulic conductivity and Rock Quality Designation data. The low end of the range of values, 0.1 percent, was selected for the effective porosity value. This value was used in calculations in revised text in the FSAR and in Environmental Report Section 2.3.1.2.3.2.

The Bass Islands Dolomite is part of an important regional bedrock aquifer system in the Midwest. No sole source aquifer systems are located in the region of the Fermi site. The nearest sole source aquifer is located in Catawba Island, Ohio, over 48 km (30 miles) southeast of the Fermi property. At that location, a portion of the Bass Islands Group aquifer is identified as a sole source aquifer.

NRC Staff's Technical Evaluation

The NRC staff reviewed the FSAR material, RAI response information, and regional reports, and finds the material to be acceptable. The revised, lower value for effective porosity increases the calculated groundwater velocity in the bedrock, thereby increasing the conservatism of subsequent analyses.

Subsurface Pathways

Information Submitted by the Applicant

The applicant described groundwater flowpaths in the overburden materials, groundwater – surface water interactions, and the flowpaths in the Bass Islands Dolomite. Regional data from the USGS representing pre-development groundwater conditions and recent conditions impacted by quarry operations were presented, along with site-specific measurements for the overburden and the bedrock aquifer.

The applicant presented estimates of the groundwater velocities under present conditions in both the rock fill overburden and the Bass Islands Dolomite aquifer in the FSAR, with additional information on the assumed starting point for groundwater movement provided in the response to RAI 2.4.12-1, dated September 30, 2009 (ADAMS Accession No. ML092790561). For the bedrock, groundwater velocities were revised on the basis of a decreased effective porosity value, as explained in the response to RAI 2.4.13-11 and RAI 2.4.13-12, dated October 19, 2010 (ADAMS Accession No. ML102940218). The applicant used Darcy's law to determine the average linear velocity of 0.996 m/day (3.27 ft/day) in the overburden based on a hydraulic conductivity of 357 m/day (1,170 ft/day), a gradient of 0.0007, and a porosity of 25 percent. Travel time from the center of the RB to the overflow canal, a distance of 250 m (820 ft), was estimated to be 250 days. For the Bass Islands Dolomite aquifer, the applicant calculated flow rates and travel times based on assumed high and low hydraulic conductivity values along with a gradient of 0.002 and an effective porosity of 0.1 percent. Calculations pertained to the 1,450 m (4,760 ft) distance from the center of the RB to the offsite well west of the site. For the high hydraulic conductivity case of 5.4 m/d (17.6 ft/d), the velocity is 11 m/d (35 ft/d) or a time of travel of 0.37 years. For the low hydraulic conductivity case of 0.034 m/d (0.11 m/d), the velocity is 0.06 m/d (0.2 ft/d) or a time of travel of 65 years.

The applicant also submitted a calculation of the groundwater velocity in the Bass Islands Dolomite aquifer assuming a pre-development condition with groundwater flowing eastward towards Lake Erie. This represents conditions that could occur if high-rate pumping from quarries west of the site were stopped. Using the hydraulic parameters described above, but with a gradient of 0.001, the applicant calculated a maximum groundwater velocity of 5 m/day (17.6 ft/day). Travel time from the center to the RB to the edge of Lake Erie was then calculated to be a minimum of 0.23 years.

NRC Staff's Technical Evaluation

The NRC staff reviewed the available data. The flowpaths in the overburden are complex due to the arrangement of low-permeability muck sediments and glacial tills with high-permeability rock fill. This may result in localized, seasonal, perched groundwater. The dolomitic Bass Islands Group aquifer has localized complexities due to stratigraphic variation and fracturing. Water levels at pairs of shallow and bedrock monitoring wells generally indicate downward flow from the overburden to the Bass Islands Dolomite. Several forms of field observations (water level comparisons between paired shallow and deep wells, heat pulse analyses in selected wells) suggest continued downward flow within the Bass Islands Dolomite and into the underlying Salina Group. Lateral flow in the overburden at the site is generally toward the canals and Lake Erie. Because of large-scale dewatering pumping at quarries west of the site, regional flow in the Bass Islands Dolomite in Monroe County has changed from pre-development eastward flow toward Lake Erie to a more complex flow pattern with locally varying flow directions. Bedrock aquifer flow at the Fermi site has a complex pattern of flow mostly to the south and west.

To clarify the applicant's discussion of pathways for potential radioactive contaminants, the staff issued RAI 2.4.12-1 to obtain information on the assumed release point. The staff reviewed the applicant's response to RAI 2.4.12-1, dated September 30, 2009 (ADAMS Accession No. ML102940218), in which the applicant removed all references to "release" and reframed the discussion to examine groundwater velocity and pathways, without reference to contaminant transport. The staff verified that the equations are appropriate to determine groundwater velocity. The staff verified the gradients used in the applicant's calculation of groundwater velocity by checking the submitted groundwater gradient maps.

Groundwater Monitoring

Information Submitted by the Applicant

The applicant described a network of monitoring wells and piezometers, including 17 overburden wells and 11 bedrock wells installed for Fermi 3 and additional wells from other Fermi projects. Water levels were measured monthly from June 2007 to May 2008. The FSAR presents four quarterly maps for the overburden, and four for the bedrock, to depict seasonal variations in water levels and flow directions.

The applicant has made a commitment (COM 2.4-12-001) in FSAR Subsection 2.4.12.4 stating that the monitoring well network will be evaluated prior to commencement of construction.

> **[START COM 2.4-12-001]** However, prior to the commencement of construction activities, the monitoring well network will be evaluated to determine if any significant data gaps are created by the abandonment of existing wells. As part of the detailed design for Fermi 3, the present groundwater monitoring programs will be evaluated with respect to the addition of Fermi 3 to determine if any modification of the existing programs is required to adequately monitor plant effects on the groundwater. **[END COM 2.4-12-001]**

NRC Staff's Technical Evaluation

The NRC staff reviewed the monitoring well network and has determined that it is generally suitable for water level measurements to assess changes in water levels and flow directions due to offsite (e.g. quarry operations) and onsite (e.g. temporary excavation dewatering) impacts. In the future, it would be generally suitable for groundwater quality monitoring, though it may need to be augmented with additional wells depending on the placement of Fermi 3 facilities, and because certain wells may need to be abandoned because of construction activities. The staff finds the applicant's information acceptable based on the existing spatial distribution of the monitoring network and the monitoring data and information provided.

Design Basis for Subsurface Hydrostatic Loadings

Information Submitted by the Applicant

The applicant described the DCD's requirement of a (maximum) groundwater level to be at least 0.6 m (2 ft) below the Fermi 3 plant grade, which is at an elevation of 179.5 m (588.8 ft) NAVD 88. The historical high groundwater level in any well under non-flood conditions was 175.6 m (576.11 ft) NAVD 88 at MW-7, which is 3.9 m (12.7 ft) below the planned Fermi 3 grade. The applicant further described the PMF elevation of 178.4 m (585.4 ft) NAVD 88, which is relevant to the discussion because high-permeability rock fill may allow onsite groundwater levels to reach the PMF level. This flood elevation is 1.1 m (3.4 ft) below the planned Fermi 3 plant grade. Seismic events are not anticipated to affect groundwater conditions.

NRC Staff's Technical Evaluation

The NRC staff concludes that the identified design bases meet the requirements of 10 CFR 50.55a, 10 CFR 100.20(c)(3), 10 CFR 100.23(d), and 10 CFR 100.20(c), with respect to establishing the design basis for SSCs important to safety. This addresses EF3 COL 2.0-23-A. In conclusion, the applicant has provided sufficient information on water elevation with respect to plant grade to satisfy corresponding requirements of 10 CFR 52.79(a)(1)(iii), 100.20(c), and 100.23(d).

2.4.12.5 *Post Combined License Activities*

The applicant idenfies the following commitment:

- **Commitment (COM 2.4-12-001) –** However, prior to the commencement of construction activities, the monitoring well network will be evaluated to determine if any significant data gaps are created by the abandonment of existing wells. As part of the detailed design for Fermi 3, the present groundwater monitoring programs will be evaluated with respect to the addition of Fermi 3 to determine if any modification of the existing programs is required to adequately monitor plant effects on the groundwater.

2.4.12.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.12 of NUREG–0800, and other NRC RGs. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed COL Item EF3 2.0-23-A as it relates to groundwater.

As set forth above, the applicant has presented and substantiated information relative to the groundwater effects important to the design and siting of this plant. The staff has reviewed the available information provided and, for the reasons given above, concludes that the identification and consideration of the potential effects of groundwater in the vicinity of the site are acceptable and meet the requirements of 10 CFR 50.55, 10 CFR 50.55a, 10 CFR 100.20(c)(3), 10 CFR 100.23(d), and 10 CFR 100.20(c), with respect to determining the acceptability of the site.

2.4.13 Accidental Release of Radioactive Liquid Effluent in Groundwater and Surface Waters

2.4.13.1 *Introduction*

This section considers the potential effects of relatively large accidental releases from systems that handle liquid effluents generated during normal plant operations. Such releases would have relatively low levels of radioactivity, but could be large in volume. Normal and accidental releases are also considered in the applicant's environmental report.

The accidental release of radioactive liquid effluents in ground and surface waters is evaluated based on the hydrogeological characteristics of the site that govern existing uses of groundwater and surface water and their known and likely future uses. The source term from a postulated accidental release is reviewed under SRP Section 11.2 following the guidance in Branch Technical Position (BTP) 11-6, "Postulated Radioactive Releases Due to Liquid-Containing Tank Failures." The source term is determined from a postulated release from a single tank inside the RWB, but outside of the reactor containment structure.

The specific areas of review are (1) alternate conceptual models of the hydrology at the site that reasonably bound hydrogeological conditions at the site inasmuch as these conditions affect the transport of radioactive liquid effluent in the ground and surface water environment; (2) bounding set of plausible surface and subsurface pathways from potential points of an accidental release to determine the critical pathways that may result in the most severe impact on existing uses and known and likely future uses of ground and surface water resources in the vicinity of the site; (3) ability of the groundwater and surface water environments to delay, disperse, dilute, or concentrate accidentally released radioactive liquid effluent during its transport; (4) assessment of scenarios wherein an accidental release of radioactive effluents is combined with potential effects of seismic and non-seismic events (e.g., assessing effects of hydraulic structures located upstream and downstream of the plant in the event of structural or operational failures and the ensuing sudden changes in the regime of flow); and (5) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.4.13.2 *Summary of Application*

Subsection 2.4.13 of the Fermi 3 COL FSAR, Revision 7, addresses the accidental release of radioactive liquid effluents in ground and surface waters. In addition, in Section 2.4.13, the applicant provides the following:

<u>*COL Item*</u>

- EF3 COL 2.0-24-A — Accidental Releases of Liquid Effluents in Ground and Surface Waters

  The applicant described the ability of the ground and surface water environment to delay, disperse, dilute, or concentrate liquid effluents, as related to existing or potential future water users.

2.4.13.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the accidental releases of liquid effluents in ground and surface waters, and the associated acceptance criteria, are in Section 2.4.13 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).
- 10 CFR 100.23(d), sets forth the criteria to determine the citing factors for plant design bases with respect to seismically induced floods and water waves at the site.
- 10 CFR 52.79(a)(1)(iii), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The following related acceptance criteria are summarized from SRP Section 2.4.13:

- Alternate Conceptual Models: Alternate conceptual models of hydrology in the vicinity of the site are reviewed.
- Pathways: The bounding set of plausible surface and subsurface pathways from the points of release are reviewed.
- Characteristics that Affect Transport: Radionuclide transport characteristics of the groundwater environment with respect to existing and known and likely future users should be described.
- Consideration of Other Site-Related Evaluation Criteria: The applicant's assessment of the potential effects of site-proximity hazards, seismic, and non-seismic events on the radioactive concentration from the postulated tank failure related to accidental release of radioactive liquid effluents to ground and surface waters for the proposed plant site is needed.
- Branch Technical Position BTP 11-6 provides guidance in assessing a potential release of radioactive liquids following the postulated failure of a tank and its components, located outside of containment, and impacts of the release of radioactive materials at the nearest potable water supply, located in an unrestricted area, for direct human consumption or indirectly through animals, crops, and food processing.

In addition, the hydrologic characteristics should be consistent with appropriate sections from RG 1.113, "Estimating Aquatic Dispersions of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I."

2.4.13.4 *Technical Evaluation*

The NRC staff reviewed the resolution to the COL specific items related to the accidental release of radioactive liquid effluents in ground and surface waters included under Section 2.4.13 of the EF3 COLA. The staff's review confirmed that the information in the application addresses the relevant information related to this subsection.

<u>COL Item</u>

- EF3 COL 2.0-24-A — Accidental Releases of Liquid Effluents in Ground and Surface Waters

  The applicant described the ability of the ground and surface water environment to delay, disperse, dilute, or concentrate liquid effluents, as related to existing or potential future water users.

Sources and Mitigating Design Features

A liquid radioactive waste tank is assumed to be the source of release to groundwater, as analyzed in the following section. The applicant assessed the scenario of the rupture of an equipment drain collection tank, with the liquid reaching groundwater. Three of these tanks are located below ground level in the RWB, which is designed to seismic requirements as specified in DCD Table 3.2-1. Compartments containing the liquid radwaste tanks are steel lined to a height capable of containing the release of all liquid radwaste. Releases as a result of major cracks in the tanks would result in the release of the liquid radwaste to the compartment and then to the building sump system for containment in other tanks or emergency tanks.

The applicant states that the release scenario is conservative because of the steel liner and seismic design described above, plus it ignores the basemat concrete barrier and assumes failure of the floor drain system.

The only above-grade tank containing radioactivity outside of the containment is the condensate storage tank. The basin surrounding this outdoor tank is sized to contain the total tank capacity, a design intended to prevent uncontrolled runoff in the event of a tank failure and to collect tank overflow. A sump located inside the retention basin has provisions for sampling collected liquids before routing them to the liquid waste management system or the storm sewer per sampling and release requirements.

Because the key potential release is from an underground tank, the analysis focuses on transport in groundwater. Groundwater discharge to Lake Erie is one flowpath that is investigated, but direct release to surface water from a source is not considered.

Groundwater Analysis

Although mitigating design features are included in the Fermi 3 plant design, as described in the previous section, the applicant analyzed the migration, through groundwater, of radioactive contaminants originating from a postulated underground release of radioactive liquid waste. The source of this release is a tank that was selected based on guidance in Branch Technical Position (BTP) 11-6, "Postulated Radioactive Releases Due to Liquid-containing Tank Failures." Although the postulated release is highly unlikely because of the mitigating design features described above, this analysis provides insight into the possible migration of radioactive contaminants that might originate from other, less severe releases.

Because of the mitigating design features provided for the above-grade condensate storage tank, and the fast response to releases that they would allow, the staff considers that only potential releases to groundwater from an underground liquid radwaste tank represents a significant enough risk to call for detailed analysis.

Information Submitted by Applicant

The below-ground equipment drain collection tank selected as the source is located at a floor elevation of approximately 164.6 m (540 ft) NAVD88 (about 15 m (49 ft) below Fermi 3 plant grade) and has a volume of 140 cubic meters (m^3) (37,000 gallons). The applicant noted that the floor elevation of the source tank is approximately 8.2 m (27 ft) below the ambient groundwater level at the location of the source tank. The tank is postulated to release its volume (112 m^3 or 30,000 gallons) instantaneously due to failure of the tank and its liners at the same time as failure (cracking) of the RWB's basemat and/or exterior walls (described in the response to RAI 2.4.13-11 and RAI 2.4.13-12, dated October 19, 2010 (ADAMS Accession No. ML102940218). The combined tank contents and influent groundwater are then used as the source in the applicant's analysis.

Two alternative hydrogeological conceptual models were proposed by the applicant. Both assume conservative, straight-line flowpaths to the nearest receptor. The first is based on currently observed flow directions in the Bass Islands Dolomite aquifer. Flow is assumed to be westward due to continued quarry dewatering operations in Monroe County, and the assumed flowpath is to the nearest private supply well, approximately 1,450 m (4,756 ft) away. The second analysis assumes a future case in which quarry dewatering has ceased, and groundwater flow returns to the pre-development case of flowing eastward toward Lake Erie, approximately 450 m (1,476 ft) away.

In FSAR Revision 0, mitigating design features were cited as justification for not performing a release analysis. The applicant made several subsequent analyses. In FSAR Revision 1, calculations are described for the analysis of contaminant transport involving radioactive decay, but without including dispersion or retardation of the plume through sorption. In this conservative (i.e. promoting transport) scenario, the containment systems are assumed to fail, a maximum groundwater flow velocity is assumed, no adjustments to concentrations are made for dilution in lake water, and continuous ingestion for a year is assumed. The resulting calculated concentrations at the receptors of several radionuclides (hydrogen-3 or tritium [H-3], manganese-54 [Mn-54], iron-55 (Fe-55), cobalt-60 [Co-60], zinc-65 [Zn-65], strontium-90 [Sr-90], yittrium-90 [Y-90], ruthenium-106 [Ru-106], cesium-134 [Cs-134], Cs-137, and cerium-144 [Ce-144]) exceeded the ECLs specified in 10 CFR Part 20, Appendix B, Table 2, Column 2. The highest exceedance was Co-60, which exceeded the ECL by a factor of 4,170. The sum of fractions (maximum calculated values relative to the 10 CFR limits) is used as a point of comparison. In this case, the sum of fractions far exceeded the limit of unity. The FSAR Revision 1 discussion concludes by citing the mitigation measures in the design features.

In RAI 2.4.13-6, the staff requested an analysis of groundwater contaminant transport that used the most conservative of plausible conceptual models of the conditions that govern transport of radioactive contaminants from the source to potential receptors. The applicant's second response to RAI 2.4.13-6, dated February 16, 2009 (ADAMS Accession No. ML090610219) was based on modeling conducted using RESRAD-OFFSITE (Yu et al. 2007) to determine concentrations at the receptor locations. This analysis relied on the same conservative assumptions as the prior analysis (maximum groundwater flow velocity), and included the effects of dispersion and retardation. For the sorption component, the analysis used the minimum distribution coefficient (K_d) value from analyses newly performed on Bass Islands Dolomite rock samples (detailed in the response to EIS RAI HY2.3.1-16, Attachment 6 to NRC3-10-0004, DTE response letter dated January 29, 2010). In this case, the ECLs for all radionuclides were below ECLs and satisfied the sum of fractions at both the well and the lake. However, the applicant's RESRAD-OFFSITE input files provided along with the RAI show some inconsistencies between the stated assumptions and their implementation in RESRAD-OFFSITE.

To meet the requirements of 10 CFR 100.20(c) and 10 CFR 52.79(a)(1)(iii), and to support the staff's review of the application and the inconsistencies identified above, the staff requested in RAI 2.4.13-9 additional information related to the RESRAD-OFFSITE simulations as follows:

1. The RESRAD-OFFSITE simulation as performed by the applicant assumes that the contaminants are present initially (i.e. immediately after the release) in a volume of contaminated soil 56 m^2 by 2 m deep. The rates at which contaminants leach from the soil are not explicitly specified in the model input, so that the model uses the supplied K_d values to calculate leaching rates. For radionuclides with large K_d values (e.g. Co-60), this means that very little of the contamination would be leached from the soil and enter the groundwater). Staff requested that the applicant perform RESRAD-OFFSITE simulations in which the contaminants enter the groundwater quickly.

2. The staff requested that the applicant provide additional justification for the well pumping rate. The value of about 5,000 m^3/yr (1,300,000 gal/yr) in the application was based on an agricultural scenario. Staff requested using a more reasonable pumping rate from a residential well.

3. Staff requested that a "risk-informed" section is added that discusses the uncertainty in the estimates of radionuclide concentrations at the receptor points and include sensitivity and/or uncertainty analyses.

The applicant's response to RAI 2.4.13-9, dated January 29, 2010 (ADAMS Accession No. ML100330612) addresses the three issues above. The response to the second issue is acceptable because the applicant; evaluated a more conservative pumping rate and revised the RESRAD-OFFSITE simulation consistent with a residential well. The response to the third issue is also acceptable because a series of analyses investigated variation in key input parameters.

For the first issue, the RAI response described the conceptual model:

- 112 cubic meters of liquid from the equipment drain collection tank escapes to the aquifer due to a combined failure of the tank and the basement floor and/or walls, and

- The 112 cubic meters of liquid is assumed to enter the aquifer instantly, and is modeled "as a volume of contaminated soil 56 square meters by 2 meters deep" (so, a contaminated aquifer volume of 112 cubic meters).

However, the implementation in RESRAD-OFFSITE was inconsistent with the conceptual model:

- The applicant's description ignored the relationship between void volume and solid volume in the setup of the RESRAD source. Porosity needed to be accounted for; an aquifer volume much larger than 112 cubic meters would comprise the source volume.

- The description mentioned the leaching of contaminants from the contaminated zone to the aquifer by assigning a high leach rate value in RESRAD-OFFSITE. This implied that the contaminated soil is in the unsaturated zone, which is not the case for the described failure scenario. The scenario is the instant release of contaminated water into a pristine aquifer, rather than leaching with an initial release rate set to the equilibrium desorption release rate. Contaminant transport analysis would include the dynamics of sorption/desorption, starting with an initial sorbed mass of zero.

Updated text was presented in FSAR Revision 2 (Detroit Edison 2010b), including a summary of the RESRAD-OFFSITE modeling effort. The calculations included the use of minimum K_d values, and the results had sum of fractions below unity for the bedrock pathways to both the well and the lake.

Because of the inconsistency between the conceptual model described and the implementation of that scenario in an appropriate code, additional information was requested in RAI 2.4.13-10. In the response, the applicant adequately modified the source volume to account for porosity. The applicant also provided details on the leach rate. A very high leach rate of 525,600/yr was assigned to the source area in an attempt to mimic a catastrophic release to the aquifer. The analysis included not only the transport to the lake and the well via the Bass Islands aquifer, but also via the rock fill. For the rock fill, minimum measured K_d values were assigned, while for the dolomite, K_d values of zero were used. Of these four scenarios, low concentrations (satisfying the sum of fractions) were calculated for the rock fill to Lake Erie scenario, while the other scenarios had zero concentrations at the receptors. The RESRAD-OFFSITE input files were provided for review. Inspection of the OFFSITE output file SUMMARY.REP indicated that the code found the assigned leach rate unattainable and substituted a significantly smaller leach rate (1.8/yr). The analysis was therefore adding contaminants to the aquifer at a much lesser rate than presumed. In addition, the selection of the Do Not Disperse Vertically option resulted in clean infiltration along the flowpath, unless particular input parameter values are selected. Clean infiltration in this case caused the plume to be driven downward and not intercepted by the receptor, given the Depth of Aquifer Contributing input. In addition, the RESRAD-OFFSITE analysis erroneously used the values of the DCD's tank concentrations (activity per volume of liquid) as input values for OFFSITE's source (activity per gram of soil).

The status of the groundwater scenario analysis relying on RESRAD-OFFSITE led to two additional RAIs. The first (RAI 2.4.13-11) noted the discrepancies concerning the leach rates and the vertical dispersion aspects of the model (as described above), and called for a revised analysis. The second (RAI 2.4.13-12) described the inability of RESRAD-OFFSITE to model an instantaneous release, and called for revised input parameter values or selection of an alternative method (which had also been suggested in RAI 2.4.13-10). The applicant provided a combined response to RAI 2.4.13-11 and RAI 2.4.13-12, dated October 19, 2010 (ADAMS Accession No. ML102940218). The response included a summary of past analysis approaches, an explanation of a revised approach, and proposed text changes for the FSAR. In the revised approach, the applicant used the following process:

- All contents of the Equipment Drain Collection Tank are released into its underground room, and groundwater floods the room, thereby initially diluting the tank liquid by a factor of at least three.

- Effective porosity is now set to the low end of a range of measurements determined by a method relying on site-specific hydraulic conductivity and Rock Quality Designation measurements. Its value is now decreased from 1 percent to 0.1 percent.

- Fate and transport calculations (without the use of RESRAD-OFFSITE) then followed a conservative approach.

- An initial analysis relied only on advective transport and radioactive decay. Radionuclides with an activity concentration above 1 percent of their ECL were evaluated in the next step.

- A second analysis added the effect of sorption, conservatively using the minimum site-specific distribution coefficients. Radionuclides with an activity concentration above 1 percent of their ECL were evaluated in the next step.

- For the pathway to Lake Erie, the third analysis considered the calculated groundwater discharge relative to the tremendous dilution capacity of an appropriate local volume of Lake Erie (on the order of a factor of 3,500). A conservative factor of 10 was used in the analysis. All radionuclides were below ECLs, and the sum of fractions was less than 1.

- For the pathway to a well, the third analysis added the effect of longitudinal dispersion. Results for radionuclide activity concentrations were below ECLs, but the sum of fractions was greater than 1.

- The final step for the pathway to the well added the effect of transverse dispersion. In this case, the sum of fractions was less than 1.

NRC Staff's Technical Evaluation

The NRC staff reviewed the available information in FSAR revisions and RAI responses submitted by the applicant, as summarized above. The ultimate approach and results summarized in the combined response to RAI 2.4.13-11 and RAI 2.4.13-12 (ML102940218, dated October 19, 2010) was found acceptable. The analysis clearly described the highly conservative (i.e. promoting transport and high activity concentrations) aspects of the approach. These included

- Instantaneous release of the complete contents of the tank with the highest radionuclide activity concentrations (generally by several orders of magnitude) according to the DCD (Rev. 06, Table 12.2-13a),

- Rapid groundwater flow, achieved in part by assuming the lowest effective porosity value obtained through a determination on field samples,

- Limited sorption taking place, achieved by assuming the lowest distribution coefficients from laboratory work on site samples,

- Appropriate careful consideration of realistic transport processes and additional modeling complexity for key radionuclides,

- Only minor dilution of groundwater discharging to Lake Erie, and

- A constant concentration source term over the operating life of 60 years for the case of transport to well.

The 60-year constant concentration source used in the well scenario is an unnecessary conservatism, but does not affect the final conclusions.

The NRC staff confirmed the calculated results to the receptors by performing independent analyses relying on conservative assumptions. The process, assumptions, and overall results resembled those ultimately provided by the applicant in the combined response to RAI 2.4.13-11 and RAI 2.4.13-12, dated October 19, 2010 (ADAMS Accession No. ML102940218).

As described above, the dilution of groundwater discharging to Lake Erie is extreme, and the applicant's assumed dilution factor of 10 is a highly conservative low value, yet resulted in sufficiently low radionuclide activity concentrations in lake water. The analysis for the well also produced sufficiently low concentrations once the effect of two-dimensional dispersion was included. Concentrations at the well, however, would be further reduced in actuality because the cone of depression caused by pumping would draw clean groundwater into the well from cross-gradient portions of the Bass Islands aquifer.

The results of the applicant's conservative analyses, and the staff's confirmatory analysis, provide confidence that a catastrophic release of the tank's contents to the Bass Islands aquifer would not result in an exceedance of ECLs or the sum of fractions at the two possible receptors. Therefore, the staff concludes the applicant's response is acceptable.

2.4.13.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.4.13.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.13 of NUREG–0800, and other NRC RGs. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed EF3 COL Item 2.0-24-A as it relates to accidental releases of liquid effluents in ground and surface waters.

The review confirms that the applicant has satisfactorily addressed the potential for radionuclides to impact receptors under two possible conceptual models for the groundwater flow system. The release scenario considered was a worst-case release to groundwater resulting from a catastrophic release of the contents of an underground equipment drain collection tank, the tank which has the highest anticipated radionuclide activities. A series of conservative (i.e. promoting transport and high concentrations) assumptions were used in an approach to determine the activity concentrations of radionuclides at receptors relative to the effluent concentration limits (ECLs) specified in 10 CFR Part 20, Appendix B, Table 2, Column 2. As described above, the calculated activity concentrations satisfied the ECLs and sum-of-fractions criteria at each receptor. The staff concludes that the analysis and its results provide sufficient information to satisfy the requirements of 10 CFR 100.20(c), 10 CFR 100.23(d), and 10 CFR 52.79(a)(1)(iii).

Mitigating design features, while not considered in the analysis, would further reduce the potential impact to groundwater or surface water for the worst-case scenario described above as well as for other release scenarios.

2.4.14 Technical Specification and Emergency Operation Requirements

2.4.14.1 *Introduction*

The technical specifications and emergency operation requirements described here implement protection against floods for safety-related facilities to ensure that an adequate supply of water for shutdown and cool-down purposes is available. The specific areas of review are (1) controlling hydrological events, as determined in previous hydrology sections of the SAR, to identify bases for emergency actions required during these events; (2) the amount of time available to initiate and complete emergency procedures before the onset of conditions while controlling hydrological events that may prevent such action; (3) reviewing technical specifications related to all emergency procedures required to ensure adequate plant safety from controlling hydrological events by the organization responsible for the review of issues related to technical specifications; (4) potential effects of seismic and non-seismic information on the postulated technical specifications and emergency operations for the proposed plant site; and (5) any additional information requirements prescribed in the “Contents of Application” sections of the applicable subparts to 10 CFR Part 52.

2.4.14.2 *Summary of Application*

Subsection 2.4.14 of the Fermi 3 COL FSAR, Revision 7, addresses technical specifications and emergency operation requirements. In addition, in FSAR Section 2.4.14, the applicant provides the following:

COL Item

- EF3 COL 2.0-25-A Technical Specifications and Emergency Operation Requirements

  To address this COL item, the applicant identified that the elevation of exterior access openings, which are above the PMF and local PMP flood levels, and the design of exterior penetrations below design flood and groundwater levels, which are appropriately sealed, result in a design and site combination that do not necessitate emergency procedures or meet the criteria for Technical Specification LCOs to ensure safety-related functions at the plant.

2.4.14.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the technical specifications and emergency operation requirements, and the associated acceptance criteria, are in Section 2.4.14 of NUREG–0800. The applicable regulatory are as follows:

1. 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirements to consider physical site characteristics in site evaluations are specified in 10 CFR 100.20(c).

2. 10 CFR 100.23(d), sets forth the criteria to determine the citing factors for plant design bases with respect to seismically induced floods and water waves at the site.

3. 10 CFR 52.79(a)(1)(iii), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding areas and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

4. 10 CFR 50.36, as it relates to identifying limiting conditions on technical specifications for safe operation of the plant.

The following related acceptance criteria are summarized from SRP Section 2.4.14:

1. Bases for Emergency Actions: To meet the requirements of 10 CFR 50.36 and 10 CFR Part 100, an assessment of the hydrological bases for emergency actions is needed.

2. Available Response Time: To meet the requirements of 10 CFR 50.36 and 10 CFR Part 100, estimates of available response times to initiate and complete emergency procedures are needed.

3. Technical Specifications: To meet the requirements of 10 CFR 50.36 and 10 CFR Part 100, the applicant's proposed technical specifications related to emergency procedures are reviewed.

4. Consideration of Other Site-Related Evaluation Criteria: To meet the requirements of 10 CFR 50.36 and 10 CFR Part 100, the applicant's assessment of the potential effects of site-related proximity, seismic, and non-seismic information on the postulated technical specifications and emergency operations is needed.

In addition, the hydrologic characteristics should be consistent with appropriate sections from: RGs 1.29, 1.59, and 1.102.

2.4.14.4 *Technical Evaluation*

The NRC staff reviewed Subsection 2.4.14 of the Fermi 3 COL FSAR and checked the referenced DCD to ensure that the combination of DCD site parameters and the information in the applicant's COL represent the complete scope of information relating to this review topic.

COL Item

- EF3 COL 2.0-25-A — Technical Specifications and Emergency Operation Requirements

The NRC staff's evaluation of COL Item EF3 COL 2.0-25-A is presented below.

Information Submitted by the Applicant

The applicant stated that the safety-related features at Fermi 3 are all located at above the maximum flooding level estimated for the site and the maximum groundwater elevation. The applicant also refers to Section 3.4 of the FSAR for a discussion on flood protection for safety-related structures, systems and components (SSCs). The applicant states that technical specifications and emergency procedures are not necessary due to the design of the plant.

NRC Staff's Technical Evaluation

The NRC staff reviewed the information contained in COL FSAR Subsection 2.4.14 and reviewed the information in Section 3.4 of the FSAR referred to by the applicant. Section 3.4 of the FSAR incorporates by reference Section 3.4 of the ESBWR DCD. The DCD Section 3.4.1 states that "safety-related systems and components of the ESBWR standard plant are located in the seismic Category I structures that provide protection against external flood and groundwater damage." The staff reviewed the details in Subsection 3.4.1 of the DCD to verify that the plant design is sufficient to prevent the need for technical specifications and emergency procedures. The DCD specifies that the elevation of the safety-related features must be at least 1 ft above the maximum design flood elevation. The Fermi 3 safety-related features are designed to be at an elevation of 589.3 ft NAVD 88. The staff determined the maximum flood elevation to be 585.4 ft, 3.9 ft lower than the elevation of the safety-related features of Fermi 3. If the predicted maximum height of wind wave at the berm is added on to the flood elevation in Alternative III, the maximum elevation is 587.63 ft NAVD 88, which is 1.67 ft below the elevation of the safety-related features.

The staff has reviewed the available information provided and for the reasons given above, concludes that the identification and consideration of the technical specifications and emergency operations is acceptable and meets the requirements of 10 CFR 50.36 and 10 CFR 100.20(c) with respect to determining the acceptability of the site.

2.4.14.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.4.14.6 *Conclusion*

The NRC staff has reviewed the application and confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. The staff confirmed that RTNSS structures that meet Criterion B (i.e., for actions required beyond 72 hours and seismic events) are required to perform reliably in the event of hazards such as external flooding considering the PMF, PMP, seiche and other pertinent hydrologic factors.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in Section 2.4.14 of NUREG–0800, and other NRC RGs. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff has determined that the applicant has adequately addressed EF3 COL Item 2.0-25-A as it relates to technical specifications and emergency operation requirements.

As set forth above, the applicant has presented and substantiated information relative to the technical specifications and emergency operations important to the design and siting of this plant. The staff has reviewed the available information provided and for the reasons given above, concludes that the identification and consideration of the technical specifications and emergency operations is acceptable and meets the requirements of 10 CFR 50.36, 10 CFR 52.79(a)(1)(iii), 10 CFR 100.20(c), and 10 CFR 100.23(d) with respect to determining the acceptability of the site.

2.5 Geology, Seismology, and Geotechnical Engineering

This FSAR section describes geologic, seismic, and geotechnical engineering properties of the proposed Fermi 3 site. Following the NRC guidance in RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," and in RG 1.208, "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion," the applicant defined the following four zones around the Fermi 3 site and conducted investigations within those zones:

- Site region – Area within 320 km (200 mi) of the site location.
- Site vicinity – Area within 40 km (25 mi) of the site location.
- Site area – Area within 8 km (5 mi) of the site location.
- Site location – Area within 1 km (0.6 mi) of the proposed Fermi 3 location.

Since the proposed Fermi 3 is located adjacent to the existing Fermi 2, the applicant used the previous site investigations for the Fermi 2 facility as its starting point for the characterization of the geologic, seismic, and geotechnical engineering properties of the site. As such, the material in Fermi 3 FSAR Section 2.5 focuses on any information published since the Fermi 2 FSAR, which was issued in 1985. The material in COL FSAR Section 2.5 also focuses on any recent geologic, seismic, geophysical, and geotechnical investigation performed for the COL site.

The applicant used seismic source models previously published by the Electric Power Research Institute (EPRI 1986, 1989) as the starting point for characterizing potential regional seismic sources and the resulting vibratory ground motion. The applicant then updated these EPRI seismic source and ground motion models in light of more recent data and evolving knowledge pertaining to seismic hazard evaluations in the central and eastern United States (CEUS). The applicant then employed the performance-based approach described in RG 1.208 to develop the ground motion response spectrum (GMRS) for the site.

NRC staff performed an extensive review of Fermi 3 COL FSAR Revision 5, Section 2.5, interacted with the applicant on many occasions through public meetings; and requested additional information to substantiate and support the applicant's conclusions in the FSAR. Because of the Fukushima Dai-ichi nuclear power plant accident after the Great Tohoku earthquake and the subsequent tsunami in Japan in 2011, the NRC issued an information request letter dated March 12, 2012, requesting all operating nuclear power plants in the U.S. to re-evaluate seismic hazards using the most recent information and methodologies available. The NRC Near-Term Task Force (NTTF) issued a series of recommendations for improving nuclear power plant safety in the U.S. following the Fukushima Dai-ichi accident. The information request letter stated that nuclear power plant sites in the CEUS will be able to use the newly published seismic source model in NUREG–2115, "Central and Eastern United States Seismic Source Characterization for Nuclear Facilities," to characterize seismic hazards related to their plants. Following the issuance of this information request letter to the operating nuclear power plants, the staff also requested all COL and Early Site Permit (ESP) applicants to address this issue.

The NRC issued RAI 01.05-1 requesting the applicant to provide additional information to address Recommendation 2.1 of the Fukushima NTTF in SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami," as it pertains to the seismic hazard evaluation. The NRC staff asked the COL applicant to reassess the calculated seismic hazard for the Fermi 3 site using the newly published NUREG-2115 seismic source model and to modify its GMRS and the foundation input response spectra (FIRS) as needed. The applicant's initial response to RAI 01.05-1 dated August 24, 2012 (ADAMS Accession No. ML12243A455), replaced the EPRI (1986, 1989) base seismic source model used for the seismic hazard analysis with the newly published NUREG–2115 seismic source model. In addition, the applicant committed to address the impact of the RAI 01.05-1 response in conjunction with the site-specific soil-structure interaction (SSI) analyses. On January 25, 2013, the applicant provided a response to RAI 01.05-1 (ADAMS Accession No. ML13032A378) that included a revised FSAR Section 2.5. Particularly significant are the calculations in revised FSAR Section 2.5.2, "Vibratory Ground Motion." The applicant then submitted FSAR Revision 5 on February 14, 2013. This change in the base seismic source model made many of the staff's previous RAIs irrelevant. The staff's technical evaluations only discuss those RAIs that remain applicable in the context of the applicant's changes, in addition to new RAIs related to this most recent version of the FSAR.

2.5.1 Basic Geologic and Seismic Information

2.5.1.1 *Introduction*

This FSAR section describes geologic, seismic, and geotechnical information. This technical information incorporates results from surface and subsurface investigations performed in increasing levels of detail for distances closer to the site. These investigations comprised four distinct circumscribed areas corresponding to the previously defined site region, site vicinity, site area, and site location. The primary purposes for conducting these investigations were (1) to determine the geologic and seismic suitability of the site; (2) to provide the bases for the plant design; and (3) to determine whether there is significant new tectonic or ground motion information that could impact the seismic design bases as determined by a probabilistic seismic hazard analysis (PSHA). The basic geologic and seismic information in FSAR Section 2.5.1 addresses the regional and site geology and includes a description of the tectonic setting and the potential for tectonic and non-tectonic deformation, as well as conditions caused by human activities.

2.5.1.2 *Summary of Application*

Section 2.5.1 of the Fermi 3 COL FSAR describes site-specific geologic, seismic, and geotechnical information. In addition, in FSAR Section 2.5.1, the applicant provides the following:

<u>*COL Item*</u>

- EF3 COL 2.0-26-A Basic Geologic and Seismic Information

In FSAR Section 2.5.1, the applicant provided information on the geologic and seismic setting for the Fermi 3 site and region. This information included four levels of investigations, each completed with additional scientific data encompassing 320 km (200 mi), 40 km (25 mi), 8 km (5 mi), and 1 km (0.6 mi). FSAR Subsection 2.5.1.1 describes the regional geologic and

tectonic setting across a radius of 320 km (200 mi) from the site; and FSAR Subsection 2.5.1.2 describes the site geology and tectonic setting across a radius of 40 km (25 mi), 8 km (5 mi), and 1 km (0.6 mi) from the site.

FSAR Section 2.5.1 is based on information derived from the applicant's review of earlier reports prepared for the Fermi 2 power plant and published geologic literature, in addition to new boreholes drilled for the proposed Fermi 3. The applicant also used recently published literature, reports, and maps to supplement and update existing geologic and seismic information.

Based on these Fermi 3 investigations, the applicant concluded in FSAR Section 2.5.1 that no geologic conditions exist at the site that would negatively impact the construction or operation of safety-related buildings or structures. The applicant further concluded that any hazards at the Fermi 3 site will be mitigated during construction or designed for appropriately. A summary of the geologic and seismic information provided by the applicant in Fermi 3 COL FSAR Section 2.5.1 is presented below.

2.5.1.2.1 Regional Geology

FSAR Subsection 2.5.1.1 discusses the physiography, geomorphology, geologic history, stratigraphy, and tectonic setting within a 320-km (200-mi) radius of the Fermi 3 site. The following subsections summarize the information provided by the applicant in FSAR Subsection 2.5.1.1.

<u>*Physiography and Geomorphology*</u>

FSAR Subsection 2.5.1.1.1 includes the applicant's descriptions of the regional physiography and geomorphology surrounding the Fermi 3 site. The applicant stated that the site is located in the Eastern Lake section of the Central Lowlands physiographic province. The applicant explained that the Fermi 3 site region comprises portions of two other physiographic provinces: the Appalachian Plateaus and St. Lawrence Lowlands. Figure 2.5.1-1 in this SER shows the location of the Fermi site in relation to the physiographic provinces.

The applicant stated that the Central Lowlands physiographic province is subdivided into eight sections. The Eastern Lake and Till Plains sections are located in the site region (a radius of 320 km [200 mi]). The Fermi 3 site is located in the Eastern Lake section, which is characterized by glacial landforms and beach and lacustrine (produced or formed in a lake) deposits. The applicant stated that the Fermi 3 site is located in a lake plain formed during the Lake Erie water level fluctuation, and Lake Erie occupies three basins that increase in depth from west to east. The applicant indicated that the western Erie basin extends to depths of 10 to 11 m (33 to 36 ft), the central basin to depths of 24 to 25 m (79 to 82 ft), and the eastern basin to depths exceeding 40 m (131 ft). The Till Plains section is dominated by glacial landforms that include end moraines, ground moraines, recessional moraines, outwash plains, and some lacustrine deposits.

The physiographic province of the Appalachian Plateaus is subdivided into seven sections. Two of those sections, the Kanawha and Southern New York, are within the 320-km (200-mi) radius of the Fermi site. The Kanawha section is described as a dissected plateau containing Pleistocene (2.6 million years ago [Ma] to 10,000 years ago) lacustrine deposits within the valleys and broadly folded Paleozoic (359 to 251 Ma) sediments. The Southern New York section is dominated by glacial landforms and lacustrine deposits underlain by broadly folded Paleozoic sediments. The applicant described the St. Lawrence physiographic province as low plains with distributed glacial landforms along with beach and lacustrine landforms.

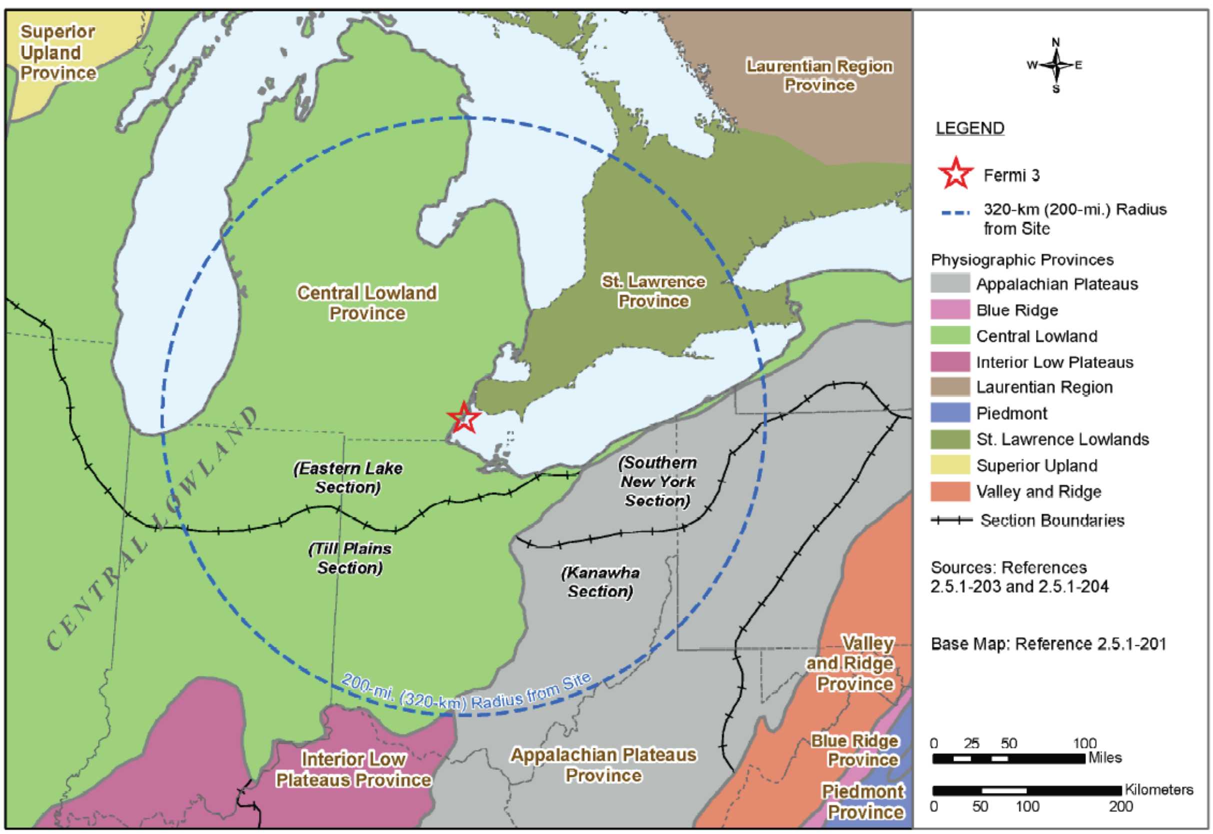


Figure 2.5.1-1 Fermi 3 Site Regional Physiographic Map
(Reproduced from Fermi 3 COL FSAR Figure 2.5.1-202)

Regional Geologic History

In FSAR Subsection 2.5.1.1.2, the applicant described the geologic and tectonic history of the Fermi site region. The applicant stated that the major tectonic events in the site region include several transgressions and regressions of epeiric (inland) seas, widespread subsidence in the continental basins, extensive uplifting in arches, and minimal activity on preexisting basement faults. The applicant stated that the last major tectonic event in the site region was rifting related to the Midcontinent Rift and Grenville Orogeny about 1.2 to 1.0 billion years ago (Ga).

In FSAR Subsections 2.5.1.1.2.3.2 and 2.5.1.1.2.3.3, the applicant described the Mesozoic (252-66 Ma) and Cenozoic (66 Ma to present) geologic history of the site. The applicant explained that no Mesozoic or early Cenozoic rock record is preserved in the site region except for some Jurassic (201 to 145.5 Ma) sedimentary rocks. According to the applicant, the missing rock record, if it did once exist, is likely due to widespread erosion between the late Paleozoic and middle Cenozoic Eras. The applicant stated that the site region is considered tectonically stable during the Cenozoic Era, except for vertical crustal movement associated with glacial isostatic adjustments.

In FSAR Subsection 2.5.1.1.2.3.4, the applicant provided detailed information on the Quaternary (2.6 Ma to present) geologic history of the site region. The applicant explained that the main geologic event in the site region during the Quaternary period is related to the growth and expansion of the continental Laurentide ice sheet. The applicant correlated major glaciation to stages of the marine oxygen isotope record (referred to as marine isotope stage, or MIS) and explained that the current interglacial period, the Holocene (12,000 years ago to present), is correlated as MIS 1; whereas the most recent glaciation, the Late Wisconsinan, is correlated to MIS 2. The most significant Wisconsinan ice sheet advances occurred between 25,000 and 12,000 years ago. Periods of low to no ice volume are recognized during the approximately 130000 years prior to the late Wisconsinan (MIS 3 to 5). The preceding Illinoian glacial period, which is correlated to MIS 6, culminated approximately 160,000 years ago. Pre-Illinoian glacial events are only referred to by their MIS number, with even numbers identifying periods of higher ice volumes. The applicant stated that surficial sediments in the site region are mostly composed of Illinoian (MIS 6) and Late Wisconsinan age (MIS 2) glacial sediments, which is further evidence that mostly ice-free conditions existed between MIS 2 and MIS 6.

Regional Stratigraphy

In FSAR Subsection 2.5.1.1.3, the applicant discussed the succession of geologic units in the site region. The applicant stated that no rocks older than the Ordovician period (488 to 444 Ma) are exposed at the surface in the site region. The applicant explained that all of the physiographic provinces in the site region enclose comparable sequences of sedimentary rocks and since the Fermi 3 site is located on the Michigan basin side of the Findlay arch, more emphasis will be given to the stratigraphy of this basin.

The applicant stated that deposition of sediments during the Paleozoic and Mesozoic eras was controlled by several transgressions (high sea levels) and regressions (low sea levels) of epeiric seas (seas on the continental shelf or interior) over the North American Craton (part of the Earth's crust that has attained stability). Each major transgression and regression is referred to as a cratonic sequence, and six cratonic sequences are recognized for the North American Craton starting in the Proterozoic period (greater than 541 Ma) to present time. The applicant explained that five of the six cratonic sequences are identified within the Fermi site region. The rocks that the applicant identified during subsurface investigations for the Fermi 3 site are part of the Tippecanoe cratonic sequence and include rocks of the Salina Group overlain by rocks of the Bass Island Group. The Bass Islands Group is composed of dolomitic rocks with some interbedded shales and provides the foundation rock for the proposed Fermi 3 nuclear island. Both the Salina Group and the Bass Islands Group were deposited during the Silurian period (441 to 419 Ma).

In FSAR Subsection 2.5.1.1.3.3, the applicant discussed the Quaternary stratigraphy of the 320 km (200 mi) in the site region. The applicant explained that Pleistocene (2.6 Ma to 10,000 years ago) features in the site region are incising bedrock valleys and their associated valley fills. Glacial sediments as well as tills of Illinoian age lie on bedrock and were deposited by ice that advanced into the eastern portion of the Lake Erie basin. Glacial lake deposits of the early to middle Wisconsinan age pertaining to the Tyrconnell Formation were deposited in a proglacial lake in the Erie basin. The applicant stated that evidence of a long ice-free period is confirmed by significant soil development in the site region following the Illinoian glaciation and prior to the late Wisconsinan glacial period.

Regional Tectonic Setting

In FSAR Subsection 2.5.1.1.4, the applicant described the regional tectonic setting of the Fermi 3 site that is relevant to the characterization of seismic sources used in the development of the Central and Eastern United States Seismic Source Characterization for Nuclear Facilities (CEUS-SSC) project (NUREG–2115) discussed in FSAR Section 2.5.2. Fermi 3 is located within a compressive midplate stress province characterized by a fairly uniform east-northeast compressive stress field, which extends from the midcontinent east toward the Atlantic continental margin and probably into the western Atlantic basin. The applicant explained that glacial isostatic adjustment (GIA) is believed to be the basis of deformation within continental plates and perhaps is a trigger of seismicity in eastern North America and in previously glaciated regions. The applicant stated that these effects on seismicity rates in the site region are not expected to vary significantly in the future due to the GIA. The applicant based this assertion on Mazzotti and Adams (2005) and on modeling of the strain and the resulting changes in seismic stress caused by the GIA in other areas.

Based on historical measurements, Larsen (1985) concluded that the uplift of Lake Erie continues to the present. The applicant noted that the glacial and post-glacial GIA is evident by deformation (tilting and warping of glacial lake strandlines) and the most appropriate geodynamical model that reconstructs related Holocene deformation accounts for the northward migration of a collapsing forebulge for the Great Lakes. The applicant explained that the directional trend in the uplift of Lake Erie does not exactly correlate with the isostatic rebound trend but is less than 64 mm/century (2.52 in/century). The applicant added that recent GIA observations indicate that the hinge line marking the boundary between regions of vertical rebound to the north and subsidence to the south is close to the northern margin of the site region; and the residual velocity field shows subsidence of 1 to 2 mm/yr (0.039 to 0.078 in/yr) along most of the site region with a possible slight uplift near the western end of Lake Erie. The applicant stated that the monitoring of present-day tilting of the Great Lakes region illustrates uplift in the northeast and subsidence in the south, which indicates a pattern of land tilting upward to the northeast that is consistent with GIA. The applicant also stated that according to the data, the Fermi 3 site and the surrounding region are not characterized by strong vertical gradients or anomalies.

Regional Geophysical Data

In FSAR Subsection 2.5.1.1.4.2.1, the applicant discussed the regional gravity and magnetic data in relation to the Fermi 3 site region. Figure 2.5.1-2 in this SER shows various anomalies covering the site region including the mid-Michigan Gravity Anomaly (MGA), the East Continent Gravity High (ECGH), the Anorthosite Complex Anomaly (ACA), the Seneca anomaly, and the Butler anomaly. The applicant stated that some of these anomalies are associated with the midcontinent rift system (MRS) and the east continent rift system (ECRS).

In FSAR Subsection 2.5.1.1.4.2.2, the applicant provided information on seismic profiles of the midcontinent region using data from the Consortium for Continental Reflection Profiling and some of the seismic line data collected by the Great Lakes International Multidisciplinary Program on Crustal Evolution. The seismic line data collected in the Lake Superior area illustrate a segmented rift structure constituted by inverted, normal faulted asymmetric half grabens. Other features defined by the seismic profile lines were the Granite-Rhyolite province, the Grenville Front Tectonic Zone (GFTZ), and the Grenville Province.

Regional Tectonic Structures

In FSAR Subsection 2.5.1.1.4.3, the applicant stated that the Fermi 3 site is located in the continental region of the North American Craton, which is characterized by low seismic activity and low stress. A transition zone lies between the Michigan interior cratonic basin and the central Appalachian foreland within the 320-km (200-mi) radius of the Fermi site. This transition zone contains structural features that were occasionally active through the Paleozoic period. However, no evidence suggests that a reactivation of Mesozoic structures occurred within the site region. Previous reports for Fermi 2 concluded that there were no capable tectonic faults within the Fermi 2 site region. In addition, the applicant indicated that the CEUS-SSC study did not identify any repeated large-magnitude earthquake (RLME) seismic sources within 320 km (200 mi) of the Fermi 3 site. The applicant discussed the following regional tectonic structures by dividing them into three groups: basins and arches, principal faults, and seismic zones.

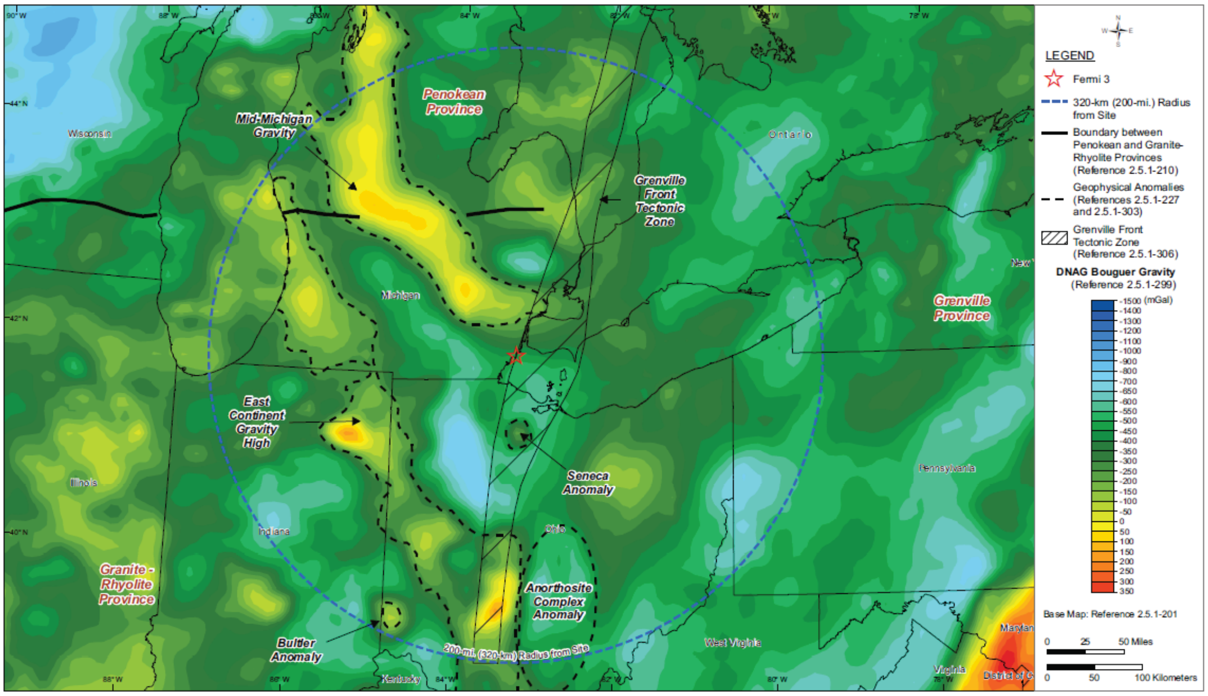


Figure 2.5.1-2 Bouguer Gravity Map of the Fermi 3 Site Region
(Reproduced from Fermi 3 COL FSAR Figure 2.5.1-220)

1. Basins and Arches

In FSAR Subsection 2.5.1.1.4.3.1, the applicant indicated that the most significant basins and arches in the site region are the Michigan basin and the Findlay and Algonquin arches. The applicant stated that the result of a long period of subsidence and deposition combined with effects from distal orogenic events along the margin of the craton resulted in a series of structural features in the basin, which range from closed anticlines to complex horst and grabens. Other structures observed in the basin are differential compaction anticlines and solution collapse features located over covered topographic highs and reefs. The applicant cited Fisher's findings (Fisher 1983) that the main structures in the Michigan basin are the result of vertical tectonics.

The Findlay arch in western Ohio and southeast Michigan and the Algonquin arch in Canada divide the Michigan basin from the Appalachian basin. The applicant explained that the Findlay and Algonquin arches influenced Paleozoic sedimentary deposition into the Middle Devonian.

2. Principal Faults

In FSAR Subsection 2.5.1.1.4.3.2, the applicant described the principal faults and tectonic features in the Fermi 3 site region. The closest faults to the Fermi 3 site area are the Bowling Green (Lucas-Monroe) anticline/fault, the Howell (Howell-Northville) anticline/fault, and the Maumee fault.

a. Bowling Green (Lucas-Monroe) Fault/Monocline

The closest distance of the Bowling Green fault to the site is about 40 km (24 mi). The Bowling Green fault is also known as the Lucas-Monroe monocline or fault and is composed of three segments: central, northern, and southern. The central (Late Cretaceous) segment is called the Bowling Green fault and is an approximately 10-m (33-ft) wide near-vertical zone of heavily sheared rock with secondary faulting. The applicant stated that the central segment of the fault coincides with the GFTZ and the Findlay arch. Citing Onash and Kahle (1991), the applicant stated that recurrent displacement may have occurred on the Bowling Green fault, in response to stress associated with the migration of the Findlay arch during the Acadian or Alleghanian events.

The applicant noted that the southern segment is composed of steeply dipping fault splays in Ohio extending to the southern boundary of Marion County in Michigan, which includes the Outlet and the Marion faults. The Outlet fault zone trends northwest and extends from Wyandot County to Wood County. The applicant stated that based on the sense of folding and the nature of displacement between the Outlet and Bowling Green faults, the Outlet fault is interpreted as a large synthetic shear zone to the Bowling Green fault. The applicant indicated that the vertical displacement on the Outlet fault zone ranges from approximately 6 to 30 m (20 to 100 ft). In addition, the applicant described the Marion fault as one of several small faults recognized on the basis of well data. The applicant indicated that the structural trends of the Marion and other faults are supported by (1) subsurface data on the top of the Trenton limestone, (2) unpublished lineament analyses by the Ohio Geological Survey, (3) an analysis of proprietary seismic data, and (4) anomalies in gravity and magnetic maps.

The northern segment of the fault is also known as the Lucas-Monroe monocline/fault. It consists of steeply dipping to vertical right and left stepping faults that extend from Lenawee and Monroe Counties to Livingstone County, where the segment apparently merges with the Howell anticline.

The applicant stated that a magnitude 3.4 earthquake occurred in 1994 approximately 130 km (90 mi) northwest of the Fermi site. Citing Faust et al. (1997), the applicant stated that the earthquake was on a hypothetical fault associated with the Lucas-Monroe fault or a shallow dipping feature related to the MRS and the Mid-Michigan Gravity High (MMGH). Structure contour maps of Paleozoic units, however, do not sustain the extension hypothesis of the Lucas-Monroe fault because the epicenter and the intense shaking zone of this earthquake were about 25 km (15.5 mi) southwest of the MRS/MMGH margin. Based on this information, the applicant concluded it is not likely that the earthquake is related to the Lucas-Monroe fault. Figure 2.5.1-3 in this SER shows the location of the Bowling Green fault. Figure 2.5.1-4 in this SER shows a summary of the displacement history of the fault that ranges from Late Ordovician to Post-Middle Silurian.

Figure 2.5.1-3 Fermi 3 Site Region Map of Tectonic Structures
(Reproduced from Fermi 3 COL FSAR Figure 2.5.1-203)

SUMMARY OF DISPLACEMENT HISTORY OF BOWLING GREEN FAULT

Episode	Sense	Displacement	Evidence	Age
I	East-down	32 m	Greater thickness of strata between top of Trenton Ls. and top of Lockport Dol. on east side of fault	Late Ordovician-Early Silurian
II	West-down	50 m	Greater thickness of strata between top of Lockport Dol. and top of Tymochtee Dol. on west side of fault	Early-Middle Silurian
III	Left (?) lateral	?	Slickenlines in Tymochtee Dol. and Bass Islands Gp. in fault zone	Post-Middle Silurian
IV	West-down	>70 m	Slickenlines in Tymochtee Dol. and Bass Islands Gp. in fault zone; offset of Tymochtee-Bass Islands contact	Post-Middle Silurian
V	East-down	Depends on IV	Slickenlines, drag folds, minor fault sense in Tymochtee Dol. and Bass Islands Gp. in fault zone	Post-Middle Silurian
VI	Thrust	<5 m	Slickenlines, offset of bedding in Tymochtee Dol. and Bass Island Gp. in fault zone	Post-Middle Silurian-Cenozoic

Source: Reference 2.5.1-332

Abbreviations:
Dol. = Dolomite
Gp. = Group
Ls. = Limestone
? = uncertain

Figure 2.5.1-4 Summary of Displacement History of Bowling Green Fault
(Reproduced from Fermi 3 COL FSAR Figure 2.5.1-223)

b. Howell Anticline

The Howell (Howell-Northville) anticline is a Precambrian, northwest-southeast trending anticline about 45 km (28 mi) north of the Fermi 3 site. The applicant explained that the southwest limb of the anticline is a steep normal fault and that no deformation associated with the Howell anticline has been observed after the early Mississippian.

c. Maumee Fault

The applicant described the Maumee fault as a northeast-southwest trending normal fault about 34 km (21 mi) south of Fermi. The applicant stated that the fault is offset (about 2 km [1.2 mi]) left laterally by the Bowling Green fault. The fault also coincides with a moderate lineament formed by the Maumee River.

Seismic Zones

In FSAR Subsection 2.5.1.1.4.3.3, the applicant explained that two seismic zones are within the site region: the Northeast Ohio Seismic Zone and the Anna Seismic Zone. Both seismic zones are classified as Class C structures.

The applicant defined the Northeast Ohio Seismic Zone as a zone of earthquakes south of Lake Erie about 50 km (30.5 mi) long. The largest seismic event in this zone was a magnitude 5 event about 40 km (24.4 mi) east of Cleveland on January 31, 1986, followed by 13 aftershocks within the subsequent 3 months. The applicant stated that the earthquakes and the aftershocks were within 12 km (7.3 mi) of deep waste disposal injection wells that may be associated with the cause of this earthquake and the aftershocks. However, the applicant indicates that the characteristics of these earthquakes would suggest that a natural origin for these events is likely. The applicant discussed events (magnitude 2.3 to 4.5) of a lesser magnitude that occurred from 1987 to 2003 in the Northeast Ohio Seismic Zone. Citing Seeber and Armbruster (1993), the applicant stated that the Northeast Ohio Seismic Zone is associated with the Akron magnetic anomaly or lineament, which could be related to the "Niagara-Pickering magnetic lineament/Central Metasedimentary Belt boundary zone as a continental-scale Grenville-age structure."

The applicant stated that for the CEUS, the most common types of surficial evidence of large prehistoric earthquakes are liquefaction features and faults that offset young strata. Obermeier (1995) conducted a paleoseismic liquefaction field study along two of the larger drainages in northeast Ohio and documented that no evidence of liquefaction was observed along the river. Crone and Wheeler (2000) later classified the Northeast Ohio Seismic Zone as a Class C feature. Those features have insufficient geologic evidence demonstrating the existence of a tectonic fault, Quaternary slip, or deformation associated with those features. The applicant indicated that the CEUS-SSC model uses broad regional seismic source zones to represent the occurrence of distributed seismicity in the CEUS. In addition, the applicant stated that the Northeast Ohio Seismic Zone appears as an area with higher seismicity rates within the larger regional source zones in which it lies.

The Anna Seismic Zone, also known as the Western Ohio Seismic Zone, has experienced around 40 earthquakes since 1875. The applicant stated that the strongest event recorded since the 1937 earthquake occurred in July 1986 with a magnitude of 4.5. Historic records show a maximum magnitude of 5, suggesting that events in this zone are able to produce a magnitude of 6 to 7. The applicant explained that researchers have found no evidence of paleoliquefaction features in the vicinity of Anna, Ohio; or in portions of the Auglaize, Great Miami, Stillwater, and St. Mary's rivers. The Anna Seismic Zone is a Class C feature based on the occurrence of significant historical earthquakes and absence of paleoseismic evidence. The applicant indicated that the Anna Seismic Zone is represented in the CEUS-SSC model as an area of a higher seismicity rate within the larger regional source zones in which it lies.

FSAR Subsection 2.5.1.1.4.4 describes significant seismic sources at a distance greater than 320 km (200 mi) from the site. The applicant described in detail the New Madrid Seismic Zone (NMSZ) and the Wabash Valley Seismic Zone (WVSZ) located 800 km (500 mi) and 500 km (300 mi) from the Fermi 3 site, respectively. The applicant explained the origin of stresses that seem to be driving the active deformation in the CEUS by describing several of the models that includes explanations for the localization of seismicity and the recurrence of large-magnitude events in the NMSZ. The applicant indicated that the CEUS-SSC characterized the RLME seismic sources in the NMSZ and the WVSZ; both of these seismic sources contribute to the seismic hazard at the Fermi 3 site.

Non-Seismic Geologic Hazards

In FSAR Subsection 2.5.1.1.5, the applicant described non seismic geologic hazards—including landslides and karst—within the Fermi 3 site region (320-km [200-mi] radius). The applicant explained that the Kanawha Section of the Appalachian Plateau is an area of moderate to high landslide susceptibility. In the Great Lakes area, landslide susceptibility was moderate and occurred mostly in lacustrine deposits. Landslides were also associated with wave erosion at the base of cliffs.

Karst features in the area are observed in limestones and dolomites of Silurian age (441 to 419 Ma) and consist of fissures, tubes, and caves that are usually less than 300 m (1,000 ft) long. The applicant explained that carbonate rock areas in northwestern Ohio covered by less than 6 m (20 ft) of glacial deposits developed large karstic features. Evaporite karst associated with halite and gypsum occurs mostly in the central area of the Michigan basin.

2.5.1.2.2 Site Geology

FSAR Subsection 2.5.1.2 describes the physiography, geologic history, stratigraphy, and structural geology of the site vicinity (40 km [25 mi]); site area (8 km [5 mi]); and site location of Fermi 3 (1 km [0.6 mi]). In addition, the FSAR includes subsections on site engineering geology and effects of human activity.

Site Physiography and Geomorphology

FSAR Subsection 2.5.1.2.1 states that the Fermi 3 site lies within the Eastern Lake section of the Central Lowlands physiographic province. FSAR Subsection 2.5.1.1.1 describes the regional physiographic provinces. The 1-km (0.6-mi) radius of the site is characterized by lacustrine deposits overlying glacial till, with an elevation that ranges from 173 to 180 m (570 to 590 ft).

The applicant indicated that geomorphic features have been identified and characterized in the western Lake Erie basin using both recent bathymetry and previous results of high-resolution seismic survey studies. The applicant described key geomorphic observations of Holcombe et al. (1987) regarding the lake-floor geomorphology of the western basin of Lake Erie.

Site Area Geologic History

In FSAR Subsection 2.5.1.2.2, the applicant described the site area geologic history during the Paleozoic and Quaternary periods. The applicant explained that units exposed in the site vicinity are from the Silurian and Devonian eras overlain by Quaternary sediments. During the Quaternary time, three ice lobes (Michigan, Saginaw, and Erie) coalesced on the lower peninsula of Michigan. The ice advance of the Port Huron stade affected the site region by creating high lake levels and proglacial lake areas such as the Glacial Lake Whittlesey and Warren Lake. Sedimentary deposits from these two lakes form the bulk of the glacial-age sediments deposited in the site vicinity.

Site Area Stratigraphy

In FSAR Subsection 2.5.1.2.3, the applicant described the site area stratigraphy during the Paleozoic and Quaternary periods. The applicant stated that the stratigraphy in the site vicinity is comparable to the regional stratigraphy, with the exception of sediment deposition associated with the Findlay arch in the Fermi site vicinity.

Paleozoic Stratigraphy of the Site Area

In FSAR Subsection 2.5.1.2.3.1, the applicant stated that three Paleozoic units are observed at the surface in the site vicinity: the Silurian Bass Islands Group, the Devonian Garden Islands Formation, and the Sylvania Sandstone.

The Silurian-age Salina Group is in the center of the Michigan basin and is subdivided into seven units identified as A through G. Unit A is further divided into four additional units: A-1 Evaporite, A-1 Carbonate, A-2 Evaporite, and A-2 Carbonate. The applicant described these units in detail and explained that the Fermi site is located in a region with no halite in the Salina and Bass Island groups. The applicant explained that the Silurian Bass Islands group is the uppermost bedrock unit found during the Fermi 3 subsurface investigation. The Bass Islands Group that the applicant encountered during its subsurface investigations is predominantly dolomite. The Devonian Garden Islands formation is described as dolomitic sandstone, dolomite, and cherty dolomite with a thickness of about 6.1 m (20 ft). The Devonian Sylvania Sandstone is a quartz sandstone cemented with dolomite and has a thickness of 6.1 m (20 ft). The Sylvania Sandstone overlies the Bois Blanc and Garden Islands formations and is exposed in the (8-km [5-mi] radius) site area.

Quaternary Stratigraphy and Geomorphology

In FSAR Subsection 2.5.1.2.3.2, the applicant described the glacial and postglacial lake strandlines and related geomorphic features, Quaternary deposits and soils in the site vicinity and site area, and the Quaternary stratigraphy of the site location. The applicant stated that the exposed Quaternary surficial geologic units in the site vicinity consist of Wisconsinan age till overlain by a thin mantle of lacustrine and eolian sands or locally thicker beach dune ridge deposits.

The applicant discussed the paleo-shoreline features in the site vicinity associated with Lakes Maumee, Arkona, Whittlesey, Warren, and Wayne. In addition, the applicant discussed the most prominent beach ridges south of Lake Erie. Totten (1982) concluded that before the most recent late Wisconsinan ice advance (Woodfordian), the major activity was wave erosion that formed wave-cut cliffs and terraces. The applicant stated that at the various lake levels following the Woodfordian glaciation, the major geomorphic activity was the deposition of beach and dune ridges rather than cliff and terrace cutting. The applicant indicated that based on the geomorphic position and elevation, the mapped paleoshorelines in the site vicinity are correlated to glacial and postglacial lake levels that postdate the most recent major glacial advance about 14,800 years ago.

1. Quaternary Units

FSAR Subsection 2.5.1.2.3.2.3 describes the glacial till, lacustrine deposits, and fill. The applicant explained that the glacial till overlies the bedrock throughout the entire site location and ranges in thickness from 1.8 to 5.8 m (6 to 19 ft). Glacial till consists of fine grained sediments with variable amounts of sand, gravel, and cobbles.

Lacustrine deposits and shoreline deposits overlie the glacial till in most of the site. The thickness of the lacustrine deposits ranges from 0 to 2.7 m (0 to 8.7 ft) and the deposits consist of laminated silt and clay. The applicant stated that the top of the lacustrine deposits may have been removed and replaced with fill at the Fermi 2 and 3 sites.

Site Area Geologic Structures

In FSAR Subsection 2.5.1.2.4.1, the applicant stated that the major Precambrian structures in the site vicinity are the MRS and the GFTZ. The applicant stated that there no known Quaternary faults in the site vicinity. The applicant explained that the Bowling Green fault and the Maumee fault are bedrock faults mapped within 40 km (25 mi) of the Fermi site. The youngest evidence for displacement on the Bowling Green fault takes place in the Silurian Bass Island Group. The applicant stated the Maumee fault has no geomorphic expression; it is offset in an apparent left lateral sense by the Bowling Green fault. The applicant indicated that offshore of where the Maumee River enters Lake Erie, a linear northeast trending channel was excavated and dredged for shipping traffic entering the Toledo Harbor. The dredged channel includes 11 km (7 mi) of channel on the Maumee River and 29 km (18 mi) on the bay. The applicant also described the Howell anticline and explained that this structure consists of en-echelon folds and other associated faults.

In FSAR Subsection 2.5.1.2.4.2, the applicant explained that recent and previous borings at the Fermi site show that the rocks underlying the site area, the Silurian Salina and Bass Islands Groups, are folded into a wide shallow syncline. FSAR Subsection 2.5.1.2.4.3 states that two joint sets were mapped at a quarry located about 1.6 km (1 mi) from the site and similar trends of joints were observed at quarries and outcrops in Michigan, Ohio, and Ontario, Canada. The applicant explained that some joint sets in the region are related to contemporary stress. Boring data from the Fermi 2 site showed that the Bass Islands dolomite is highly jointed. The applicant described the joints as relatively tight with minor solution activity. During the Fermi 3 subsurface investigations, the applicant observed jointing throughout the Bass Islands Group and Salina Group Unit F. The applicant stated that these joints vary from isolated joints to groups of closely spaced joints with orientations that fluctuate from near horizontal to near vertical and joint apertures up to several inches. The applicant added that joint density decreases below the Salina Group Unit F and only a few joints are observed in Salina Group Units C and B. However, there are joints filled with minerals such as anhydrite even in the deepest formations.

Site Area Geologic Hazard Evaluation

In FSAR Subsection 2.5.1.2.5, the applicant discussed the potential geologic hazards in the 40-km (25-mi) radius of the Fermi 3 site. Based on the Landslide Overview Map of the conterminous United States, the applicant stated that the site area and site location are in a region of moderate landslide vulnerability based on the presence of lacustrine deposits. The lacustrine deposits at the site are about 3 m (9 ft) thick, and the site area is relatively flat with no steep slopes. However, the applicant stated that even though the natural slopes are not landslide prone, "the stability of the lacustrine deposits should be considered in excavation design."

The applicant stated that some karst features may be present in the site vicinity, site area, and site location. Research performed by Davies et al. (1984) reflects active karst areas near northwestern Ohio that take place in zones where the noncarbonated overburden is less than 6 m (20 ft). The applicant thus concluded that the probability for karst in the 1-km (0.6-mi) radius of the site is low considering that the combined thickness of the till and lacustrine deposits is more than 6 m (20 ft). The applicant stated that there are no sinkholes in the 8-km (5-mi) site area radius, but sinkholes were observed outside of this radius.

The applicant explained that a possible reason for the presence of breccias and soft zones at the site is related to paleokarst occurrences and the associated dissolution of evaporite minerals. The applicant explained that only minor amounts of gypsum and anhydrite and no halite exist at the site. Thus, the potential for modern evaporite karst is small.

Site Engineering Geology Evaluation

FSAR Subsection 2.5.1.2.6 discusses the applicant's evaluation of the site engineering geology, including potential effects of human activities at the Fermi 3 site. The applicant stated that the engineering behavior of the soils and rock is discussed in FSAR Subsection 2.5.4.2. In FSAR Section 2.5.1.2.6, the applicant explained several engineering aspects of the soil and rocks such as zones of alterations, residual stresses in bedrock, unstable subsurface conditions, deformational zones, and prior earthquake effects.

FSAR Subsection 2.5.1.2.6.7 discusses the effects from human activities in the Fermi site such as oil and gas production, subsurface gas storage, and dissolution mining of salt. The applicant stated that various producing wells are within the Ohio site vicinity. No producing oil wells are within the 8-km (5-mi) radius of the site. The applicant indicated that no subsurface gas storage facilities or salt deposits are within the 8-km (5-mi) radius of the site area, and no mining is anticipated.

The applicant explained that the Fermi site has surface deposits composed of artificial fill that overlies the lacustrine and glacial till, which are less permeable. These less permeable materials formed a confined layer over the Silurian Bass Islands and Salina Groups that are considered bedrock aquifers at the site. The applicant discussed groundwater in more detail in FSAR Section 2.4.12.

2.5.1.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the basic geologic and seismic information, and the associated acceptance criteria, are in Section 2.5.1 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR 52.79(a)(1)(iii) as it relates to identifying geologic site characteristics with appropriate consideration of the most severe of the natural phenomena historically reported for the site and surrounding area and with a sufficient margin for the limited accuracy, quantity, and period of time that the historical data were accumulated.

- 10 CFR Part 100, Section 100.23, "Geologic and Seismic Siting Criteria," for evaluating the suitability of a proposed site based on consideration of geologic, geotechnical, geophysical, and seismic characteristics of the proposed site. Geologic and seismic siting factors must include the safe-shutdown earthquake (SSE) ground motion for the site and the potential for surface tectonic and non-tectonic deformation. The site-specific GMRS satisfies requirements of 10 CFR 100.23 with respect to the development of the SSE ground motion.

The related acceptance criteria from Section 2.5.1 of NUREG–0800 are as follows:

- Regional Geology: In meeting the requirements of 10 CFR 52.79 and 10 CFR 100.23, FSAR Subsection 2.5.1.1 will be considered acceptable if a complete and documented discussion is presented for all geologic (including tectonic and nontectonic), geotechnical, seismic, and geophysical characteristics; as well as conditions caused by human activities that are deemed important for the safe siting and design of the plant.

- Site Geology: In meeting the requirements of 10 CFR 52.79 and 10 CFR 100.23 and the regulatory positions in RG 1.208, RG1.132, RG1.138, RG1.198, and RG1.206, FSAR Subsection 2.5.1.2 will be considered acceptable if it contains a description and evaluation of geologic (including tectonic and non- tectonic) features; geotechnical characteristics; seismic conditions; and conditions caused by human activities in appropriate levels of detail within areas defined by circles drawn around the site using radii of 40 km (25 mi) for site vicinity, 8 km (5mi) for the site area, and 1 km (0.6 mi) for the site location.

In addition, the geologic characteristics should be consistent with the appropriate sections from RG 1.208, "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion"; RG 1.132, Revision 2, "Site Investigations for Foundations of Nuclear Power Plants"; RG 1.138, Revision 2, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants"; RG 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites"; and RG 1.206, "Combined License Applications for Nuclear Power Plants - LWR Edition."

2.5.1.4 *Technical Evaluation*

NRC Staff reviewed the information in Section 2.5.1 of the Fermi 3 COL FSAR, related to the site basic geologic and seismic information as follows:

COL Item

- EF3 COL 2.0-26-A Basic Geologic and Seismic Information

NRC staff reviewed the applicant's information on the resolution of COL Item EF3 COL 2.0-26-A related to the evaluation of the geologic, seismic, and geophysical information included under Section 2.5.1 of the Fermi 3 COL FSAR.

The technical information in FSAR Section 2.5.1 was based on the applicant's surface and subsurface geologic, seismic, and geotechnical investigations, which were undertaken in increasing levels of detail for distances closer to the site. The NRC staff reviewed FSAR Section 2.5.1 to determine whether the applicant had complied with the applicable NRC regulations and had conducted investigations with the appropriate levels of detail within the four circumscribed areas designated in RG 1.208. These areas are defined according to various distances from the site specified as 320 km (200 mi), 40 km (25 mi), 8 km (5 m), and 1 km (0.6 mi).

Fermi 3 FSAR Section 2.5.1 contains geologic and seismic information collected by the applicant in support of the vibratory ground motion analysis and the site-specific GMRS in FSAR Section 2.5.2. RG 1.208 recommends that applicants update the geologic, seismic, and geophysical databases and evaluate any new data to determine whether revisions to the existing seismic source models are necessary. Consequently, the staff's review focused on geologic and seismic data published since the mid- to late-1980s to assess whether these data indicate a need to update the existing seismic source models.

During the early site investigation stage, the staff visited the site and interacted with the applicant regarding the geologic, seismic, and geotechnical investigations conducted for the Fermi 3 COL application. To thoroughly evaluate these investigations, the staff obtained additional assistance from experts at the United States Geological Survey (USGS) and participated with the USGS in a site audit at the Fermi 3 site in November 2009 (ADAMS Accession No. ML14112A212). The purpose of that visit was to confirm the applicant's interpretations, assumptions, and conclusions related to potential geologic and seismic hazards. The staff's evaluation of the information presented by the applicant in COL FSAR Section 2.5.1 and of the applicant's responses to RAIs is presented below. As discussed earlier under the introduction to Section 2.5 of this SER, the staff had asked several RAIs and had evaluated the responses received earlier in the review process. However, following the issuance of the NRC's NTTF after the Fukushima accident in Japan in March 2011, and the subsequent submissions of an RAI to all COL and ESP applicants, the COL applicant revised the FSAR—including FSAR Section 2.5.1. As part of this FSAR revision, the applicant replaced the EPRI (1986) seismic source models previously used in the seismic hazard calculations with the newly published NUREG–2115 CEUS-SSC model. As a result of this change, some of the earlier RAIs became irrelevant and were closed. The staff's evaluations of some of these earlier RAIs are therefore not discussed in this report. However, several of the original RAIs are still applicable to the staff's review and they are discussed below.

The staff reviewed the resolution to COL Item EF3 COL 2.0-26-A that addresses regional and site-specific geologic, seismic, and geophysical information, as well as conditions caused by human activities included under Section 2.5.1 of the Fermi 3 COL FSAR. The staff's review is provided below:

2.5.1.4.1 Regional Geology

The staff's review of FSAR Subsection 2.5.1.1 focused on the applicant's description of the regional physiography, geomorphology, geologic history, stratigraphy, tectonic setting, and non-seismic geologic hazards within a 320-km (200-mile) radius of the Fermi 3 site. The following SER subsections present the staff's evaluation of the information in FSAR Subsection 2.5.1.1 and the applicant's responses to the staff's RAIs.

Regional Physiography and Geomorphology

In FSAR Subsection 2.5.1.1.1, the applicant described the three physiographic provinces and associated geomorphologies found in the Fermi 3 site region—the Central Lowlands province; the St. Lawrence province; and the Appalachian Plateaus province. The Fermi 3 site lies in the Eastern Lake subprovince of the Central Lowlands province. The staff's review of FSAR Subsection 2.5.1.1.1 focused on the applicant's descriptions of the effects from glaciations and lake level fluctuations on the surrounding landforms. The staff performed an independent review of the published geologic information and concluded that the applicant has provided a thorough and accurate description of the regional physiography and geomorphology surrounding the Fermi 3 site to support the Fermi 3 COL application. The staff found that the applicant's information is in accordance with RG 1.208 and meets the requirements of 10 CFR 100.23.

Regional Geologic History

FSAR Subsection 2.5.1.1.2 describes the Precambrian (greater than 542 Ma), Paleozoic (542 to 251 Ma), Mesozoic (251 to 65.5 Ma), and Cenozoic (65.5 Ma to present) geologic history of the Fermi 3 site region. The applicant's discussions in this subsection concentrated on the early tectonic evolution of the site region before 251 Ma and on the glacial events of the Quaternary period (2.6 Ma to the present). Based on the applicant's descriptions in FSAR Subsection 2.5.1.1.2, the site region has not experienced major tectonic activity in the last 1 to 1.2 billion years (Ga).

The applicant documented that (1) sequences of collisions and rifting events took place before 542 Ma, (2) these sequences contributed to the formation of the basement structure within the site region, and (3) the site region was tectonically stable during the Paleozoic era. The applicant described the formation of the Michigan basin and the Findlay and Algonquin arches that developed in the site region during the Paleozoic era. The applicant documented that only minor sedimentary deposition in the Michigan basin occurred during the Mesozoic era (251 to 65.5 Ma); there is no Tertiary geologic history preserved in the site region; and much of the Quaternary period before about 10,000 years ago was dominated by glacial activity.

The staff's review of FSAR Subsection 2.5.1.1.2 focused on the applicant's descriptions of the Quaternary geologic history of the site region, because this period represents the most recent geologic activity that could affect potential hazards at the site. The staff also focused on the depositional history of the site region, because the geologic units beneath the proposed site also contribute to the safety at the site. The staff performed an independent review of the applicant's data sources and of additional geologic literature to verify the applicant's descriptions and conclusions in the FSAR. The staff concluded that the applicant's documentation of the geologic and tectonic history of the Fermi 3 site region is consistent with the most recent geologic literature. The staff found that there is no major evidence for tectonic activity or deformation in the site region during the Quaternary period. Furthermore, the staff concluded that the applicant has provided a thorough and accurate description of the geologic and tectonic history in the site region to support the Fermi 3 COL application. The staff found that the applicant's documentation is in accordance with RG 1.208 and meets the requirements of 10 CFR 100.23.

Regional Stratigraphy

FSAR Subsection 2.5.1.1.3 describes Precambrian (greater than 542 Ma), Paleozoic (542 to 251 Ma), Mesozoic (251 to 65.5 Ma), and Quaternary (less than 2.6 Ma) sedimentary units in the site region. The applicant focused on those units that make up the Michigan Basin and noted that there are no exposed rocks older than 488 Ma at the surface in the Fermi 3 site region. The applicant documented five Paleozoic-Mesozoic cratonic sequences in the site region that represent sequences of inland sea transgressions and regressions. Of particular interest to the staff are the applicant's descriptions of the Tippecanoe II cratonic sequence that was deposited during the Silurian and early Devonian periods (444-398 Ma) and the 183-m (600-ft) thick Bass Islands Group, which is the foundation unit for the proposed Fermi 3 nuclear island structures and is composed of mostly dolomite with some interbedded shales. The applicant's subsurface investigations for the Fermi 3 site are in FSAR Section 2.5.4. The staff's evaluation of these investigations is in Subsection 2.5.4.4 of this SER and includes the Tippecanoe II sequence rocks.

The staff reviewed FSAR Subsection 2.5.1.1.3 and performed an independent review of the geologic literature describing the regional stratigraphy of the Michigan Basin and surrounding areas. In addition, to verify the applicant's stratigraphic descriptions in the FSAR, the staff visited the Fermi 3 site in November 2009 and evaluated rock core samples obtained during the applicant's subsurface investigations of the Fermi 3 site. Based on this review, the staff concluded that the applicant has provided a thorough and accurate description of the stratigraphic history of the Fermi 3 site region to support the Fermi 3 COL application. The staff found that the applicant's documentation is in accordance with RG 1.208 and meets the requirements of 10 CFR 100.23.

Regional Tectonic Setting

In FSAR Subsection 2.5.1.1.4, the applicant discussed the regional tectonic setting of the Fermi 3 site that includes a description of the regional tectonic stress environment; an overview of the regional gravity, magnetic, and seismic profile data; and descriptions of the regional tectonic structures and seismic zones, in addition to significant seismic sources located beyond the 320-km (200-mi) site radius. Finally, the applicant also discussed regional non-seismic geologic hazards. The topics related to the regional tectonic setting follow, and include both glacial isostatic adjustments and regional tectonic structures.

Glacial Isostatic Adjustments

In FSAR Subsection 2.5.1.1.4.1.1, the applicant discussed the GIA in relation to the local tectonic stress environment. The GIA is also known as the post-glacial rebound and is the response of the earth's surface to glacial changes, such as the melting of large glaciers. The applicant stated that based on GPS measurements, the effects of the GIA on tectonic stress in the Fermi site region are mostly small. The applicant noted minor subsidence throughout most of the site region on the order of 1–2 mm/yr (0.039–0.078 in./yr) and some minor uplifts in the western portion of Lake Erie on the order of 64 mm per hundred years (0.026 in./yr). In RAI 02.05.01-03, the staff asked the applicant to provide additional information on the effects of the GIA in the site region with respect to the potential GIA effects on seismic hazards at the Fermi 3 site.

In the response to RAI 02.05.01-03 dated February 11, 2010 (ADAMS Accession No. ML100570306), the applicant referenced the 2005 paper by Mazzotti and Adams (Mazzotti and

Adam 2005). According to these authors, research conducted during the previous 25 years documents that the GIA is likely responsible for only a very small number of earthquakes. The applicant's RAI response also includes an explanation and figures documenting the distribution and rates of geodetic strain, which is dominated by the effects of the GIA. The applicant stated that modeled strain rates for parts of the central United States and eastern Canada suggest that seismicity rates will likely remain constant in the next few hundred to thousands of years and will not "vary significantly in the future due to the GIA."

The staff reviewed the applicant's response to RAI 02.05.01-03 and performed an independent assessment of the geologic literature including papers by Mazzotti and Adams (2005), James and Bent (1994), Clark et al. (1994), Grollimund and Zoback (2001), and Sella et al. (2007). The staff concluded that the applicant has adequately evaluated the potential for seismicity in the Fermi 3 site region resulting from the effects of the GIA. In addition, the staff noted that no significant geodetic anomalies exist in the site region when the current deformation field is compared with the deformation field predicted by the GIA models. The staff concluded that the applicant's interpretation that the GIA has little effect on any changes to the regional seismicity is technically defensible. Finally, the staff concluded that there is no evidence in the geologic literature—including available data on strain rates in the central United States and eastern Canada—to suggest a likely increase in the seismic hazard at the proposed Fermi 3 site from future effects of the GIA. Therefore, RAI 02.05.01-03 is resolved and closed.

In RAI 02.05.01-04, the staff asked the applicant to provide additional information on the deformation of old shorelines attributable to the GIA in the Fermi site region—including any evidence for uplift or subsidence along identified old shorelines. In addition, the staff asked the applicant to provide figures or maps to help illustrate deformation attributable to the GIA along old shorelines in the Fermi 3 site region. In the response to RAI 02.05.01-04 dated February 11, 2010 (ADAMS Accession No. ML100570306), the applicant referenced its response to RAI 02.05.01-03, which included a figure (FSAR Figure 2.5.1-251) plotting the elevation versus the distance from the raised and uplifted relict shorelines of multiple lake sequences in the Lake Erie basin within the 320-km (200-mi) site radius. The applicant also provided FSAR Figure 2.5.1-252, which illustrates the location of the Fermi 3 site with respect to areas of higher deformation due to the GIA effects. This figure shows that the Fermi 3 site vicinity is located outside of the uplift zone. The applicant stated that the deformation of relict glacial lake shorelines is consistent with expected deformation due to the GIA.

The staff conducted an independent review of the available geologic literature and noted that the Fermi 3 site is located in an area known as the "zone of horizontality" (or the zone of "zero isobase"), which is away from the hinge line that separates zones of higher uplift due to the GIA. Because of this location, the staff concluded that the Fermi 3 site is more likely to experience minor subsidence rather than uplift and is not expected to experience any significant uplift or deformation attributable to the GIA effects. The staff noted that the applicant had used the USGS 10-m (33-ft) digital elevation model to determine that there is no obvious warping of glacial lake shorelines within the 40-km (25-mile) site vicinity. The staff also noted that the lack of deformation along glacial lake shorelines within the site vicinity is consistent with the geologic literature that assumes little to no deformation in much of the site region related to the effects of GIA. Furthermore, the staff observed that actual GPS measurements described by Sella et al. (2006) and shown in FSAR Figure 2.5.1-253 suggest that the site vicinity may be experiencing subsidence rather than uplift on the order of 0 to 2 mm/yr (0 to 0.078 in/yr).

The staff concluded that the applicant's response is consistent with the available geologic literature and current state of knowledge. The staff further concluded that there is no geologic evidence to suggest significant deformation attributable to the effects of the GIA at the proposed Fermi 3 site. Therefore, RAI 02.05.01-04 is resolved and closed.

Regional Tectonic Structures

FSAR Subsection 2.5.1.1.4.3 discusses significant geologic structures in the proposed Fermi 3 site region including basins, arches, faults, and seismic zones. The applicant described 14 principal geologic faults and tectonic features in the site region and stated that there is no evidence of Quaternary tectonic faulting in the states of Michigan and Ohio. For most of the 14 structures, the applicant discussed limits on the timing of the most recent deformation.

1. Basins and Arches

FSAR Subsection 2.5.1.1.4.3.1 describes Paleozoic basins and arches, including the Michigan basin and the Findlay and Algonquin arches near the Fermi site. NRC staff reviewed this information and performed an independent review of the available geologic literature. The staff concluded that the applicant has provided a thorough and adequate description of the geologic basins and arches consistent with the current knowledge and available literature. The staff further concluded that there is no geologic evidence to suggest that any of these features represent recent geologic deformation, and therefore they would not be expected to pose a geologic hazard at the site.

2. Principal Faults within the Site Region

FSAR Subsection 2.5.1.1.4.3.2 describes 14 tectonic faults or features in the Fermi 3 site region. FSAR Table 2.5.1-201 summarizes these features and discusses the evidence for geologic deformation associated with each feature. In RAI 02.05.01-06, the staff asked the applicant to further discuss information on the timing of the most recent deformation for three faults in the site region—the Peck fault, the Sharpsville fault, and the Transylvania fault.

In the response to RAI 02.05.01-06 dated February 11, 2010 (ADAMS Accession No. ML100570306), the applicant performed a more thorough search of the geologic literature and contacted regional geologic experts concerning these faults. The Peck Fault is located approximately 133 km (82 miles) north of the Fermi 3 site. Although the youngest evidence of deformation is early Mississippian (359-347 Ma), Fisher (1981) concludes that the deformation on this fault may have occurred through the end of the Paleozoic age (252 Ma). However, the applicant noted that there is no evidence in the available geologic literature to suggest that the Peck fault deformed units younger than the Mississippian age. For the Sharpsville Fault, the applicant noted that the youngest deformation is Devonian age (greater than 359 Ma).

The Transylvania Fault Extension comprises multiple geologic structures in the site region. The applicant contacted Mark Baranoski of the Ohio Geological Survey who stated that there was no evidence of Mesozoic or Cenozoic deformation on the Transylvania Fault Extension. This expert noted that although the age of the youngest deformation is not clear, it is likely from the Devonian age. As part of the response to RAI 02.05.01-6 the applicant updated FSAR Table 2.5.1-201; this describes regional tectonic structures within the 320-km (200-mi) radius of the Fermi 3 site region. Based on the staff's review of RAI 02.05.01-6 and the staff's independent literature review, the staff concluded that the applicant's response to RAI 02.05.01-6 adequately resolves the issues surrounding the age of the most recent deformation among the Peck, Sharpsville, and Transylvania faults. The staff noted that there is no documented evidence for a Quaternary deformation along the Peck, Sharpsville, and

Transylvania faults or evidence that would contradict the applicant's characterization of these faults. Therefore, RAI 02.05.01-6 is resolved and closed.

The staff noted that FSAR Table 2.5.1–201 summarizes the faults and folds in the Fermi site region, including the youngest faulted or deformed unit for most structures. However, the applicant did not explicitly discuss the oldest unfaulted unit associated with each fault or fold. In RAI 02.05.01-7, the staff asked the applicant to revise FSAR Table 2.5.1-201 and to discuss the oldest unfaulted geologic units associated with each of the major tectonic faults that the applicant described in FSAR Subsection 2.5.1.1.4.3.2.

In the response to RAI 02.05.01-7 dated February 11, 2010 (ADAMS Accession No. ML100570306), the applicant revised FSAR Table 2.5.1-201 to reflect a more thorough literature review. The applicant also contacted experts at four state agencies in Michigan, Ohio, and Indiana for additional information. Based on these additional reviews, the applicant concluded that there is no evidence for Quaternary tectonic faulting in the Fermi 3 site region. The applicant also observed an unconformity between the Paleozoic and the overlying Quaternary glacial, fluvial, and lacustrine sediments. In general, the faulted Paleozoic rocks are overlain by Quaternary sediments, which are not known to be faulted in the site region according to information reported in the literature.

The staff reviewed the applicant's response to RAI 02.05.01-7 and noted that not one of the 14 faults that the applicant described in FSAR Subsection 2.5.1.1.4.3.2 shows evidence of Quaternary geologic deformation that would increase the seismic hazard at the proposed Fermi 3 site. The staff also noted that the applicant's descriptions of the faults are consistent with those in the available literature. Furthermore, FSAR Figure 2.5.1-203 illustrates tectonic structures in the Fermi site region. The applicant described most of these tectonic features in FSAR Subsection 2.5.1.1.4.3.2 with the exception of the Outlet, Marian, and Colchester faults.

In RAI 02.05.01-24, the staff asked the applicant to describe the three faults depicted in FSAR Figure 2.5.1-203 but not described in the FSAR text. In the response to RAI 02.05.01-24 dated February 11, 2010 (ADAMS Accession No. ML100570306), the applicant explained that the Outlet and Marion faults are part of the Bowling Green fault zone that the applicant described in FSAR Subsection 2.5.1.1.4.3.2.3. The Bowling Green fault zone is located approximately 40 km (25 mi) from the Fermi site at its closest point. There is no evidence of Quaternary age faulting along any of the faults within the Bowling Green system. The applicant revised FSAR Subsection 2.5.1.1.4.3.2.3 to differentiate the faults in the Bowling Green fault zone.

Also in the response to RAI 02.05.01-24 is the applicant's revision of the FSAR to include a description of the Colchester fault. The Colchester fault shows no evidence of Quaternary geologic faulting. The staff reviewed the applicant's response to RAI 02.05.01-24 and concluded that the applicant has adequately evaluated all known potential fault sources in the Fermi site region based on the most current geologic literature. Following the applicant's response to RAI 02.05.01-24 and the applicant's revisions to FSAR Subsection 2.5.1.1.4.3.2 and FSAR Table 2.5.1-201, the staff concluded that the applicant has provided an adequate discussion of known geologic faults in the Fermi site region. Therefore, RAI 02.05.01-24 and RAI 02.05.01-07 are resolved and closed.

<u>NRC Staff's Conclusions Regarding Faults within the Site Region</u>

Based on information in FSAR Subsection 2.5.1.1.4.3.2 and the applicant's responses to the staff's RAIs, the staff concludes that the applicant has provided a thorough and adequate description of known geologic faults in the Fermi 3 site region. The staff concludes that there is no evidence of a Quaternary deformation on these faults to suggest a hazard at the site. Finally, the staff determined that the applicant has provided a sufficient characterization of faults in the site region to support the Fermi 3 COL application. The staff found that the applicant's information is in accordance with RG 1.208 and meets the requirements of 10 CFR 100.23.

3. Seismic Zones within the Site Region

FSAR Subsection 2.5.1.1.4.3.3 describes two seismic zones in the Fermi 3 site region—the Anna and the Northeast Ohio Seismic Zones. In the 2000 USGS Quaternary Fault and Fold Database, Crone and Wheeler (2000) designated these two zones as Class C features. Crone and Wheeler define Class C features as "those for which geologic evidence is insufficient to demonstrate the existence of a tectonic fault, Quaternary slip, or deformation associated with the feature."

a. Northeast Ohio Seismic Zone

The staff noted that FSAR Subsection 2.5.1.1.4.3.3.1 does not discuss earthquake-induced paleoliquefaction studies in the Northeast Ohio Seismic Zone. However, Crone and Wheeler (2000) cite Obermeier's 1995 examination of stream banks in the Northeast Ohio Seismic Zone for liquefaction features. Paleoliquefaction investigations are relevant to evaluating the possibility that magnitude 6 or larger earthquakes may have occurred in the past. Paleoliquefaction information may also indicate the potential for future earthquakes. Given the proximity of the Northeast Ohio Seismic Zone to the Fermi site, an earthquake of magnitude 6 or larger may impact the seismic hazard at the Fermi site. The staff therefore asked the applicant in RAI 02.05.01-10 to describe any paleoseismic investigations conducted in the Northeast Ohio Seismic Zone, including the locations investigated and the level of detail of the investigations.

In the response to RAI 02.05.01-10 dated February 11, 2010 (ADAMS Accession No. ML100570306), the applicant described paleoseismic liquefaction field studies that Obermeier had conducted in 1995 along the Grand and Cuyahoga Rivers in northeast Ohio (Obermeier 1995). Dr. Obermeier investigated approximately 25 km (15.5 mi) of stream bank exposures along each of these rivers in search of evidence for earthquake-induced liquefaction features. Obermeier investigated Holocene sediments from the past 8,000 to 10,000 years that he considered to be moderately susceptible to earthquake-induced liquefaction and found no evidence of previously liquefied deposits. The applicant provided a table summarizing the field locations that Obermeier had visited in 1995 in addition to details about the geology, age of deposits, and liquefaction susceptibility for each location. The applicant also described unsuccessful searches for liquefaction evidence in the area near the Perry Nuclear Power Plant in Perry, Ohio. The applicant confirmed through research and through discussions with the Ohio Geological Survey that no additional paleoseismic field investigations have been conducted in northeast Ohio since the 1995 investigations by Obermeier.

The staff reviewed the applicant's response to RAI 02.05.01-10 and the results of the letter report from Obermeier to the NRC in May 1996 (Obermeier 1996). The staff determined that the applicant's information adequately describes the extent of paleoseismic investigations conducted in the Northeast Ohio Seismic Zone. RAI 02.05.01-10 is therefore resolved and closed.

FSAR Subsection 2.5.1.1.4.3.3.1 describes a series of earthquakes that occurred between 1987 and 2001 near Ashtabula County, Ohio, and also discusses the proximity of the 1987 earthquakes to an injection well. The staff noted that a series of earthquakes in 2001 were precisely recorded by the Ohio seismic network. However, the applicant did not provide any additional details of the larger 2001 event or the associated smaller events, including their location or the basis for linking the 1987 and 2001 events. The staff also noted that FSAR Figure 2.5.1-207 does not differentiate between the 1987 and 2001 events. In RAIs 02.05.01-12 and 02.05.01-28, the staff asked the applicant to provide additional information describing (1) the linkage between the 1987 and 2001 earthquakes near Ashtabula County; (2) evidence regarding whether or not these earthquakes are related to fluid injection; and (3) the potential for these earthquakes to produce magnitude greater than 5 earthquakes.

In the responses to RAI 02.05.01-12, and RAI 02.05.01-28, both dated February 11, 2010 (ADAMS Accession No. ML100570304), the applicant explained that earthquakes occurring between 1987 and 2003 near Ashtabula County, Ohio, are in close proximity to waste fluid injection wells that were active from 1986 to 1994. The earthquake sequences that took place between 1987 and 2003 were recorded by three short-term deployments of portable seismographs and by regional broadband seismographs. Based on an analysis of the recorded seismicity, Seeber et al. (2004) interpreted that these earthquakes had occurred along two existing subparallel faults due to increased pore pressures that are likely associated with the nearby fluid injection. The 1987 and 1992 earthquake sequences likely occurred along a strike slip fault close to the injection well activity. The increased pore pressures propagated outward from the fluid injection source and over time, the pressure led to induced seismicity (associated with the later 2001 and 2003 earthquakes) along a second favorably oriented fault further from the injection source (Seeber et al. 2004). These investigators concluded that the evidence for increased pore pressures along multiple faults provides evidence that these faults would not likely produce earthquakes with a magnitude greater than 5 (Seeber et al. 2004).

As a result of RAIs 02.05.01-12 and 02.05.01-28, the applicant revised FSAR Subsection 2.5.1.1.4.3.3.1 to include a more thorough description of the sequence of earthquakes that occurred near Ashtabula County, Ohio. The applicant provided a more complete description of the evidence linking these earthquakes to nearby fluid injection, as well as evidence linking these earthquakes to multiple pre-existing fault structures. The applicant also updated FSAR Figure 2.5.1-207 to include the timing of earthquakes identified in the Northeast Ohio Seismic Zone. The applicant also added FSAR Figure 2.5.1-266 to show the earthquakes and inferred fault planes associated with the Ashtabula seismic events. The staff reviewed the applicant's responses to RAIs 02.05.01-12 and 02.05.01-28, as well as the evidence and conclusions from Seeber and Armbruster (1993) and Seeber et al. (2004). The staff concludes that the applicant has provided a more thorough characterization of the Ashtabula seismicity in the RAI responses and in the revised FSAR descriptions. Therefore, RAIs 02.05.01-12 and 02.05.01-28 are resolved and closed.

In RAI 02.05.01-11, the staff asked the applicant to identify any other locations in the Fermi site region where large volumes of fluid are being injected or withdrawn. In the response to RAI 02.05.01-11 dated February 11, 2010 (ADAMS Accession No. ML100570306), the applicant provided a table of active waste disposal wells located in the site region in Michigan, Ohio, and Indiana. The table identifies when the wells were drilled as well as the depth of the wells and the affected subsurface units. Triggered seismicity is only correlated with the fluid injection wells near Ashtabula County, Ohio. The staff reviewed the applicant's response to RAI

02.05.01-11 and determined that the tables in the applicant's response adequately detail the locations and history of injection wells in the Fermi 3 site region. Accordingly, RAI 02.05.01-11 is resolved and closed.

b. Anna Seismic Zone

FSAR Subsection 2.5.1.1.4.3.3.2 states that Obermeier (1995) performed paleoliquefaction surveys along stream banks surrounding the Anna, Ohio, area to evaluate evidence or the lack of evidence for large historic or prehistoric earthquakes. The applicant stated that Obermeier (1995) discovered no evidence for magnitude 7 earthquakes during the past several thousand years.

In RAI 02.05.01-14, NRC staff asked the applicant to more thoroughly describe Obermeier's paleoliquefaction investigations conducted in the Anna Seismic Zone. In the response to this RAI dated February 11, 2010 (ADAMS Accession No. ML100570306), the applicant's detailed description of those investigations included the locations that Obermeier had surveyed. Obermeier investigated more than 100 km (62 mi) of deposits along multiple rivers and streams to the south and southwest of the Fermi 3 site. The applicant also included a figure showing the locations of the rivers in the investigation, most of which are within the 320-km (200-mi) radius of the Fermi 3 site region but at least 100 km (62 miles) from the Fermi 3 site. The applicant also contacted Dr. Stephen Obermeier, USGS geologists Drs. Russ Wheeler and Richard Harrison, and geologists with the Ohio Geological Survey and the University of Indiana who are familiar with the Obermeier studies. The applicant also noted that there are no known surviving maps of Obermeier's field investigations to identify the exact locations of the paleoliquefaction studies.

The staff reviewed the RAI response and performed an independent evaluation of the Obermeier (1995) field investigations, which describe the types of deposits encountered along the rivers that were studied. Obermeier noted that although the quality of the outcrop locations along many of the stream banks was poor, there were sufficient exposures to evaluate the likelihood that larger, magnitude 7, earthquakes had occurred within the Anna Seismic Zone. Obermeier found no such evidence of earthquake activity during his paleoliquefaction field investigations in the Anna Seismic Zone. The staff observed that the Obermeier report does not preclude the possibility that smaller (magnitude 5 or less) earthquakes have occurred the Anna Seismic Zone.

The NRC staff's review found that the applicant's response to RAI 02.05.01-14 provides sufficient information regarding paleoliquefaction evaluations in the Anna Seismic Zone to assure the staff that the applicant had adequately evaluated the potential for large damaging earthquakes in the Fermi 3 site region. Furthermore, the staff concludes that based on published data of field investigations along several rivers in and surrounding the Anna Seismic Zone, there is no paleoliquefaction evidence to suggest that large magnitude earthquakes had occurred in the Anna Seismic Zone. Therefore, RAI 02.05.01-14 is resolved and closed.

NRC Staff's Conclusions Regarding Seismic Zones within the Site Region

Based on information in FSAR Subsection 2.5.1.1.4.3.3, the applicant's responses to the staff's RAIs, and the staff's independent literature investigations, the staff concludes that the applicant has provided a thorough and accurate description of the seismic zones located in the site region to support the Fermi 3 COL application. The staff found that the applicant's information is in accordance with RG 1.208 and meets the requirements of 10 CFR 100.23.

Seismic Zones outside of the Site Region

FSAR Subsection 2.5.1.1.4.4 describes two seismic zones outside of the site region: the NMSZ and the WVSZ. The NMSZ is located approximately 800 km (500 mi) from the Fermi 3 site, while the WVSZ is located approximately 500 km (300 mi) from the site. The applicant indicated that the CEUS-SSC model characterizes both zones as seismic sources of a RLME. The applicant also noted that both of these seismic sources contribute to the seismic hazard at the Fermi 3 site.

New Madrid Seismic Zone

FSAR Subsection 2.5.1.1.4.4.1 discusses the NMSZ, which is located approximately 800 km (500 mi) from the Fermi 3 site. The CEUS-SSC developed an RLME source to represent the central faults in the NMSZ. The applicant described a publication by Forte et al. (2007) proposing a mechanism to explain the occurrence of earthquakes in the NMSZ. Furthermore, the staff is aware of additional recent publications proposing other faulting mechanisms in the New Madrid region. In RAI 02.05.01-15, the staff asked the applicant to discuss the mechanisms considered as part of the NMSZ evaluation and to explain whether there is a consensus that favors one mechanism over another.

In the response to RAI 02.05.01-15, dated January 11, 2010 (ADAMS Accession No. ML100130382), the applicant explained that there are several proposed models to help explain seismicity in the New Madrid region. The applicant provided a comprehensive description of the many mechanisms various researchers have proposed to explain New Madrid earthquakes and updated the FSAR to include these discussions. The applicant emphasized that there is considerable uncertainty regarding the causative mechanisms and long-term behavior of fault sources in the New Madrid region, and no single hypothesis is widely accepted. What is widely accepted is the evidence of large earthquakes with a magnitude greater than 7 in the NMSZ at various times in the last 2,000 years, regardless of the mechanism.

The staff reviewed the applicant's response to RAI 02.05.01-15, in addition to more than 15 published resources that discuss possible mechanisms for earthquakes in the New Madrid region. The staff concludes that the applicant has performed a thorough review of these mechanisms and the varied possible explanations for NMSZ seismicity. The applicant evaluated the effects of earthquakes in the NMSZ as part of the PSHA for the Fermi 3 site. SER Section 2.5.2 provides the NRC staff's evaluation of the applicant's PSHA for the site. RAI 02.05.01-15 is therefore resolved and closed.

Wabash Valley Seismic Zone

The staff reviewed the applicant's description of the WVSZ in FSAR Subsection 2.5.1.1.4.4.2, in addition to published resources that discuss possible mechanisms for earthquakes in the Wabash Valley region. The staff concludes that the applicant has performed a thorough review of these mechanisms and the varied possible explanations for WVSZ seismicity. The applicant evaluated the effects of earthquakes in the WVSZ as part of the PSHA for the Fermi 3 site. SER Section 2.5.2 provides the NRC staff's evaluation of the applicant's PSHA for the site. The staff did not request any additional information from the applicant with respect to the WVSZ.

NRC Staff's Conclusions Regarding Seismic Zones outside of the Site Region

Based on the information in FSAR Subsection 2.5.1.1.4.4 and the applicant's response to RAI 02.05.01-15, NRC staff concludes that the applicant has provided a thorough and accurate description of seismic zones located outside of the site region that have the potential to affect hazards at the Fermi 3 site. The staff found that the applicant's information is sufficient to support the Fermi 3 COL application. The staff concludes that the applicant's description is in accordance with RG 1.208 and meets the requirements of 10 CFR 100.23.

Regional Non-seismic Geologic Hazards

In FSAR Section 2.5.1.1.5, the applicant discussed landslide hazards and the occurrence of karst in the Fermi 3 site region. The staff's review concludes that the applicant has provided an adequate evaluation of non-seismically related geologic hazards in FSAR Subsection 2.5.1.1.5 to support the Fermi 3 COL application. The staff found that the applicant's information is in accordance with RG 1.208 and meets the requirements of 10 CFR 100.23. The staff's evaluation of the potential for landslide and karst hazards at the Fermi 3 site is under the "Site Geological Hazard Evaluations" later in this SER.

2.5.1.4.2 Site Geology

The staff's review of Fermi 3 COL FSAR Subsection 2.5.1.2 focused on the applicant's description of the site physiography, geologic history, stratigraphy, and structural geology within the site vicinity (40-km [25-mile] radius), site area (8-km [5-mile] radius), and site location (1-km [0.6-mi] radius) of the Fermi 3 COL site. The following section presents the staff's evaluation of the applicant's information in FSAR Subsection 2.5.1.2 and the applicant's responses to the staff's RAIs.

Site Physiography and Geomorphology

FSAR Subsection 2.5.1.2.1 discusses the site physiography. The applicant stated that the Fermi 3 site is located in the Eastern Lake section of the Central Lowlands physiographic province. The site vicinity is also located in the St. Lawrence Lowlands physiographic province. These provinces are described in more detail in FSAR Subsection 2.5.1.1.1. The applicant also described the Maumee Lake plains section of the Eastern Lake and the St. Clair Clay Plains section of the St. Lawrence Lowlands.

The staff reviewed the site physiography in FSAR Subsection 2.5.1.2.1 and performed an independent review of the published geologic information. The staff concluded that the applicant has provided a thorough and accurate description of the physiography and geomorphology surrounding the Fermi 3 site to support the Fermi 3 COL application. The staff found that the applicant's information is in accordance with the guidance of RG 1.208 and meets the requirements of 10 CFR 100.23.

Site Geologic History

The applicant discussed the regional geologic history of the Fermi 3 site in FSAR Subsection 2.5.1.1.2. The staff's evaluation of the regional geology is provided above under "Regional Geologic History."

FSAR Subsection 2.5.1.2.2 describes the Paleozoic and Quaternary geologic history, including an unconformity between the Pennsylvanian and Pliocene periods. The applicant also described the glacial history of the Fermi 3 site area and vicinity during the Quaternary and more specifically, during the past 25,000 years. The applicant described the relationships between lake phases, glacial lake shorelines, and ice margin positions in the site vicinity. The applicant also described the predecessor of Lake Erie, Glacial Lake Leverett, whose shoreline may have been within the site vicinity limits.

In RAI 02.05.01-17, the staff asked the applicant to explain any correlations that may exist between mapped glacial shorelines in the site vicinity and possible relict shorelines associated with Glacial Lake Leverett. In the response to RAI 02.05.01-17 dated February 11, 2010 (ADAMS Accession No. ML100570306), the applicant summarized the sequence of glacial events affecting the preservation of the Lake Leverett shorelines. The applicant noted that the lake levels associated with Glacial Lake Leverett were affected by subsequent ice advances. These younger ice advances, in addition to subsequent lake level fluctuations from transgressions and regressions, explain the very limited evidence of Lake Leverett shorelines in the Fermi 3 site vicinity.

The staff reviewed the applicant's response to RAI 02.05.01-17 as well as a number of publications that discuss the glacial history of the Great Lakes region. The staff concluded that the applicant's response to RAI 02.05.01-17 is sufficient to clarify that subsequent glacial-related processes have mostly overridden evidence for former Glacial Lake Leverett shorelines. RAI 02.05.01-17 is therefore resolved and closed.

FSAR Subsection 2.5.1.2.2.2 suggests that glacial lakes formed in the last 14,000 years "have surface expression continuity and preserved landforms that document the rebound history of the area." In RAI 02.05.01-18, the staff asked the applicant to describe the post-glacial rebound history in the site vicinity in order to better understand the history of vertical deformation at and near the Fermi 3 site. In the response to RAI 02.05.01-18 dated February 11, 2010 (ADAMS Accession No. ML100570306), the applicant referred to the response to RAI 02.05.01-03 that discussed the evidence for vertical deformation of glacial and post-glacial lake shoreline features that record the GIA in the site region. The applicant also referenced its response to RAI 02.05.03-6, which is discussed in Section 2.5.3 of this SER. The applicant summarized the history of Lake Erie levels during the past approximately 10,000 years based on recent interpretations by Holcombe et al. (2003), whose historic descriptions of Lake Erie post-glacial levels are based on the latest detailed bathymetric and water budget data. The applicant noted that relict shorelines in the site region and vicinity are near the hinge line between uplift to the northeast and a zone of horizontality to the southwest.

The applicant noted that the elevations of lake strand lines in the site vicinity indicate that isostatic adjustments are relatively uniform. The applicant also updated the FSAR to clarify those landforms and features associated with young glacial lakes reflect the "cumulative response of the site vicinity to glacial isostatic adjustments."

The staff reviewed the applicant's response to RAI 02.05.01-18. The staff also performed an independent review of the pertinent geologic literature relating to glacial landforms in the Great Lakes region and the vertical deformation of glacial shorelines. The staff concluded that the applicant has provided an adequate description of the glacial rebound history of the Fermi 3 site vicinity. Therefore, RAI 02.05.01-18 is resolved and closed.

NRC Staff's Conclusions Regarding Site Geologic History

Based on the information in FSAR Subsection 2.5.1.1.2 and the applicant's responses to the staff's RAI's, NRC staff concludes that the applicant has provided a thorough and accurate description of the site geologic history to support the Fermi 3 COL application. The staff found that the applicant's information is in accordance with RG 1.208 and meets the requirements of 10 CFR 100.23.

Site Stratigraphy

FSAR Subsection 2.5.1.2.3 describes the site area and site location stratigraphy based on the applicant's subsurface investigations conducted for the Fermi 3 COL application. The staff's review of FSAR Subsection 2.5.1.2.3 focused on the applicant's descriptions of the Silurian-age Bass Islands Group and Salina Group units that underlie the proposed Fermi 3 site. In particular, the Bass Islands Group is the foundation-bearing unit for the proposed Fermi 3 nuclear island and is predominantly composed of dolomite with interbedded shale. The applicant also described the Quaternary stratigraphy and geomorphology in the Fermi 3 site vicinity. Glacial and lake deposits overlie the Paleozoic Bass Islands and Salina Groups. The applicant's descriptions of the stratigraphic and geomorphic history in the Fermi 3 site vicinity correlates with the regional descriptions that the applicant provided in FSAR Subsection 2.5.1.1. FSAR Section 2.5.4 discusses the applicant's subsurface investigations. The NRC staff's technical evaluation of FSAR Section 2.5.4 is in SER Subsection 2.5.4.4.

The staff reviewed FSAR Subsection 2.5.1.2.3 and performed an independent review of the geologic literature describing the regional and the site stratigraphy of the Fermi 3 site. In addition, in November 2009, the staff visited the Fermi 3 site and evaluated rock core samples obtained during the applicant's subsurface investigations of the site to verify the applicant's stratigraphic descriptions included in the FSAR. Based on this review, the staff concludes that the applicant has provided a thorough and accurate description of the stratigraphic and geomorphic history of the Fermi 3 site vicinity, site area, and site location to support the Fermi 3 COL application. The staff found that the applicant's information is in accordance with RG 1.208 and meets the requirements of 10 CFR 100.23.

Site Structural Geology

In FSAR Subsection 2.5.1.2.4, the applicant described the structural geology of the site vicinity. FSAR Subsection 2.5.1.2.4.1 states that there is no evidence of Quaternary faulting in the site vicinity. However, the applicant described two mapped bedrock faults in the Fermi 3 site vicinity: the Bowling Green and Maumee faults. The staff also noted that the Howell anticline and the Howell fault lie just outside of the site vicinity within 45 km (28 mi) of the Fermi 3 site.

FSAR Subsection 2.5.1.2.4.1 states that the Maumee fault is a northeast-southwest trending normal fault that follows the Maumee River and extends to the Lake Erie shore. FSAR Figures 2.5.1-230 and 2.5.1-231 show the trend of the Maumee fault and its location with respect to the Lake Erie shoreline while also showing the lake bottom bathymetry, including a northeast-southwest trending linear feature from the mouth of Lake Erie toward the lake basin. In RAI 02.05.01-20, the staff asked the applicant to explain the linear feature shown in the Lake Erie bathymetry with respect to the similar trending Maumee fault. In the response to RAI 02.05.01-20 dated January 11, 2010 (ADAMS Accession No. ML100130382), the applicant explained that the linear feature represents an excavated and dredged channel used to facilitate shipping traffic in order to permit barges to enter the Toledo Harbor. The applicant provided additional documentation of the dredging history and annual dredging activity. The staff reviewed the applicant's response to RAI 02.05.01-20 and concludes that the applicant has adequately described the linear feature shown in the Lake Erie bathymetry and has adequately justified that this linear feature is not a likely extension of the onshore Maumee fault. Therefore, RAI 02.05.01-20 is resolved and closed.

During the NRC staff's visit to the Denniston Quarry in Monroe County, Michigan, as part of a November 2009 Fermi 3 COL site audit, the staff noted at least three zones of disrupted bedding exposed in the quarry walls. These disrupted zones suggest possible faulting of the Bass Islands Group. In one location, disrupted bedding exists beneath an interpreted paleokarst feature (located near the top of the geologic section) and suggests that the paleokarst development may be associated with faulting at depth. Figure 2.5.1-5 in this SER shows this paleokarst feature above a zone of disrupted bedding in the Bass Islands Group. In a second quarry location, a zone of disrupted bedding exists with mostly undisturbed bedding on either side. This second zone appears to be at least seven to ten meters wide; contains disrupted bedding from the top to the bottom of the exposed wall; and is flanked by relatively undisturbed bedding on both sides. The third zone of possible disturbed bedding was visible in a distant wall and could be related to vertical offsets within the Bass Islands Group.

RAI 02.05.01-29 asked the applicant to further evaluate the disturbed zones and the apparent offset beds visible at the Denniston Quarry, including a determination of whether or not the disturbed bedding and apparent offsets are fault related. In addition, the staff asked the applicant to evaluate the overlying Quaternary units and to determine whether these younger deposits were deformed by the underlying structures.

In the response to RAI 02.05.01-29 dated February 11, 2010 (ADAMS Accession No. ML100570306), the applicant provided a 56-page Technical Memorandum that comprehensively discusses the studies in the Denniston Quarry. The applicant's quarry studies included trenches in the Quaternary deposits across the traces of the faults, sample descriptions of Quaternary deposits, and light detection and ranging (LiDAR) mapping of selected walls in the quarry. The applicant documented all of the evaluations, provided photographs and maps of the exposures, and included information such as a description of the oldest and youngest deformed strata that established the ages of the deformation. In one case, the applicant documented deformation in the Bass Islands Group that was traceable to the top of the bedrock. However, the applicant provided no evidence for faulting or deformation in the overlying Quaternary deposits from the past 12,000 years. The applicant's investigations identified no open caves or modern karst features at the Denniston Quarry that would indicate karst activity within the past 12,000 years. In the response to RAI 02.05.01-29 and as a result of the field investigations at the Denniston Quarry, the applicant updated the FSAR to document the results of the investigations.

The staff reviewed the applicant's response to RAI 02.05.01-29 and the applicant's field investigation report from the Denniston Quarry. The staff concludes that the applicant had conducted a thorough investigation of the evidence for Quaternary faulting and karst activity in the exposures at the Denniston Quarry. Based on this review, the staff noted that the applicant's investigations had revealed no evidence for faulting, deformation due to subsurface faulting, or karst activity in the overlying quaternary sediments at the Denniston Quarry. Based on the applicant's investigations and the information detailed in the applicant's report, the staff concludes that the applicant has provided a thorough characterization of the deformation features at the Denniston Quarry in the response to RAI 02.05.01-29. Thus, RAI 02.05.01-29 is resolved and closed.

NRC Staff's Conclusions Regarding Site Structural Geology

Based on information in FSAR Subsection 2.5.1.2.4, the applicant's responses to the staff's RAIs, and the staff's independent assessment, NRC staff concludes that the applicant has provided a thorough and accurate description of the structural geology at the site to support the Fermi 3 COL application. The staff found that the applicant's information is in accordance with RG 1.208 and meets the requirements of 10 CFR 100.23.

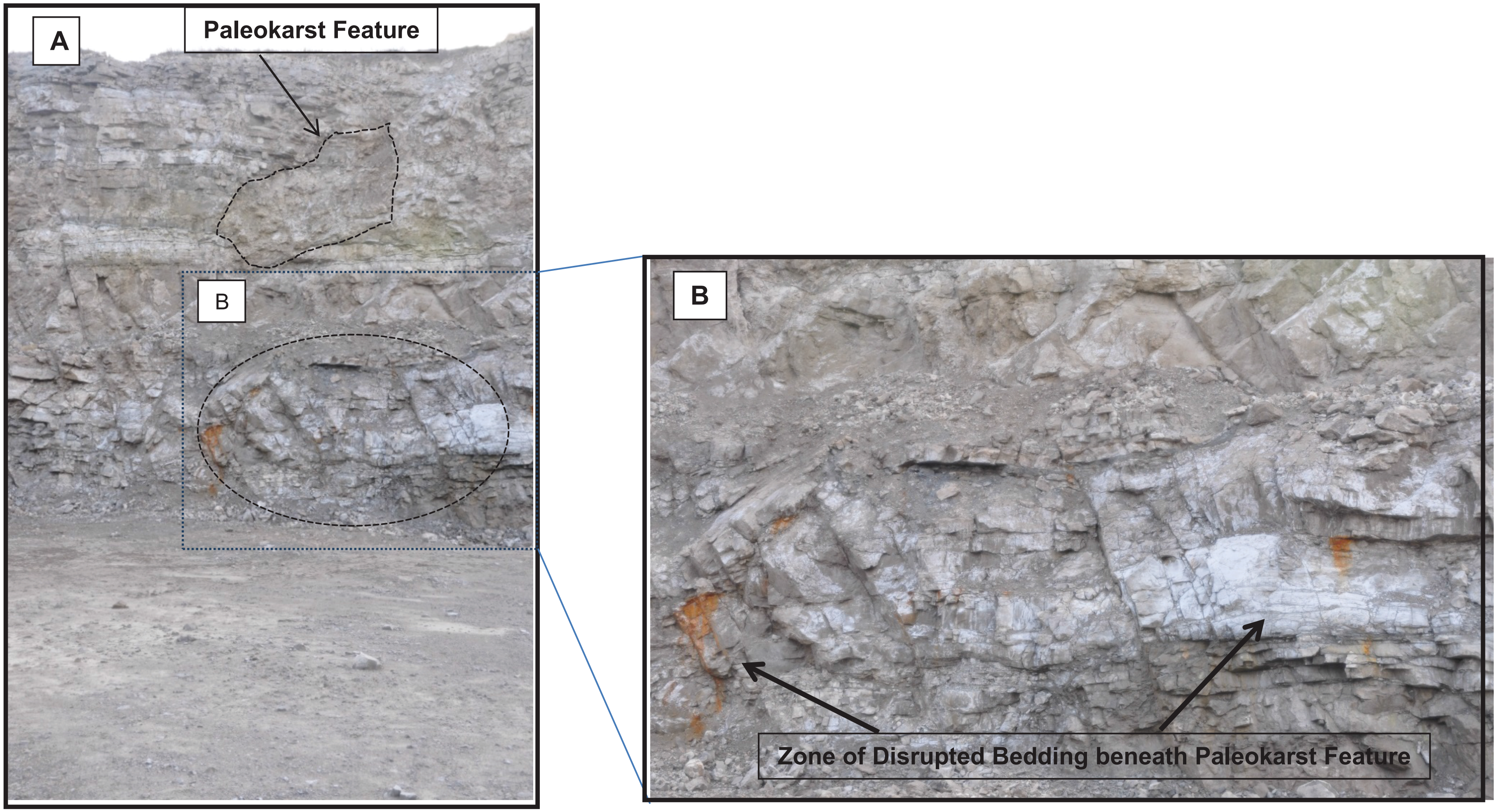


Figure 2.5.1-5 Photographs of Strata in the Denniston Quarry, Monroe, Michigan.

Note: A. Exposure of paleokarst feature in the Bass Islands Group and disrupted bedding beneath the feature.
B. Insert of disrupted bedding beneath paleokarst feature.]

Site Geologic Hazard Evaluation

FSAR Subsection 2.5.1.2.5 describes non-seismically related geologic hazards in the Fermi 3 site vicinity. FSAR Figure 2.5.1-227 illustrates potential landslide hazards in the Fermi 3 site region, and FSAR Figure 2.5.1-228 illustrates the potential for karst in the site region.

1. Site Landslide Hazard Evaluation

FSAR Figure 2.5.1-227 shows a high-incidence landslide area near the Fermi 3 site. In RAI 02.05.01-21, the staff asked the applicant to define the location of the high-incidence landslide probability in relationship to the Fermi 3 site and to explain whether any potential landslide hazards exist at the Fermi 3 site. In the response to RAI 02.05.01-21 dated February 11, 2010 (ADAMS Accession No. ML100570306), the applicant noted that the high-incidence landslide zone highlighted in FSAR Figure 2.5.1-227 is located approximately 50 km (31 mi) southwest of the Fermi 3 site, outside of the site vicinity. The applicant stated that the landslide area is associated with steep banks of the Maumee River and thick glacial deposits. The applicant noted, however, that a landslide hazard in the site vicinity is "low incidence, moderate susceptibility." The local relief along the Maumee River that is prone to landslides is approximately 15 m (50 ft) high, but the local relief along the streams near the Fermi 3 site is less than 3 m (10 ft). The applicant noted that this lower relief along the streams close to the site decreases the landslide probability of those stream banks. Based on the applicant's response to RAI 02.05.01-21 and the staff's field visit to the Fermi 3 site and the surrounding area in November 2009, the staff concluded that the applicant has sufficiently considered the potential for landslides. The applicant's response confirmed that the high incidence landslide area is outside of the site vicinity. Furthermore, the staff confirmed that landslide hazard at the site is likely low because of less relief along the stream banks and thinner glacial deposits. Therefore, RAI 02.05.01-21 is resolved and closed.

2. Site Karst Hazard Evaluation

FSAR Subsection 2.5.1.2.5 discusses the probability of karst within the 8-km (5-mile) radius of the Fermi 3 site, with respect to existing karst features in similar Silurian-age rock found in northwestern Ohio. The staff noted that FSAR Figure 2.5.1-228 shows an area of extensive subsidence near the Fermi 3 site. The applicant stated that the probability for karst development is low at the Fermi 3 site because the foundation-bearing Bass Islands Group is covered by more than 6 m (20 ft) of glacial till and lacustrine deposits. The applicant also stated that although the probability for karst is low at the site, karst features in units of a similar age in northwestern Ohio are "large enough to cause engineering problems." In RAI 02.05.01-30, the staff asked the applicant to provide a thorough discussion justifying the applicant's conclusion that the probability of karst at the Fermi 3 site is low.

In the response to RAI 02.05.01-30 dated February 11, 2010 (ADAMS Accession No. ML100570307), the applicant provided three lines of evidence to support its conclusion that there is a low probability of karst at the Fermi 3 site. The applicant first noted that karst formation is less likely in areas that have been formerly covered by ice sheets and are now covered by glacial deposits, because glaciers typically eroded away carbonate material or filled in existing karst features. Second, the applicant noted the absence of large voids or cavities due to dissolution in the subsurface investigations into the Salina and Bass Islands Groups at the Fermi 3 site. Finally, the applicant noted the absence of any large voids and cavities in bedrock exposures at the nearby Denniston Quarry. The applicant further explained that karst features typically form in the site region in Silurian-age carbonate rocks where they are not overlain by thick glacial deposits.

The staff reviewed the applicant's response to RAI 02.05.01-30 and reviewed local and regional karst studies surrounding the Fermi 3 site region. The staff determined that the applicant has adequately justified the conclusion that the evidence supports a low probability of karst formation at the site. The staff also reviewed the subsurface samples collected during the applicant's boring program and evaluated rock units exposed in the Denniston Quarry during a visit to the site in November 2009. The staff did not see any evidence for large cavities or voids due to dissolution in the subsurface foundation units observed by the staff. As a means of verifying that there are no subsurface faults or deformation features that could cause a hazard to the Fermi 3 site, the staff implemented a geologic license condition requiring the applicant to geologically map and evaluate all excavations for nuclear island structures and to evaluate all excavations for safety-related structures other than the nuclear island. License Condition 02.05.03-1 is defined in Subsection 2.5.3.5 of this SER. The staff's evaluation of cavities and voids in subsurface borings is in Section 2.5.4 of this SER. RAI 02.05.01-30 is therefore resolved and closed.

<u>NRC Staff's Conclusions Regarding Site Geologic Hazard Evaluation</u>

Based on information in FSAR Subsection 2.5.1.2.5 and the applicant's responses to the staff's RAIs, NRC staff concluded that the applicant has provided a thorough and accurate description of the site geologic hazards to support the Fermi 3 COL application. The staff found that the applicant's documentation is in accordance with RG 1.208 and meets the requirements of 10 CFR 100.23.

<u>Site Engineering Geology</u>

FSAR Subsection 2.5.1.2.6 describes the potential for engineering issues within the Fermi 3 site vicinity. The applicant evaluated zones of alteration, weathering, and structural weakness within the Bass Islands and Salina groups. The applicant also evaluated the potential for impacts from unrelieved residual stresses in bedrock and for weak or unstable subsurface conditions. The applicant evaluated deformational zones, the effects of human activities, and site groundwater conditions. The staff reviewed FSAR Subsection 2.5.1.2.6 and concluded that the applicant has adequately characterized potential engineering issues for the Fermi 3 site to support the Fermi 3 COL application. The staff found that the applicant's documentation is in accordance with RG 1.208 and meets the requirements of 10 CFR 100.23.

2.5.1.5 *Post Combined License Activities*

There are no post COL activities related to FSAR Section 2.5.1. However, in SER Subsection 2.5.3.5, the staff identifies a geologic mapping License Condition for Fermi 3 as the responsibility of the applicant and specifies it as License Condition 2.5.3-1.

2.5.1.6 *Conclusion*

NRC staff reviewed the application and confirmed that the applicant has addressed the required information relating to the basic geologic and seismic information, and no outstanding information is expected to be addressed in the Fermi 3 COL FSAR related to this section.

In addition, the staff compared the additional information in the COL application to the relevant NRC regulations, the guidance in Section 2.5.1 of NUREG–0800, and other applicable NRC RGs. The staff's review concluded that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff determined that the applicant has adequately addressed COL Item EF3 COL 2.0-26-A, as it relates to the basic geologic and seismic information.

The staff found that the applicant has provided a thorough characterization of the geologic and seismic characteristics of the Fermi site, as required by 10 CFR 100.23 and 10 CFR 52.79(a)(1)(iii). In addition, the staff concluded that the applicant has identified and appropriately characterized all seismic sources significant to determining the GMRS for the Fermi site, in accordance with NRC regulations in 10 CFR 100.23 and 10 CFR 52.79(a)(1)(iii) and the guidance in RG 1.208. Based on the applicant's geologic investigations of the site vicinity and the site area, the staff determined that the applicant has properly characterized regional and site lithology, stratigraphy, geologic and tectonic history, and structural geology, as well as subsurface soil and rock units at the site. The staff concluded that there is no potential for the effects of human activities (e.g., mining activity or groundwater injection or withdrawal) to compromise the safety of the site. Therefore, the staff concludes that the proposed COL site is acceptable from a geologic and seismologic standpoint and meets the requirements of 10 CFR 100.23.

2.5.2 Vibratory Ground Motion

2.5.2.1 *Introduction*

The vibratory ground motion is evaluated based on seismological, geological, geophysical, and geotechnical investigations carried out to determine the site-specific GMRS, which must meet the SSE regulations in 10 CFR 100.23. The GMRS is defined as the free-field horizontal and vertical ground motion response spectra at the plant site. The development of the GMRS is based on a detailed evaluation of earthquake potential that takes into account the regional and local geology, Quaternary tectonics, seismicity, and site-specific geotechnical engineering characteristics of the site's subsurface material. The specific investigations necessary to determine the GMRS include the seismicity of the site region and the correlation of earthquake activity with seismic sources. Seismic sources are identified and characterized, including the rates of occurrence of earthquakes associated with each seismic source. Seismic sources that have any part within 320 km (200 mi) of the site must be identified. More distant sources that have a potential for earthquakes large enough to affect the site must also be identified. Seismic sources can be capable tectonic sources or seismogenic sources. Specific areas covered in the review are (1) seismicity; (2) geologic and tectonic characteristics of the site and region; (3) the correlation of earthquake activity with seismic sources; (4) a probabilistic seismic hazard analysis and controlling earthquakes; (5) seismic wave transmission characteristics of the site; (6) site-specific GMRS; and (7) any additional information requirements prescribed within the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.5.2.2 *Summary of Application*

Section 2.5.2 of the Fermi 3 COL FSAR describes potential vibratory ground motion at the Fermi 3 site. In addition, in FSAR Section 2.5.2, the applicant provides the following:

<u>*COL Item*</u>

- EF3 COL 2.0-27-A Vibratory Ground Motion

In FSAR Section 2.5.2, the applicant provided site-specific information in accordance with SRP Section 2.5.2 to address COL Item EF3 COL 2.0-27-A.

The applicant developed the GMRS using the recommended performance-based approach in RG 1.208. Based on the evaluation, the applicant presented the following details related to the vibratory ground motion information for the Fermi 3 site.

2.5.2.2.1 Seismicity

FSAR Subsection 2.5.2.1 documents that the applicant used the most recent earthquake catalog published as part of NUREG–2115, in the seismic hazard assessment at the Fermi 3 site. The NUREG–2115 earthquake catalog covers earthquakes in the CEUS region from 1568 through 2008. The applicant stated that the NUREG–2115 catalog is the starting point for developing an updated earthquake catalog for the Fermi 3 site region. The applicant developed the updated catalog for the portion of the NUREG–2115 catalog (between latitude 39° and 45°N and longitude 79° and 87.5°W) covering the time period from January 1, 2009, through December 31, 2012. Furthermore, the applicant followed the process used in NUREG–2115 for developing an earthquake catalog. Consistent with the NUREG–2115 catalog, E[**M**] is the expected value of the true moment magnitude (**M**) and was calculated for all post-CEUS-SSC catalog earthquakes in the updated catalog. The applicant obtained updated earthquake information from the USGS National Earthquake Information Center (NEIC) Web site, the Advanced National Seismic System (ANSS) Web site, the Ohio Seismic Network Web site operated by the Ohio Geologic Survey, as well as the National Earthquake Database (NEDB) operated by the Geologic Survey of Canada.

Figure 2.5.2-1 in this SER shows the seismicity of the Fermi 3 site region and its surroundings. The applicant noted that the earthquakes occurring since 2008 have similar spatial distributions and do not indicate new concentrations of seismicity. In FSAR Subsection 2.5.2.1.2, the applicant noted that several significant earthquakes had occurred beyond the 320-km (200-mi) site radius in the period following the completion of the NUREG–2115 catalog—including the August 23, 2011, E[**M**] 5.73 earthquake near Mineral, Virginia; and the November 6, 2011, E[**M**] 5.66 earthquake in central Oklahoma. The applicant evaluated the impact of these earthquakes on the Fermi 3 seismic hazard is in FSAR Subsection 2.5.2.4.1.2.

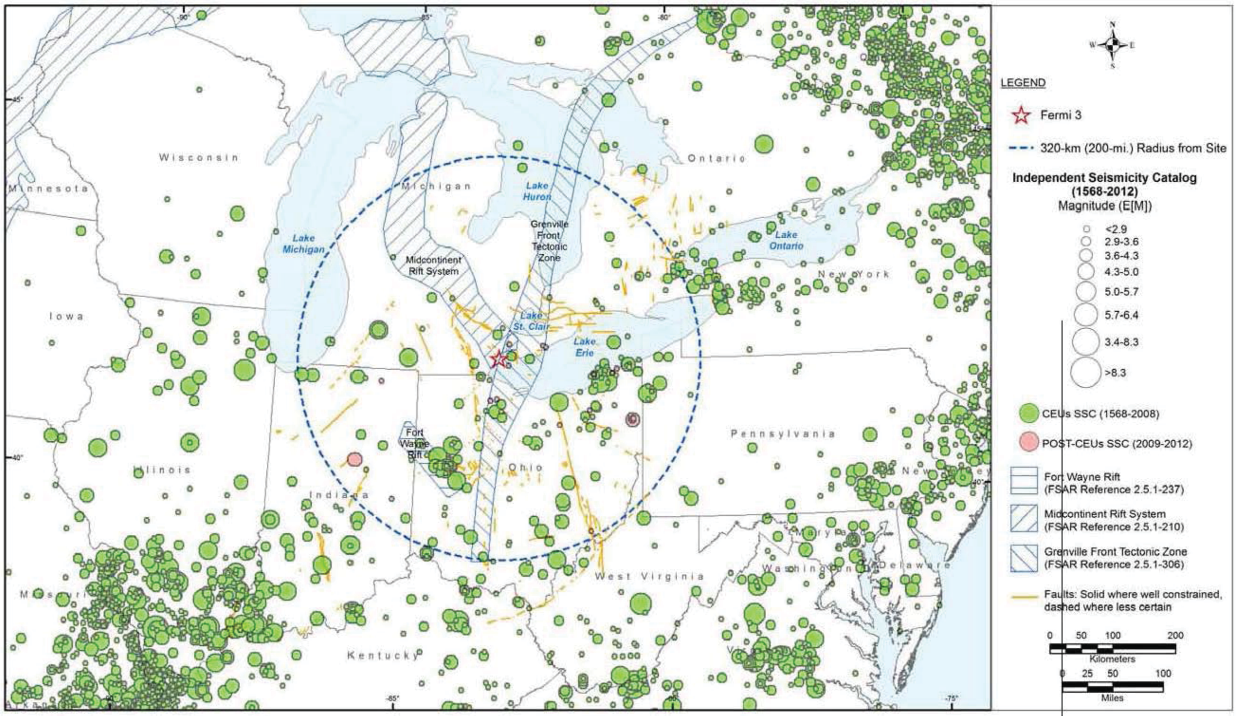


Figure 2.5.2-1 Seismicity of the Site Region of the Fermi 3 Site (taken from COL FSAR markups in the March 15, 2013, response to RAI 01.05-1; Figure 2.5.2-202 [ML13079A493])

2.5.2.2.2 Geologic and Tectonic Characteristics of the Site and Region

FSAR Subsection 2.5.2.2 describes the seismic sources and seismic model parameters that the applicant used to calculate the seismic ground motion hazard at the Fermi 3 site. The applicant used the NUREG–2115 regional seismic source characterization model developed for the CEUS region as a starting point for its seismic ground motion hazard. It took 3 years to develop the NUREG–2115 seismic source model, which was published in January 2012. The development of the model followed the Senior Seismic Hazard Analysis Committee (SSHAC) Level 3 procedures as outlined in NUREG/CR–6372, “Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and Use of Experts.” It is a regional seismic source model to be used as a starting model in seismic hazard calculations for nuclear facilities in the CEUS region. In FSAR Subsections 2.5.2.2.1 and 2.5.2.4.3.1, the applicant conducted a review of the CEUS-SSC model to identify which seismic sources are relevant to the assessment of the seismic hazard at the Fermi 3 site and whether there is a need to update any of the seismic sources. Based on this review, the applicant stated that the regional model as published is adequate for use in seismic hazard calculations for the Fermi 3 site. The following summary of the CEUS-SSC model includes the source selection process the COL applicant used.

<u>Summary of the NUREG–2115 Seismic Source Model</u>

The applicant stated that the CEUS-SSC model described in NUREG–2115 contains two types of seismic sources: distributed seismicity sources and RLME sources. While the distributed seismicity sources are based on available earthquake locations and regional geologic/tectonic characterizations, the RLME sources are based on geologic and paleoearthquake records. The RLME source records describe the zones where the occurrence of repeated (two or more) large magnitude earthquakes (**M** > 6.5) are documented.

The CEUS-SSC model categorizes the distributed seismicity sources into two subgroups: M_{max} zones and seismotectonic zones. These subgroups represent uncertainties in source characterizations and differences of opinions regarding the identification of seismic sources in this region. In hazard estimates, the M_{max} and seismotectonics sources are weighted by 40 percent and 60 percent, respectively, to determine their contributions to the total seismic hazard at the site. The M_{max} zones are broad seismic sources that were identified based on limited tectonic information and represent potential seismic sources of future earthquakes. The seismotectonic sources are those that were developed using extensive analyses of regional geology, tectonics, and seismicity for the CEUS region. Both the M_{max} and the seismotectonics zones also include alternative source geometries that accommodate inherent uncertainty in seismic source characterization.

In FSAR Subsection 2.5.2.4.3, the COL applicant stated that the PSHA conducted for the Fermi 3 site includes the contributions from all or parts of each distributed seismicity model (i.e., M_{max} and seismotectonic source zones) that lie within 1,000 km (620 mi) of the site. As a result, the applicant used the following alternative seismic source configurations for the M_{max} zones: the Study Region, NMESE-N, NMESE-W, MESE-N, and MESE-W. The Study Region is the largest seismic source in the CEUS model, and it represents the entire area of the CEUS region. MESE and NMESE represent regions where the Mesozoic-aged tectonic extension did (MESE) or did not (NMESE) take place. The MESE-N, MESE-W, NMESE-N, and NMESE-N represent alternative configurations of these two overall classifications. Narrow "N" or wide "W" extensions represent varying alternative geometries of these sources. The applicant noted that the Fermi 3 site is located in the NMESE M_{max} source zone in both interpretations.

The applicant stated that the following nine seismotectonic source zones are included in the seismic hazard model for the Fermi 3 site: Atlantic Highly Extended (AHEX) Crust; Extended Continental Crust – Atlantic Margin (ECC-AM); Great Meteor Hotspot (GMH); Illinois Basin Extended Basement (IBEB); Midcontinent-Craton (MIDC) including MIDC -A, MIDC-B, MIDC-C, and MIDC-D; Northern Appalachian (NAP); Paleozoic Extended Crust Zone (PEZ) including PEZ-N and PEZ-W; Reelfoot Rift (RR) and Reelfoot Rift-Rough Creek Graben (RR-RCG); and St. Lawrence Rift (SLR). FSAR Figures 2.5.2-209, 2.5.2-210, 2.5.2-211, and 2.5.2-212 depict these seismotectonic zones. The applicant stated that the region within 320 km (200 mi) of the site is almost entirely contained within the MIDC seismotectonic zone. The MIDC seismic source is a large zone encompassing the regions of the continental interior. Tectonically, the MIDC represents a region with very little or no significant tectonic deformation in the past several hundred million years. Because the MIDC zone boundaries are uncertain, four alternatives define this zone: MIDC-A; MIDC-B; MIDC-C; and MIDC-D. Accordingly, FSAR Figures 2.5.2-211 and 2.5.2-212 show that the PEZ-W falls within a small eastern portion of the 320-km (200-mi) site region radius for the MIDC-C and MIDC-D source zone alternatives. The western boundary of this zone, however, is not well constrained. Therefore, the CEUS-SSC model has two alternative geometries for this source—PEZ-W and PEZ–N—that represent the wide zone geometry and the narrow zone geometry, respectively. Specifically, the PEZ-W alternative geometry falls within the 320-km (200-mi) site region radius, (see Figure 2.5.2-2 in this SER).

The applicant stated that in addition to the alternative geometries, the characterization of the distributed seismicity source zones includes the use of three alternative magnitude ranges for computing seismicity parameters; alternative values for seismogenic crustal thickness; rupture geometry; maximum magnitude distributions for each source; and seismicity parameter distributions for each source. The applicant stated that FSAR Subsection 2.5.2.4.1.2 includes the applicant's evaluation of the impact from earthquakes occurring after the completion of the CEUS-SSC model catalogued with an E[**M**] greater than or equal to 4.3 on the maximum magnitude distributions for the distributed seismicity source zones.

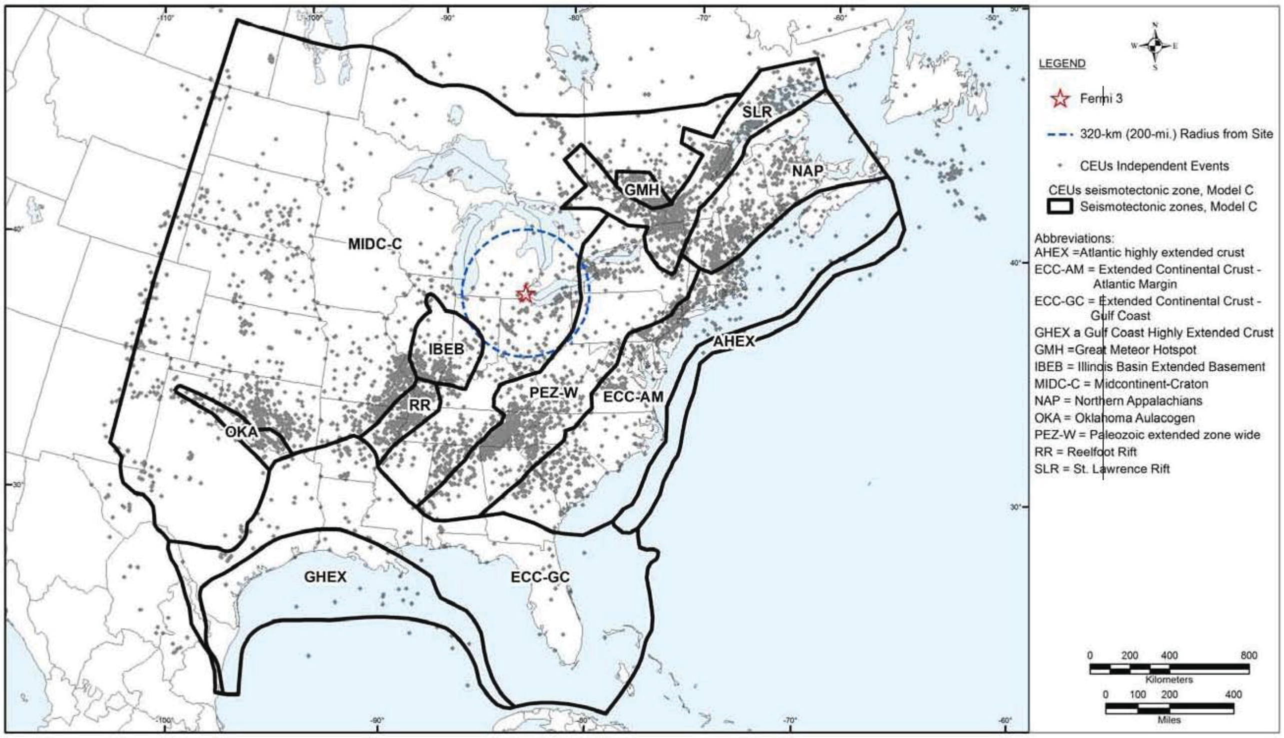


Figure 2.5.2-2 Map Showing the CEUS-SSC Seismotectonic Zones where the Rough Creek Graben Is Not Part of the Reelfoot Rift (RR) and the Wide Paleozoic Extended Crust (PEZ-W)
(taken from COL FSAR markups in the March 15, 2013, response to RAI 01.05-1; Figure 2.5.2-211 [ML13079A493])
[Note: The source configuration shown is one of the four alternative models for the MIDC seismotectonic zone.]

In the response to RAI 01.05-1 dated March 15, 2013 (ADAMS Accession No. ML13079A491), FSAR Revision 5, Subsection 2.5.2.2.4 summarizes the RLME sources used in the Fermi 3 seismic hazard calculations. The CEUS-SSC model requires contributions from the RLME sources to be added to seismic hazard estimates obtained from the distributed seismicity models. Figure 2.5.2-3 in this SER shows the locations of the RLME sources characterized in the CEUS-SSC model. The applicant identified the following RLMEs that were used in the Fermi Unit 3 seismic hazard calculations and are listed in order of significance to the Fermi 3 site hazard: New Madrid fault system (NMFS), Wabash Valley (WV), Charlevoix (CHV), and Charleston (CHS) RLME seismic sources. FSAR Subsection 2.5.2.4.3.1 provides the details regarding the RLME selection process, which are summarized in Subsection 2.5.2.4 of this SER.

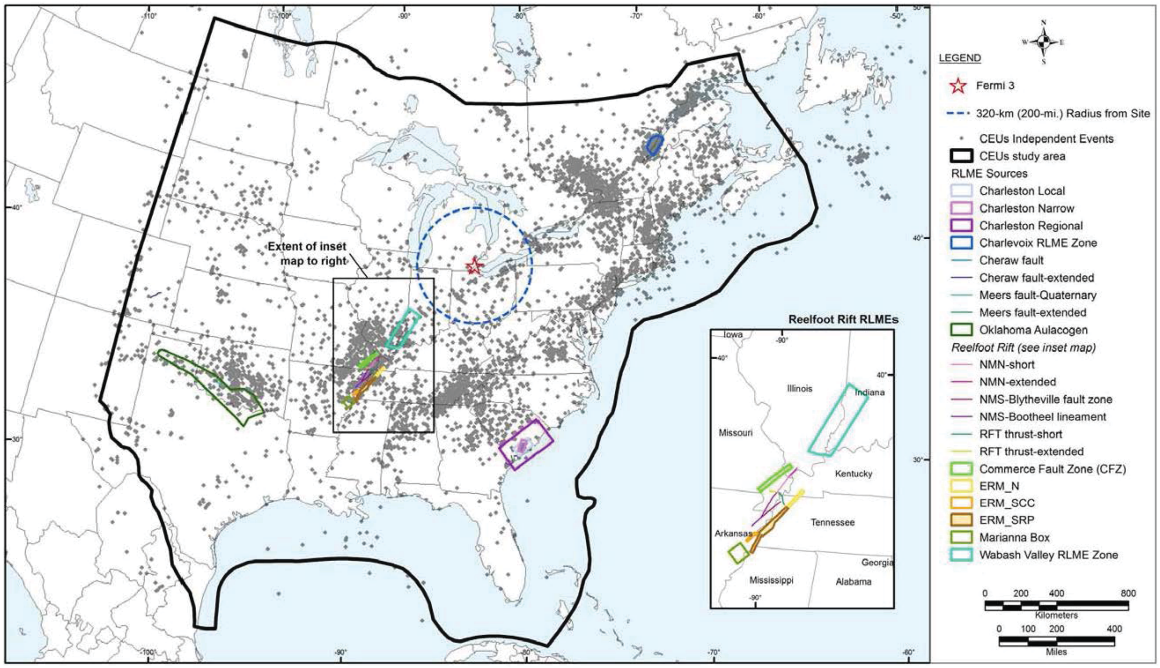


Figure 2.5.2-3 Map Showing the Repeated Large Magnitude Earthquake Sources in the CEUS-SSC Model (taken from COL FSAR markups in the March 15, 2013, response to RAI 01.05-1; Figure 2.5.2-213 [ML13079A493])

[Note: Nine primary RMLE sources and their alternative geometries are shown.]

2.5.2.2.3 Correlation of Earthquake Activity with Seismic Sources

FSAR Subsection 2.5.2.3 describes the correlation between the updated seismicity with the CEUS-SSC model sources. The applicant compared the distribution of earthquake epicenters from the NUREG–2115 earthquake catalog with the CEUS-SSC model sources and also with the updated earthquake catalog. The applicant concluded that the updated catalog does not show a pattern of seismicity that would require a new seismic source or significant revisions to the geometry of the seismic sources defined in the CEUS-SSC model that are in the Fermi 3 site region. The applicant also concluded that the updated CEUS catalog of the site region cannot be associated with a known geologic structure with the exception of the Anna and Northeast Ohio Seismic Zones, which lie at distances greater than 150 km (90 mi) from the Fermi 3 site. The applicant stated that seismicity in the Anna Seismic Zone occurs near the Ft. Wayne rift and seismicity in the Northeast Ohio Seismic Zone is associated with the Akron Magnetic Boundary; the CEUS-SSC model considers both areas.

2.5.2.2.4 Probabilistic Seismic Hazard Analysis and Controlling Earthquakes

FSAR Subsection 2.5.2.4 describes the applicant’s PSHA calculations for the Fermi 3 site. The hazard curves generated by the applicant’s PSHA represent the hazard calculated for generic hard rock conditions [characterized by a shear wave velocity (S-wave) of 2.8 km/s (9,200 fps)]. FSAR Subsection 2.5.2.4 also describes the earthquake potential for the Fermi site in terms of the most likely earthquake magnitudes and source-to-site distances, which are referred to as “deaggregation earthquakes.” In this subsection, the applicant also determined the low-frequency (1 and 2.5 Hz) and high-frequency (5 and 10 Hz) deaggregation earthquakes by deaggregating the PSHA—in accordance with RG 1.208—at the specified probability levels of 10^{-4} and 10^{-5}.

PSHA Inputs

The applicant's PSHA calculations used the recently published CEUS-SSC model in NUREG–2115 in addition to the ground motion model in EPRI Technical Reports 1009684 and 1014381 (EPRI 2004, 2006).

Seismic Source Model

The applicant stated that the PSHA inputs for the Fermi 3 site consist of the distributed seismicity sources (M_{max} and seismotectonic zones) or portions of these zones that are within 1,000 km (620 mi) of the Fermi 3 site. The applicant conducted PSHA sensitivity calculations to aid in the selection of an appropriate set of RLME sources to include in the PSHA from the CEUS-SSC model. Based on these results, the applicant included CHV, CHS, NMF, and WV RLME sources because they contribute close to or greater than 1 percent to the total mean hazard at the Fermi 3 site. The seismic sources used in the PSHA calculations are summarized earlier under "Geologic and Tectonic Characteristics of the Site and Region" in this SER.

Seismicity Rates

The applicant evaluated the effect of the updated NUREG–2115 earthquake catalog on recurrence estimates within the 320-km (200-mi) site region. According to the applicant, two earthquakes of E[**M**] equal to or greater than 2.9 occurred within 320 km (200 mi) of the Fermi 3 site in the updated catalog (i.e., E[**M**] 3.79 and 3.66). The applicant conducted a one-side exact Poisson test of the hypothesis that the observation of two earthquakes in the 4-year period from 2009 through 2012 is consistent with the earthquake recurrence rates derived from the CEUS-SSC model. The results of the evaluation showed that the two observed earthquakes within 320 km (200 mi) of the Fermi 3 site are consistent with the distribution of earthquake recurrence rates derived from the CEUS-SSC model. Based on these results, the applicant concluded that it is not necessary to update the earthquake recurrence rates for the distributed seismicity source zones of the CEUS-SSC model in the Fermi 3 site region.

Maximum Magnitude Distributions

The applicant stated that FSAR Table 2.5.2-202 lists the earthquakes that have occurred after the completion of the CEUS-SSC model catalog in the time period from 2009 through 2012 with E[**M**] equal to or greater than 4.3. The applicant noted that these earthquakes potentially affect the M_{max} distributions for the following distributed seismicity zones that are applicable to the Fermi 3 PSHA: ECC-AM, GMH, MIDC-A, MIDC-B, MIDC-C, MIDC-D, MESE-N, and NMESE-W. The applicant used the procedure described in Section 5.2.1 of NUREG–2115 to compute the M_{max} distributions for the above source zones and considered the post NUREG–2115 catalog earthquakes listed in FSAR Table 2.5.2-202. The applicant's analysis indicated that forzones ECC-AM, MIDC-A, MIDC-B, MIDC-C, MIDC-D, and NMESE-W, incorporation of the updated earthquake catalog data results in a truncation of the lowest magnitude portion of the NUREG–2115 M_{max} distributions. For the NMESE-W and the MIDC zones, there is also an increase in the probability weight in the lower portion of the adjusted distributions. For the MESE-N and GMH zones, the additional earthquake data have an insignificant effect on the computed M_{max} distributions. As described in FSAR Subsection 2.5.2.4.3, the applicant performed sensitivity calculations using the updated M_{max} distributions in FSAR Table 2.5.2-203. The effect of including these adjusted M_{max} distributions in the hazard calculation produced a 0.3 percent maximum increase in the total mean hazard at 1 Hz and 10 Hz spectral accelerations for the Fermi 3 site. Even though this result indicates that the model does not need to be updated, the applicant conservatively performed the PSHA for the Fermi 3 site using the updated M_{max} distributions.

Ground Motion Prediction Equations

The applicant used the EPRI (2004, 2006) ground motion prediction equations (GMPEs) for the updated PSHA, in addition to the updated aleatory uncertainties and weights. The applicant stated that a number of GMPEs for the CEUS have been published since the completion of the EPRI ground motion median model. In FSAR Figures 2.5.2-239a, 2.5.2-239b, and 2.5.2-239c, the applicant compared these newer GMPEs to the EPRI (2004) 5th, 50th, and 95th percentile 10 Hz and 1 Hz ground motion median models according to the cluster in which they could be assigned. The applicant concluded that the median ground motions obtained using the newer GMPEs—specifically Silva et al. (2003), Atkinson and Boore (2011), and Pezeshk et al. (2011)—produce similar or lower ground motion amplitudes compared to the EPRI (2006) ground motion median models; so they are thus likely to produce lower hazard levels. Therefore, the applicant did not update the EPRI median ground motion models for the purpose of computing the hazard at the Fermi 3 site.

The applicant also discussed the aleatory variability models associated with more recent GMPEs. The applicant noted that the Pezeshk et al. (2011) GMPE uses an average of the Next Generation Attenuation (NGA) aleatory variability values from western North America (WNA). In addition, Atkinson and Boore's (2006) simulation-based aleatory variability value is similar to that for the empirical data in WNA. Atkinson (2013) concluded that aleatory variability models in WNA and central and eastern North America (CENA) should be similar. The applicant thus concluded that it is appropriate to use the EPRI (2006) aleatory variability model in the Fermi 3 PSHA, which is based on empirical ground motion data from active tectonic regions such as WNA.

PSHA Methodology and Calculation

Using the modified CEUS (with modified M_{max} distributions described in FSAR Subsection 2.5.2.4.3) and the EPRI GMPEs (2004, 2006), the applicant performed the PSHA calculations using a fixed lower bound magnitude of **M**5.0 and modeled earthquakes occurring in the CEUS-SSC-distributed seismicity sources as point sources. The applicant applied the EPRI (2004) models for distance adjustment and for additional aleatory variability resulting from the use of point sources (epicenter) to model earthquakes. The models assumed a random rupture location with respect to the epicenter. The applicant modeled earthquakes occurring in the RLME sources as extended ruptures and did not apply the distance adjustment and additional aleatory variability models to these sources. In calculating the magnitude-dependent rupture area of earthquakes for the RLME sources, the applicant made the adjustment to use the 4.35 value instead of 4.366 in Equation H-1 of NUREG–2115.

The applicant performed the above PSHA calculations for peak ground acceleration (PGA) and ground motion frequencies of 25, 10, 5, 2.5, 1, and 0.5 Hz, as described in RG 1.208.

PSHA Results

Figure 2.5.2-4 in this SER shows the mean hard rock uniform hazard response spectra (UHRS) for the 10^{-4}, 10^{-5}, and 10^{-6} annual frequencies of exceedance that the applicant generated using the PSHA results.

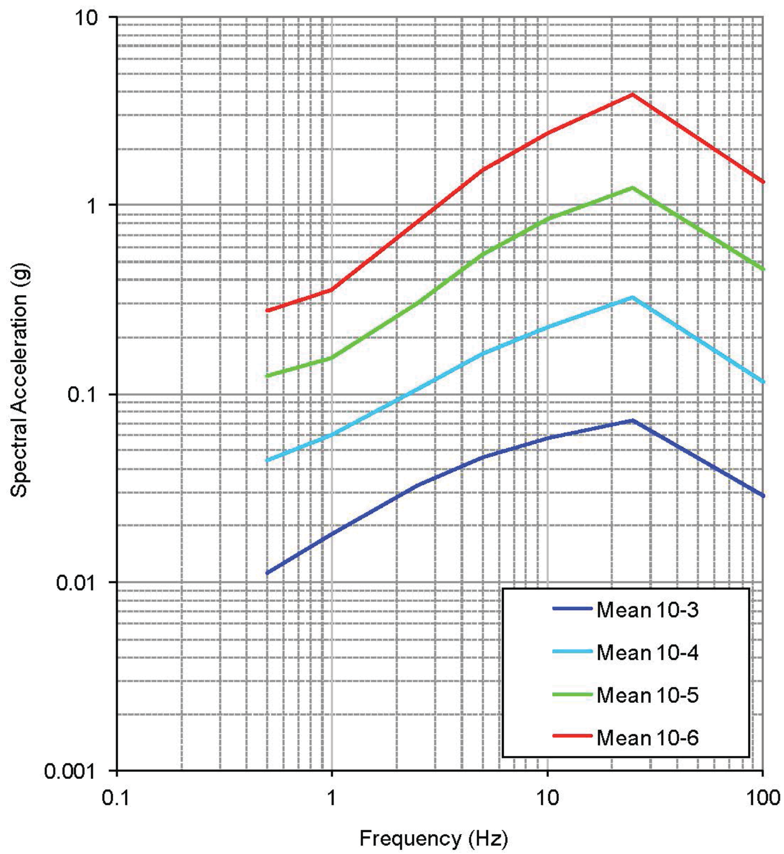


Figure 2.5.2-4 Mean Hard Rock UHRS for the Fermi 3 Site (taken from Fermi COL FSAR markups in the March 15, 2013, response to RAI 01.05-1; Figure 2.5.2-256 (ML13079A491)

To determine the low- and high-frequency controlling earthquakes for the Fermi 3 site, the applicant followed the procedure outlined in RG 1.208, Appendix D. This procedure involves the deaggregation of the PSHA results at a target probability level to determine the controlling earthquake in terms of a magnitude and source-to-site distance. Table 2.5.2-1 in this SER lists the mean magnitudes and geometric mean distances computed for the high- and low-frequency mean 10^{-4}, 10^{-5}, and 10^{-6} hazard results. Following Appendix D of RG 1.208, the applicant selected the controlling earthquake for the low-frequency ground motions from the distance calculation of greater than 100 km (62 mi). The applicant also referred to these controlling earthquakes as reference earthquakes (RE) because Approach 2B was followed for site response analyses described in NUREG/CR–6728, "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard- and Risk-Consistent Ground Motion Spectra Guidelines." As part of Approach 2B, the applicant also specified three high-frequency and three low-frequency deaggregation earthquakes (DE) in order to represent the distribution of earthquakes contributing to the hazard. These DEs are also listed in Table 2.5.2-1 in this SER and are designated as DEL, DEM, and DEH for the low-, middle-, and high-magnitude DEs, respectively. Table 2.5.2-1 shows that the high-frequency hazard is dominated by earthquakes with magnitudes of **M**5.5 occurring at short distances. At low frequencies, earthquakes that are several hundreds of kilometers away with magnitudes greater than **M**7 contribute significantly to the hazard.

Table 2.5.2-1 Rock Hazard Reference and Deaggregation Earthquakes (based on information in Fermi COL FSAR Table 2.5.2-212)

Reference (Controlling) Earthquakes			Deaggregation Earthquakes			
Mean Hazard	**Magnitude (M)**	**Distance (km)**	**Designation**	**Magnitude (M)**	**Distance (km)**	**Weight**
Mean 10^{-4}, 5, and 10 Hz	6.0	48	DEL	5.5	25.8	0.616
			DEM	6.5	76	0.291
			DEH	7.6	585	0.093
Mean 10^{-4}, 1, and 2.5 Hz	7.4	457	DEL	5.5	22.5	0.240
			DEM	6.6	84	0.250
			DEH	7.6	585	0.510
Mean 10^{-5}, 5, and 10 Hz	5.9	15.1	DEL	5.5	10.8	0.657
			DEM	6.4	22.4	0.286
			DEH	7.4	73	0.057
Mean 10^{-5} , 1, and 2.5 Hz	7.6	468	DEL	5.5	11.5	0.295
			DEM	6.7	37	0.395
			DEH	7.7	594	0.310
DE = deaggregation earthquake DEL = DE low DEM = DE middle DEH = DE high			Km = kilometers To convert kilometers to miles divide the numbers by 1.609			

The applicant developed smooth response spectra to represent each RE and DE listed in FSAR Table 2.5.2-212 using the EPRI (2004) ground motion models and the EPRI (2006) aleatory variability models, as well as the spectral shape functions (average of the single and double corner spectral shape models for the CEUS) of the ground motions in NUREG/CR–6728. This involved the development of conditional mean spectral shapes based on Baker and Cornell (2006) and Baker and Jayaram (2008) and is described in more detail in FASR Subsection 2.5.2.4.4.3. The applicant also used the average of the single-corner and double-corner spectral shape models developed in NUREG/CR–6728 to (1) smooth the conditional mean spectral shapes between the seven frequencies defined in the EPRI (2004) ground motion models; and (2) extrapolate the EPRI median ground motion model from a frequency of 0.5 Hz down to a frequency of 0.1 Hz, specifically for the DEL and DEM events as well as the high-frequency (HF) RE events.

The applicant used constant velocity scaling to extend the DEH and low-frequency (LF) RE spectra from 0.5 Hz to 0.1 Hz (with a small decrease from constant velocity scaling from 0.2 Hz to 0.1 Hz) based on recently developed ground motion models (Somerville et al. 2001; Pezeshk et al. 2011; Atkinson and Boore 2011; and Silva et al. 2008a and 2008b). The applicant also extended the EPRI (2006) aleatory variability models down to a frequency of 0.1 Hz using a linear increase in aleatory variability with a decreasing log frequency from 0 percent to 0.5 Hz to 14 percent at 0.1 Hz, which was based on ground motion models developed as part of the Pacific Earthquake Engineering Research (PEER) Center's NGA Project (Abrahamson and Silva 2008; Boore and Atkinson 2008; Campbell and Bozorgnia 2008; Chiou and Youngs 2008; and Idriss 2008).

FSAR Figures 2.5.2-262 through Figure 2.5.2-265 shows the resulting DE and RE response spectra.

2.5.2.2.5 Seismic Wave Transmission Characteristics of the Site

FSAR Subsection 2.5.2.5 describes the method the applicant used for develop the Fermi 3 site free-field soil UHRS. Those resulting from the applicant's PSHA are defined for generic, hard rock conditions characterized by an S-wave of 2.8 km/s [9,200 fps]). According to the applicant, these hard rock conditions exist at an elevation of 48 m (156 ft) NAVD 88 at the Fermi 3 site. To determine the near-surface soil UHRS, the applicant first developed soil/rock profile models for the Fermi 3 site; selected representative hard rock ground motions based on a hard rock seismic hazard calculation; and performed site response analyses to obtain the free-field soil UHRS at the competent layer level beneath the Fermi 3 site.

Site Response Model

According to the applicant, the geology at the Fermi 3 site consists of thin layers of fill, lacustrine deposits, and glacial till overlying dolomite of the Bass Islands and Salina groups. The applicant intends to remove the upper ~4 m (13 ft) of fill, ~1.5 m (5 ft) of low velocity lacustrine deposits, and ~3.4 m (11 ft) of glacial till. The applicant also proposed to locate the GMRS at the top of the Bass Islands group, which corresponds to an average elevation of 168.2 m (551.7 ft) NAVD 88. The applicant performed P-S (compression [P] - shear [S]) suspension logging, downhole seismic testing, and SASW surveys to obtain an S-wave velocity profile for the Fermi 3 site—as shown in Figure 2.5.2-5 of this SER. The applicant used the P-S suspension logging results to obtain the S-wave velocities of the soil and bedrock units. The applicant also used the downhole seismic test results to obtain bedrock S-wave velocities. The applicant encountered CEUS generic hard rock conditions (i.e., an S-wave velocity of about 2.8 km/s [9,200 fps]) at a depth of approximately 143.3 m (470 ft) or an elevation of 48 m (156 ft)—which corresponds to the Salina Group Unit B.

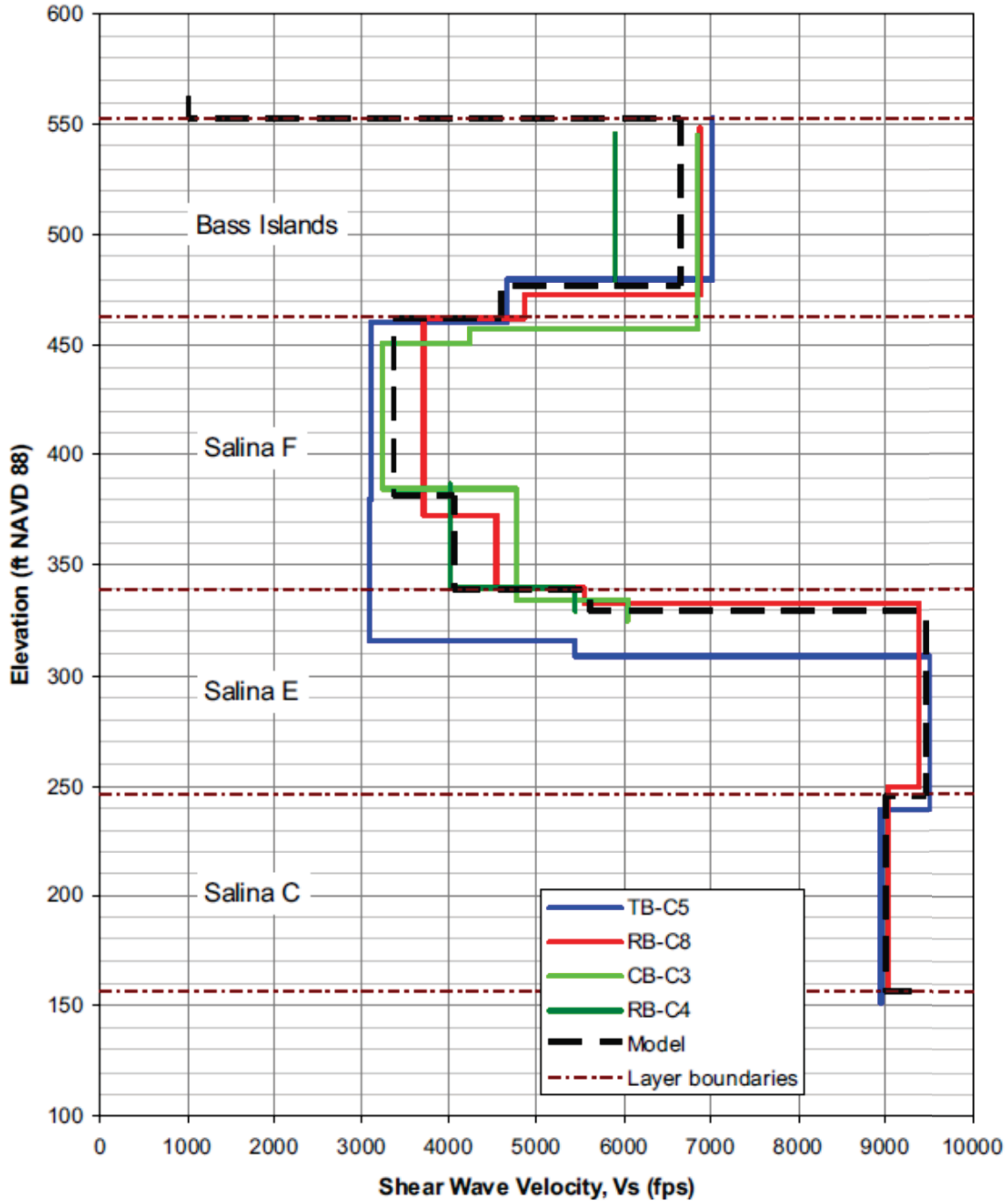


Figure 2.5.2-5 S-Wave Velocity Profile (taken from Fermi COL FSAR markups in the March 15, 2013, response to RAI 01.05-1: Figure 2.5.2-270 [ML13079A491])

[Note: The curves labeled TB-C5, RB-C8, CB-C3, and RB-C4 corresponds to the mean S-wave velocity profiles developed for each boring. The curve denoted as "Model" corresponds to the geometric mean of the velocity profiles developed for each boring.]

In addition to the S-wave velocity profile, the applicant noted that the other material parameters used as inputs to the site response analysis included material unit weight, shear modulus, and damping. The applicant obtained soil and rock unit weights for the site response profile from laboratory test results and the site characterization. In summary, the applicant stated that unit weights for the rock units beneath the site range from 2,402.8 kg/m^3 to 2,562.95 kg/m^3 (150 pounds per cubic-foot [pcf] to 160 pcf). The applicant assigned a value of 2,707.12 kg/m^3 (169 pcf) to the unit weight of the underlying bedrock.

The applicant stated that the site response profile consists of dolomites and claystones with S-wave velocities exceeding 910 m/s (3,000 fps). The applicant expects the behavior of these materials to remain essentially linear at the expected levels of shaking (as defined by the rock hazard). The applicant determined the damping within these materials using the following procedure involving kappa (κ), a near-surface damping parameter, which is an estimate of the seismic energy dissipation at the site during an earthquake caused by damping within soil/rock layers and waveform scattering at layer boundaries. The applicant used estimates of the kappa to determine an appropriate damping ratio value for the rock layers below the glacial till.

The applicant stated that the kappa is an additive for soil/rock layers and is dependant on the individual layers. The applicant assigned the EPRI CEUS hard rock shallow crustal kappa of 0.006 seconds to shallow crust below an elevation of 48 m (156 ft). The applicant noted that the material above this elevation will contribute an additional damping and will thus add to the total site kappa. The applicant used a relationship between the kappa and the site S-wave velocity from EPRI (2005) to estimate the kappa above an elevation of 48 m (156 ft). Using an average S-wave velocity value of 1,737 m/s (5,700 fps), the applicant obtained a kappa of 0.013 seconds. The applicant then subtracted this value from the hard rock value of 0.006, which yielded a remaining kappa of 0.007 seconds for the top 121 m (396 ft) of dolomite. The applicant's conversion to damping, however, constrained the low strain damping for the Salina Group Unit F to a range of 1 to 3 percent based on values from the literature (Silva et al. 1996; EPRI 2005); and Silva 2007. The applicant then computed the damping values for the remaining rock layers using Equations 1, 2, and 4 in FSAR Subsection 2.5.2.5.1.2. The applicant noted that these assigned damping values add an additional kappa of 0.001 to 0.003 seconds. The applicant's conversion from kappa to material damping, made corrections to account for scattering effects due to velocity reversals present in the velocity model, as well as reversals introduced by randomizing the velocity profiles. The applicant assigned a damping value of 0.1 percent to the halfspace.

The applicant determined the appropriate soil and rock dynamic properties and then modeled the variability in the site data by randomizing the S-wave velocity profile. The applicant generated randomized profiles using the S-wave velocity correlation model developed by Silva et al. (1996). The applicant computed the damping in the sedimentary rocks beneath the glacial till using the randomized sedimentary rock layer velocities and thicknesses, as well as the selected kappa values. These artificial profiles represent the soil column from the top of the bedrock (with a bedrock S-wave velocity of 2.8 km/s [9,200 fps]) to the top of the Bass Islands Group bedrock for calculating the GMRS. The applicant used these randomized profiles as input to the site response calculations, which are summarized below in this SER.

In addition to the GMRS, the applicant developed foundation input response spectra (FIRS) at the base of the RB/FB, the control building (CB), and the fire water service complex (FWSC) that are presented in FSAR Section 3.7.1.

Site Response Input Time Histories

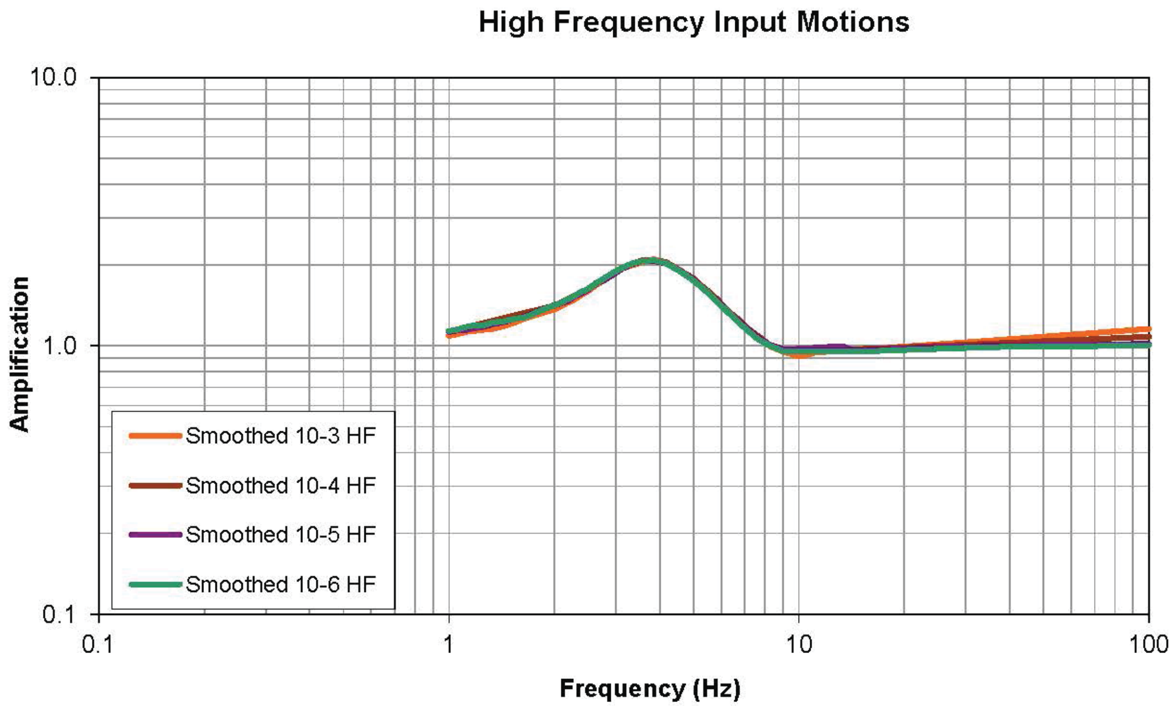
In order to develop rock input time histories for the Fermi 3 site response, FSAR Subsection 2.5.2.5.2 refers to the applicant's response spectra developed for each DE in FSAR

Subsection 2.5.2.4.4.3. The applicant stated that 30 time histories were developed for each DE (i.e., three DEs for each HF and LF 10^{-3}, 10^{-4}, 10^{-5}, and 10^{-6} hazard level). The applicant selected time histories from NUREG/CR–6728 and scaled them to approximately match the target DE spectrum using the routine RSPM06, which implements the time domain spectral matching approach developed by Lilhanand and Teng (1988). The applicant concluded that the weak scaling produced records that have, in general, the desired relative frequency content of the DE spectra while maintaining a degree of natural variability.

Site Response Methodology and Results

The applicant used an updated version of the SHAKE computer program to calculate the site response at the Fermi 3 site. To calculate the final site amplification effects of the soil, the applicant divided the response spectrum for the computed surface motion by the corresponding response spectrum for the hard rock input motion. The applicant paired the 60 randomized S-wave velocity profiles with the 30 scaled time histories to compute the response of two profiles. The applicant then computed the arithmetic mean of the 60 individual response spectral ratios to define the amplification function.

In addition, for each DE, the applicant computed mean amplification functions for the three sets of rock damping values (1, 2, and 3 percent). For each annual exceedance probability level, the results from the three DEs (DEL, DEM, and DEH) are then combined to produce a weighted mean amplification function. The corresponding weights are in FSAR Table 2.5.2-215. FSAR Figure 2.5.2-277 shows the applicant's results for the different rock damping values that were used (1, 2, and 3 percent) for the 10^{-4} exceedance level. The applicant noted that the range in the damping leads to less than a 15 percent difference in the mean amplification at 100 Hz, which is less than a 25 percent difference near 40 Hz and decreases to less than a difference of 6 percent at 10 Hz. This difference continues to decrease for frequencies below 10 Hz. In addition, based on the results in FSAR Figure 2.5.2-278, the applicant concluded that the site amplification functions are insensitive to the differences in the DEs. Figure 2.5.2-6 in this SER plots the resulting high- and low-frequency amplification functions for the 10^{-3}, 10^{-4}, 10^{-5}, and 10^{-6} hazard levels. According to the applicant, the site amplification is insensitive to the level of input motion from the presence of relatively hard rock that is modeled as linear material.



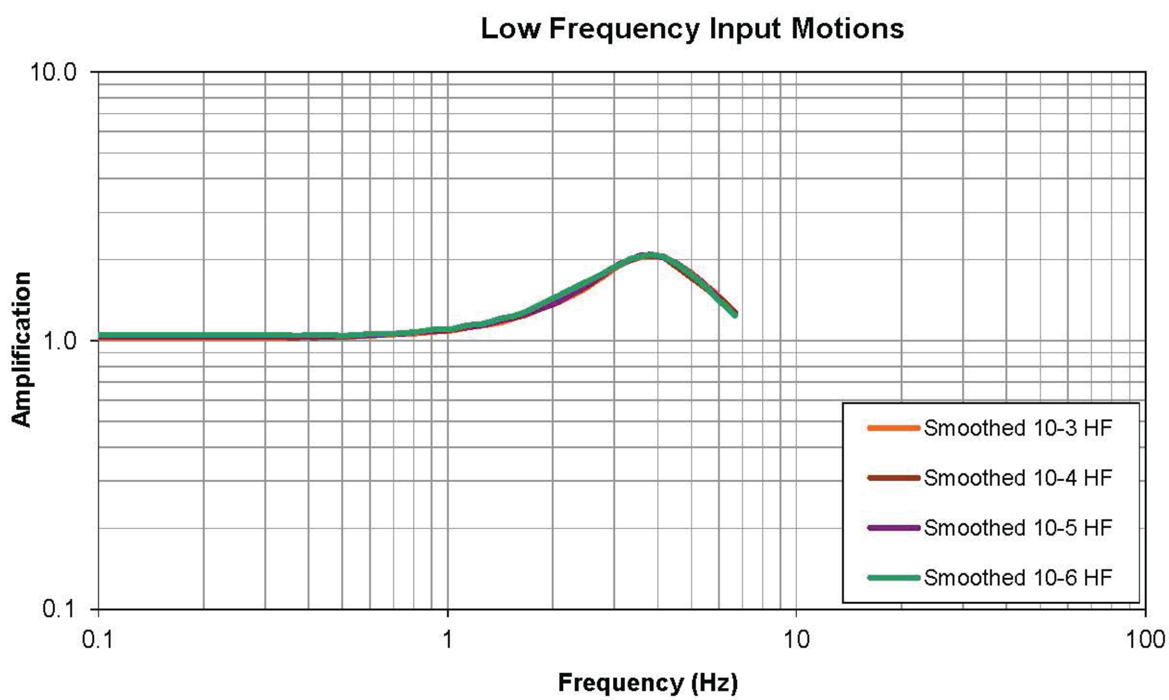


Figure 2.5.2-6 Mean Amplification Functions Corresponding to the Four Levels of Input Motion (i.e., annual probability of exceedance levels of 10^{-3}, 10^{-4}, 10^{-5}, and 10^{-6}) (taken from Fermi COL FSAR markups in the March 15, 2013, response to RAI 01.05-1: Figure 2.5.2-279 [ML13079A491])

2.5.2.2.6 Ground Motion Response Spectra

FSAR Subsection 2.5.2.6 describes the method the applicant used to develop the horizontal and vertical site-specific GMRS. To obtain the horizontal GMRS, the applicant used the performance-based approach in RG 1.208 and in ASCE/SEI Standard 43–05, "Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities." The applicant developed the vertical GMRS using vertical-to-horizontal response spectral ratios for generic CEUS hard rock sites in NUREG/CR–6728.

The applicant first described the development of the hazard-consistent surface spectra using the 10^{-4} hazard level ground motions as an example. The applicant defined the surface spectra as free-field outcropping motions at an elevation of 168 m (551.7 ft) NAVD88. In summary, the applicant scaled the high- and low-frequency RE spectra by the appropriate smoothed amplification function. The applicant also scaled the generic hard rock UHRS using the appropriate low- and high-frequency amplification functions. Before applying the amplification functions, the applicant interpolated the rock UHRS between 10 and 100 Hz using the approach in FSAR Subsection 2.5.2.4.4.3. This approach was also summarized earlier in this SER section because there is a sharp peak at 25 Hz, which is an artifact of the PSHA computed for a limited number of frequency values (10, 25, and 100 Hz).

The final surface 10^{-4} UHRS is defined by the smooth envelope of the two spectra described above. The applicant conservatively removed the dip observed in the surface UHRS in the frequency range of 4 to 20 Hz that had resulted from (1) peaks in the site amplification function near 4 Hz from the overall rock profile, and (2) the peak near 25 Hz in the hard rock UHRS.

The applicant repeated the above procedure for the 10^{-5} and 10^{-6} exceedance level motions and then used the resulting surface spectra to develop the Fermi 3 horizontal and vertical GMRS.

Horizontal GMRS

The applicant calculated a horizontal, site-specific, performance-based GMRS using the method in RG 1.208. The performance-based method achieves the annual target performance goal (P_F) of 10^{-5} per year for the frequency of onset of significant inelastic deformation. This damage state (i.e., deformation) represents a minimum structural damage state—or essentially elastic behavior—and falls well short of the damage state that would interfere with functionality. The GMRS was calculated using the following relationship:

$$GMRS = DF^{*}\ UHRS(10^{-4})$$

Where:

$$DF = \max\{1.0,\ 0.6\ (A_R)^{0.8}\}$$

$$A_R = UHRS(10^{-5})/UHRS(10^{-4})$$

The applicant noted that when the value of A_R exceeds 4.2, RG 1.208 specifies that it is appropriate to use a GMRS value equal to 45 percent of the mean 10^{-5} UHRS. The applicant calculated the GMRS using the two approaches and developed the final GMRS from the envelope of the two, which corresponds to the 10^{-4} UHRS multiplied by the DF. Figure 2.5.2-7 of this SER shows the resulting horizontal GMRS.

Vertical GMRS

The applicant obtained the vertical GMRS by deriving V/H ratios and applying them to the horizontal GMRS. The applicant used the V/H spectral ratios for the generic CEUS hard rock sites in NUREG/CR–6728. The applicant justified the use of the generic CEUS hard rock V/H ratios by pointing out that the S-wave velocity of the Fermi 3 site is relatively high, and the kappa value of the assessed site is not significantly greater than the generic hard rock value. Figure 2.5.2-7 in this SER shows the resulting vertical GMRS.

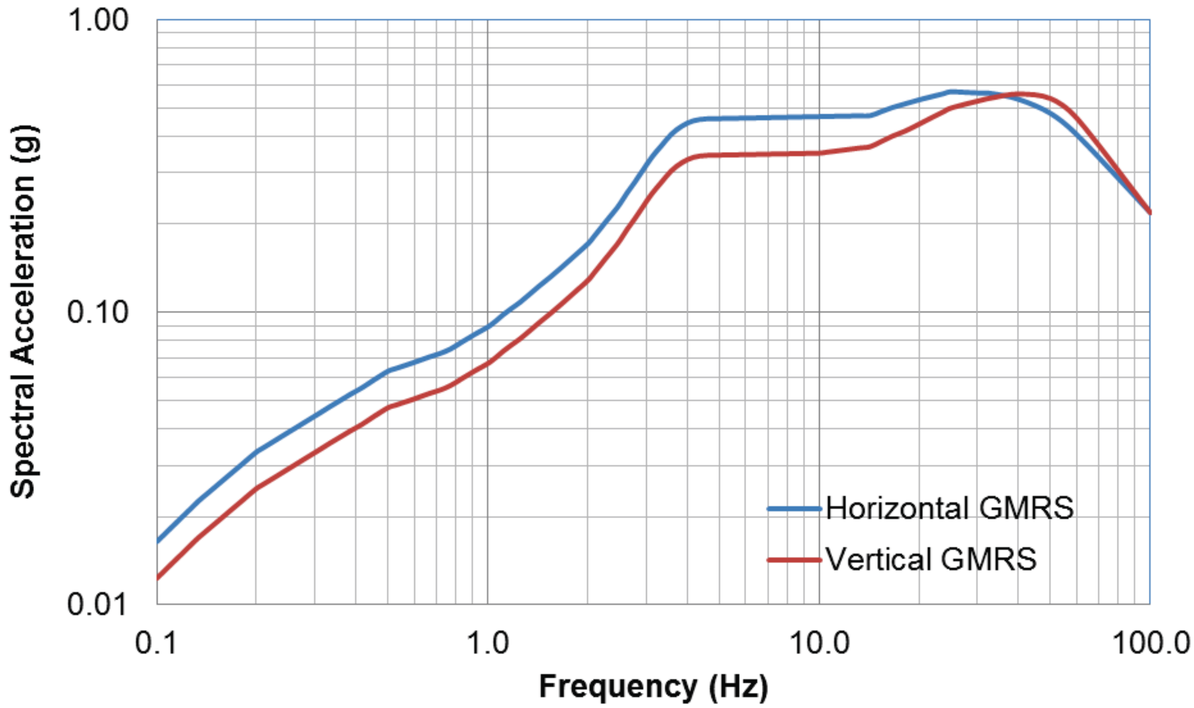


Figure 2.5.2-7 Fermi 3 Horizontal and Vertical GMRS (plot generated from data in Attachment 1 to the response to RAI 01.05-1 dated February 22, 2013 [ML13070A339])

2.5.2.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the vibratory ground motion, and the associated acceptance criteria, are in Section 2.5.2 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR 100.23 with respect to obtaining geologic and seismic information necessary to determine site suitability and to ascertain that any new information derived from site-specific investigations does not impact the GMRS derived from a probabilistic seismic hazard analysis. In complying with this regulation, the COL applicant also meets the guidance in RG 1.132 and RG 1.208.

- 10 CFR 52.79(a)(1)(iii) as it relates to considerations of the most severe of the natural phenomena historically reported for the site and surrounding area and with a sufficient margin for the limited accuracy, quantity, and period of time when the historical data were accumulated.

The related acceptance criteria from NUREG–0800, Section 2.5.2, are summarized as follows:

- Seismicity: To meet the requirements in 10 CFR 100.23, this section is accepted when the complete historical record of earthquakes in the region is listed and when all available parameters are given for each earthquake in the historical record.

- Geologic and Tectonic Characteristics of Site and Region: Seismic sources identified and characterized in NUREG–2115 were used.

- Correlation of Earthquake Activity with Seismic Sources: To meet the requirements in 10 CFR 100.23, the acceptance of this section is based on the development of the relationship between the history of earthquake activities and the seismic sources of the region.

- Probabilistic Seismic Hazard Analysis and Controlling Earthquakes: For CEUS sites that rely on the NUREG–2115 seismic source characterization model, the staff will review the applicant's PSHA including the underlying assumptions, how the results of the site investigations are used to update the existing sources in the PSHA, and how these site investigation results are used to develop additional sources or to develop a new database.

- Seismic Wave Transmission Characteristics of the Site: In the PSHA procedure described in RG 1.208, the controlling earthquakes are determined for generic rock conditions.

- Ground Motion Response Spectra: In this section, the staff reviews the COL applicant's procedure for determining the GMRS.

In addition, the geologic and seismic characteristics should be consistent with the appropriate sections in: RG 1.60 Revision 1, "Design Response Spectra for Seismic Design of Nuclear Power Plants"; RG 1.132; RG 1.208; and RG 1.206.

2.5.2.4 *Technical Evaluation*

The staff reviewed the information in COL FSAR Section 2.5.2 related to vibratory ground motion in the response to RAI 01.05-1 as follows:

COL Items

- EF3 COL 2.0-27-A Vibratory Ground Motion

NRC staff reviewed Fermi COL FSAR Section 2.5-2 related to COL Item 2.0-27A. This COL item addresses the provision for site-specific information related to the vibratory ground motion aspects of the site including: seismicity, geologic and tectonic characteristics, the correlation of earthquake activity with seismic sources, a probabilistic seismic hazard analysis, seismic wave transmission characteristics, and the SSE ground motion.

The staff also reviewed the applicant's information that addresses the provision for performing site-specific evaluations, (1) if the site-specific GMRS at the foundation level exceeds the response spectra in DCD Figures 2.0-1 and 2.0-2 at any frequency; or (2) if soil conditions are outside the range evaluated for the ESBWR DCD.

This SER section provides the NRC staff's evaluation of the seismic, geologic, geophysical, and geotechnical investigations carried out by the applicant to determine the site-specific GMRS or the SSE ground motion for the site. The development of the GMRS is based on a detailed evaluation of the potential for an earthquake that takes into account the regional and local geology, Quaternary tectonics, seismicity, and site-specific geotechnical engineering characteristics of the site subsurface material.

During the early site investigation stage, the staff visited the site and interacted with the applicant regarding the geologic, seismic, and geotechnical investigations conducted for the Fermi 3 COL application. To thoroughly evaluate the applicant's geologic, seismic, and geophysical information, the staff obtained additional assistance from experts at the USGS. With the USGS advisors, the staff made an additional visit to the Fermi 3 site in November 2009 (ML14112A212) to confirm the applicant's interpretations, assumptions, and conclusions related to potential geologic and seismic hazards. As discussed in the introduction to Section 2.5 of this SER, the staff had submitted several RAIs to the applicant and had evaluated the responses during the review process conducted during the past several years. However, following the NTTF that the NRC issued after Japan's Fukushima accident in March 2011, and the subsequent submissions of an RAI to all COL and ESP applicants (RAI 01.05-1), the applicant significantly revised the COL FSAR—especially COL FSAR Section 2.5.2 related to seismic hazard calculations. As part of this COL FSAR revision, the COL applicant replaced the previously used EPRI (1986) seismic source models in the seismic hazard calculations with the newly published NUREG–2115 CEUS seismic source characterization model. With this change in the base seismic source model, many of the earlier RAIs became irrelevant and were closed. Therefore, the staff's evaluations of many of these earlier RAIs are not part of this report. However, several of the original RAIs are still applicable to the staff's review. They are discussed below, in addition to the new RAIs that the staff developed in response to the revised COL FSAR.

2.5.2.4.1 Seismicity

FSAR Subsection 2.5.2.1 states that the earthquake catalog used for the Fermi 3 site seismic hazard assessment is the NUREG–2115 earthquake catalog. The earthquake catalog is published as part of the NUREG–2115 seismic source model and covers the entire CEUS region, from 1568 through 2008, and includes a uniform moment magnitude scale for all earthquakes listed in the catalog. The staff recently reviewed the NUREG–2115 earthquake catalog. The staff's technical evaluation of COL FSAR Subsection 2.5.2.1 focused on the applicant's efforts to update the original NUREG–2115 earthquake catalog to use in the PSHA of the Fermi 3 site.

The applicant stated that the NUREG–2115 catalog is the starting point for developing an updated earthquake catalog for the Fermi 3 site region. The applicant developed the updated catalog for the portion of the NUREG–-2115 catalog between latitude 39° and 45°N and longitude 79° and 87.5°W, from January 2009 through December 2012. Furthermore, the applicant followed the process used in NUREG–2115 to develop an updated earthquake catalog that FSAR Figure 2.5.2-202 depicts. According to the applicant, the updated catalog shows that from 2009 through 2012, two earthquakes of E[**M**] equal to or greater than 2.9 occurred within 320 km (200 mi) of the Fermi 3 site. The first of these earthquakes had a magnitude of E[**M**] 3.79; the second had a magnitude of E[**M**] of 3.66. The applicant's updated catalog showed that no significant (E[**M**] ≥ 4) earthquakes have occurred in the 320-km (200-mi) site region. The applicant also evaluated earthquakes that have occurred beyond the 320-km (200-mi) site radius.

As shown in FSAR Table 2.5.2-202 and FSAR Figure 2.5.233, the applicant identified 12 earthquakes in the updated NUREG–2115 catalog with the potential to impact CEUS-SSC distributed seismicity sources (E[**M**] ≥ 4.3). This list included the August 23, 2011, E[**M**] 5.73 earthquake near Mineral (Virginia) and the November 6, 2011, E[**M**] 5.66 earthquake in central Oklahoma.

The staff developed a supplementary earthquake catalog covering the CEUS region from 2009 through 2012, in order to evaluate the completeness of the applicant's updated catalog and subsequent conclusions. The staff used the USGS ANSS, which is in Figure 2.5.2-8 in this SER. The staff compared this recent seismicity with the applicant's updated catalog in FSAR Figures 2.5.2-202 and 2.5.2-203. The staff concluded that the recent seismicity does not show any significant deviations from the applicant's updated seismicity catalog. Therefore, the staff concludes that the Fermi 3 earthquake catalog adequately characterizes the regional and local seismicity through 2012.

NRC Staff's Conclusions Regarding Seismicity

After reviewing FSAR Subsection 2.5.2.1, the staff concludes that the applicant has developed a complete and accurate earthquake catalog for the region surrounding the Fermi 3 site and that the earthquake catalog as described in FSAR Subsection 2.5.2.1 forms an adequate basis for the seismic hazard characterization of the site and meets the requirements of 10 CFR 52.79 and 10 CFR 100.23.

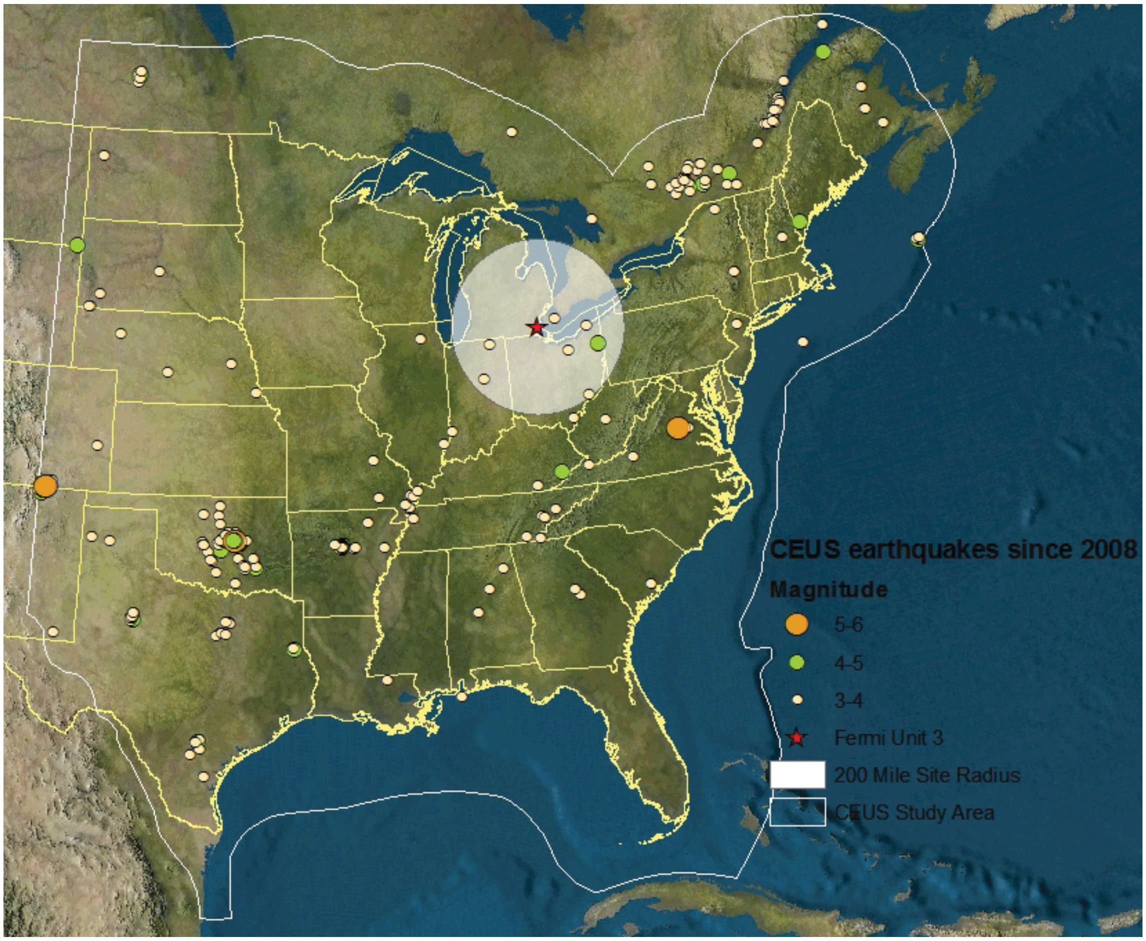


Figure 2.5.2-8 Earthquakes with Magnitudes Equal to or Greater than 3.0 in the CEUS between 2009 and 2012

2.5.2.4.2 Geologic and Tectonic Characteristics of the Site and Region

FSAR Subsection 2.5.2.2 describes the seismic sources the applicant used to calculate the seismic ground motion hazard for the Fermi 3 site. Specifically, the applicant described the seismic source model published as part of NUREG–2115. The staff previously reviewed the NUREG–2115 seismic source model and approved its use as a starting regional model for nuclear power plant applications. However, NUREG–2115 specifically states that a regional mode should be compared against the local data and information. If needed, there must also be appropriate local adjustments. However, FSAR Subsection 2.5.2.4.1 describes the applicant's investigation of potential local seismic sources and source parameter adjustments to the NUREG–2115 model. The staff's review in this SER section therefore focused on the applicant's selection of the appropriate seismic sources from the CEUS-SSC model. The staff's detailed review of potential local seismic sources and source parameter adjustments to the NUREG–2115 model is in Subsection 2.5.2.4.4 of this SER.

<u>*NUREG–2115 Seismic Source Model*</u>

The CEUS-SSC model is published as part of NUREG–2115 and contains two types of seismic sources—distributed seismicity sources and RLME sources. The total seismic hazard at a given site is calculated by adding the hazard contributions of the distributed seismicity sources to those obtained using the RLME sources. Whereas the distributed seismicity sources are based on available earthquake locations and regional geologic/tectonic characterizations, the RLME sources are primarily based on geologic and paleoearthquake records. The NUREG-2115 model incorporates uncertainties in source geometries and model parameters by using logic trees and by assigning varying degrees of weights to the branches of the logic trees based on supporting data and evidence.

RLME Sources

The RLME sources describe seismic zones where there are documented occurrences of repeated (two or more) large magnitude earthquakes (**M** > 6.5). There are nine RLME sources defined in the NUREG–2115 model covering the entire CEUS region; they are all depicted in Figure 2.5.2-3 of this SER. These seismic sources are the CHV, CHS, Cheraw fault, Meers fault, NMF system, Eastern Rift margin fault, Marianna, Commerce fault zone (CFZ), and WV seismic sources. The applicant conducted PSHA sensitivity calculations to aid in the selection of an appropriate set of RLME sources to include in the PSHA. The applicant examined the following RLME sources closest to the Fermi 3 site: the CFZ, CHS, CHV, Eastern Rift Margin, Marianna, WV, and NMF system. Based on the results of sensitivity calculations, the applicant only included the CHV, CHS, NMF system, and WV RLME sources in the final PSHA because they contribute close to or greater than 1 percent to the total mean hazard at the Fermi 3 site.

The staff evaluated the applicant's rationale for selecting four out of the nine RLME sources for use in the PSHA calculations and finds that the applicant's selection of only the RLME sources that contribute close to or greater than 1 percent of the total mean hazard is adequate for the Fermi 3 PSHA calculations, because the remaining RLME source would not contribute significantly to the total mean hazard.

Distributed Seismicity Sources

The distributed seismicity sources are the second type of seismic sources described in the NUREG–2115 model, which classifies the distributed seismicity sources into two main subgroups: M_{max} zones and seismotectonic zones. These subgroups reflect the fact that there are differing views about seismic source characterizations in the CEUS region. The M_{max} zones represent the view that large magnitude earthquakes may occur anywhere in the CEUS region, and the tectonics of the region contribute minimally to the occurrence of medium and large earthquakes. The M_{max} zones are broad seismic sources with limited tectonic information; they represent areas with potential sources of future earthquakes. Seismotectonic sources represent an alternative view of variations in the occurrence of medium and large magnitude earthquakes based on tectonic environments. The seismotectonic sources result from extensive analyses of regional geology, tectonics, and seismicity in the CEUS region. Both the M_{max} and the seismotectonic zones also include alternative source geometries that accommodate inherent uncertainties in seismic source characterizations. Seismic hazard contributions are calculated for both subgroups, and the results of the M_{max} sources and the seismotectonic sources are weighted by 40 percent and 60 percent, respectively, to determine the total seismic hazard contributions of the distributed seismic sources at a given site.

The applicant included all or parts of each M_{max} source zone that is located within 1,000 km (620 mi) of the Fermi 3 site. Therefore, the applicant's PSHA is comprised of the following five alternative M_{max} seismic source configurations: Study Region, MESE-W, MESE-N, NMESE-W, and NMESE-N. The Study Region seismic source is the largest seismic source in the CEUS model, and it represents the entire area of the CEUS region. The MESE and NMESE sources represent regions where either the Mesozoic-aged (250 million years) or the younger tectonic extension did (MESE) or did not (NMESE) take place. The subgroups of the MESE and NMESE seismic sources—MESE-W, NMESE-N, and MESE-N—represent alternative configurations for each of these sources. The extension "N" represents the "narrow" and the extension "W" represents the "wide" alternative source geometries. The staff confirmed the applicant's choice of the M_{max} sources because they are adequate and satisfy the guidance in RG 1.208, which states that all seismic sources within the 320-km (200-mi) radius of the site should be investigated.

The NUREG–2115 seismic source characterization model also identifies 12 primary seismic sources within the seismotectonic subcategory of the distributed seismicity sources. Because there are uncertainties in source geometry definitions, some of these sources also have defined alternative geometries. The applicant used the same criteria of 1,000 km (620 mi) used for the M_{max} source zone selection, in order to determine which seismotectonic sources to include in the PSHA. Among the 12 seismotectonic-based seismic sources identified in NUREG–2115, the applicant identified the following sources as contributors to the seismic hazard estimates at the Fermi 3 site: AHEX; ECC–AM; GMH; IBEB;,MIDC-A, MIDC-B, MIDC-C, and MIDC-D; NAP; PEZ-N and PEC-W; RR and RR-RCG; and SLR.

The staff reviewed all of the CEUS-SSC seismic sources described in NUREG–2115 that occur within the 1,000-km (620-mi) site radius and confirmed that the applicant's choices of seismic source models are adequate and conform to the guidance in RG 1.208.

NRC Staff's Conclusions of the Geologic and Tectonic Characteristics of the Site and Region

Based on the review of the seismic sources described in the NUREG–2115 model, the staff concluded that the applicant has selected all of the appropriate CEUS-SSC RLME, M_{max}, and seismotectonic sources for inputs into the PSHA of the Fermi 3 site. The staff found that the applicant's has selected all sources that lie well beyond the 320-km (200-mi) site radius and also selected all RLMEs that contribute close to or greater than 1 percent of the total mean hazard. Therefore, the staff concludes that the applicant's seismic source zone model forms an adequate basis for the seismic hazard calculation of the site and meets the requirements of 10 CFR 52.79 and 10 CFR 100.23.

2.5.2.4.3 Correlation of Earthquake Activity with Seismic Sources

FSAR Subsection 2.5.2.3 describes the correlation of updated seismicity with the CEUS-SSC model sources. The applicant compared the distribution of earthquake epicenters in the NUREG–2115 earthquake catalog with the CEUS-SSC model sources and also with its updated earthquake catalog. Based on this comparison, the applicant concluded that the updated catalog does not show a pattern of seismicity that would require a new seismic source or significant revisions to the geometry of the seismic sources defined in the CEUS-SSC model of the Fermi 3 site region. The applicant also concluded that the updated CEUS catalog does not show any earthquakes in the site region that can be associated with a known geologic structure, with the exception of the Anna and Northeast Ohio Seismic Zones, which lie at distances greater than 150 km (90 mi) from the Fermi 3 site. The applicant stated that seismicity in the Anna Seismic Zone occurs near the Ft. Wayne rift, while seismicity in the Northeast Ohio Seismic Zone is associated with the Akron Magnetic Boundary; the CEUS-SSC model considers both areas.

In Subsection 2.5.2.4.1 of this SER, the staff evaluated the completeness of the applicant's updated earthquake catalog and the applicant's subsequent conclusions, by comparing the applicant's earthquake catalog to a compilation catalog derived from the USGS ANSS seismicity catalog. Based on the spatial distribution of earthquakes in the updated catalog, the staff concurred with the applicant's conclusion that significant revisions to the existing CEUS-SSC source geometries are not warranted. The staff found that the applicant has adequately evaluated the potential for new seismic sources or for revisions to existing source geometries based on seismicity patterns. Therefore, the applicant's analysis meets the requirements of 10 CFR 52.79 and 10 CFR 100.23.

2.5.2.4.4 Probabilistic Seismic Hazard Analysis and Controlling Earthquakes

FSAR Subsection 2.5.2.4 presents the applicant's PSHA results and estimates of potential earthquakes for the Fermi 3 site in terms of deaggregation earthquakes. The applicant determined the high- and low-frequency deaggregation earthquakes by deaggregating the PSHA results at selected probability levels, in accordance with the guidance in RG 1.208. Before conducting the PSHA calculations and determining the deaggregation earthquakes, the applicant investigated the local and regional geologic and tectonic features and any potential adjustments to the seismic sources and their model parameters. Subsection 2.5.1.4 of this SER describes the staff's assessments of the local and regional geological features and concludes that no additional updates are needed. Therefore, the staff's review focused on the applicant's PSHA procedures for and the calculation of the Fermi 3 site deaggregation earthquakes.

PSHA Calculation

FSAR Subsection 2.5.2.4.1 states that the applicant used the NUREG–2115 seismic model for the probabilistic seismic hazard calculations of the Fermi 3 site and also outlines the procedures. Because the NUREG–2115 model covers the entire CEUS region, it may be unnecessary to use seismic sources in the PSHA calculations that are farther away and have lower seismicity rates. The applicant first identified seismic sources that will impact the seismic hazard calculations at the Fermi 3 and then used those selected seismic sources and the EPRI (2004, 2006) ground motion model (GMM) to calculate generic hard rock seismic hazard curves at the seven frequencies defined by the EPRI (2004, 2006) GMM. Using the hard rock seismic hazard curves, the applicant obtained uniform hazard response spectra at the annual frequency of exceedances of 10^{-4}, 10^{-5}, and 10^{-6}. Using the procedures outlined in RG 1.208, the applicant also developed the magnitudes and distances of deaggregation earthquakes. The following discussion describes the staff's assessment of the applicant's PSHA calculations and the determination of the deaggregation earthquakes and their parameters.

PSHA Inputs

Among the distributed seismicity sources described in the NUREG–2115 model, Subsection 2.5.2.4.2 of this SER notes that the applicant used those sources with boundaries that are intersected by the 1,000-km (620-mi) site radius—which is well beyond the 320-km (200-mi) region specified by RG 1.208. The applicant also screened the RLME sources based on their potential contribution to the total seismic hazard. Specifically, the applicant included the RLME sources if they contribute close to or greater than 1 percent to the total mean hazard at the Fermi 3 site. RG 1.208 states that if seismic sources are completely beyond the 320-km (200-mi) site region radius but are large enough seismic sources with the potential to contribute to the total seismic hazard, the seismic sources should be considered in the seismic hazard calculations. Thus, the staff concludes that the applicant's source zone selection criteria are adequate.

The applicant used the EPRI (2004, 2006) GMM and the updated aleatory uncertainties and weights for the PSHA. Since the development of the EPRI (2004, 2006) GMM, several GMPEs for the CEUS have been published. In RAI 02.05.02-4, the staff requested the applicant to evaluate the impacts from including more recent GMPEs in the Fermi 3 seismic hazard—such as Tavakoli and Pezeshk (2005) and Atkinson and Boore (2006). Based on comparisons of the newer GMPEs with the EPRI (2004) model, the applicant concluded that the median ground motions obtained using the newer GMPEs—specifically Silva et al. (2003), Atkinson and Boore (2011), and Pezeshk et al. (2011)—produce similar or lower ground motion amplitudes compared to the EPRI (2004) GMMs, and are thus likely to produce lower hazard levels. Therefore, the applicant did not update the EPRI (2004, 2006) GMM for the purpose of computing the hazard levels for the Fermi Unit 3 site.

The staff reviewed the applicant's comparisons of the EPRI (2004, 2006) GMM with more recent GMPEs and determined that the applicant's conclusions are supported by the recently updated EPRI (2004, 2006) GMM (EPRI 2013) conducted in accordance with the SSHAC process. In a letter dated August 28, 2013 (ADAMS Accession No. ML13233A102), the NRC determined that the Updated GMM is an acceptable ground motion model to use for CEUS plants in developing plant-specific, ground motion response spectra until the NGA project for eastern North America (NGA-East) is complete and NRC staff has reviewed and approved it (NRC 2013).

Chapter 8 of the EPRI (2013) report provides the results of demonstration hazard calculations performed using the updated EPRI (2004, 2006) GMM and the EPRI (2004, 2006) GMPE for seven test sites; including the Central Illinois test site, which is the closest test site to the Fermi 3 site. The resulting UHRS are in Figures 8.2-1h, 8.2-2h, 8.2-3h, 8.2-4h, 8.2-5h, 8.2-6h, and 8.2-7h in the EPRI (2013) report. All of the test site comparisons show that the updated EPRI (2004, 2006) GMPEs produce equivalent or lower spectral accelerations when compared to the EPRI (2004, 2004) GMPEs. Furthermore, the spectral shapes remain consistent between both the earlier and the updated models, with the exception of very low hazard sites (e.g., the Houston test site) at frequencies below ~1 Hz. The staff therefore concludes that the applicant's use of the EPRI (2004, 2006) GMPEs is adequate for the Fermi 3 PSHA calculation.

PSHA Methodology and Calculation

Using the NUREG–2115 CEUS-SSC model and the EPRI (2004, 2006) GMPEs, the applicant performed PSHA calculations for the PGA and ground motion frequencies of 25, 10, 5, 2.5, 1, and 0.5 Hz, as described in RG 1.208. Before performing the final PSHA calculation for the Fermi 3 site, the applicant first conducted sensitivity calculations in order to (1) determine which set of RLMEs to include in the final calculation; and (2) evaluate the impacts of more recent earthquakes and determine whether or not updates to the associated CEUS-SSC seismic sources are necessary.

In FSAR Subsection 2.5.2.4.3.1, the applicant described the selection process used to identify which RLME sources to include in the PSHA model for the Fermi 3 site. The applicant examined the source contributions at 1 Hz and 10 Hz spectral accelerations for the eight RLME sources closest to the Fermi 3 site (the CFZ, CHS, CHV, Eastern Rift Margin – North [ERM-N], Eastern Rift Margin – South [ERM-S], Marianna Zone [MAR], NMF, and the WV sources). Based on the results of these sensitivity calculations, which are shown in FSAR

Figures 2.5.2-240 and 2.5.2-241, the applicant decided to include the NMF, WV, CHS, and CHV RLME sources because they contributed close to or greater than 1 percent to the total mean hazard at the Fermi 3 site. The applicant did not include the remaining RLMEs because they contribute to less than 1 percent of the total mean hazard. The staff reviewed the applicant's results in FSAR Figures 2.5.2-240 and 2.5.2-241 and concurred with the applicant that inclusion of only the NMF, WV, CHS, and CHV RLME sources is adequate, because the remaining RLME sources would not produce a significant contribution to the total mean hazard at the Fermi 3 site.

As described in FSAR Subsection 2.5.2.4.3, the applicant performed PSHA sensitivity calculations using the updated M_{max} distributions shown in FSAR Table 2.5.2-203. These updated M_{max} distributions are based on the earthquakes with an E[**M**] equal to or greater than 4.3 that have occurred after completion of the CEUS-SSC model catalog in the time period from 2009 through 2012. The applicant found that the effect of including these adjusted M_{max} distributions in the hazard calculation produces a 0.3 percent maximum increase in total mean hazard at 1 Hz and 10 Hz spectral accelerations for the Fermi 3 site. Even though this result indicated that the model did not need to be updated, the applicant conservatively performed the PSHA for the Fermi 3 site using the updated M_{max} distributions. Based on the applicant's discussion of the results, the staff concurs that updating the M_{max} distributions did not result in any significant change in the seismic hazard calculation results. Therefore, updates to the CEUS-SSC model source zone are not warranted at the Fermi 3 site.

NRC PSHA Confirmatory Analyses

To determine the adequacy of the applicant's PSHA calculations, the staff performed its own confirmatory PSHA calculation for the Fermi 3 site. The staff used the CEUS-SSC model (NUREG–2115) along with the EPRI (2004, 2006) GMM. The staff conducted the PSHA for the Fermi site using a source distance radius of 1,000 km (620 mi) for the CEUS-SSC-distributed seismicity sources. The staff's calculation did not include the RLME source zones. Therefore, the staff compared its confirmatory 0.5, 1, 2.5, 5, 10, 25, and 100 Hz hazard curve results with the applicant's results for the distributed seismicity sources and determined that the two sets of results are almost identical. This finding is illustrated in Figures 2.5.2-9 through Figure 2.5.2-11 in this SER showing the PSHA hard rock hazard curve results for 1, 10, and 100 Hz, respectively, for the distributed seismicity sources.

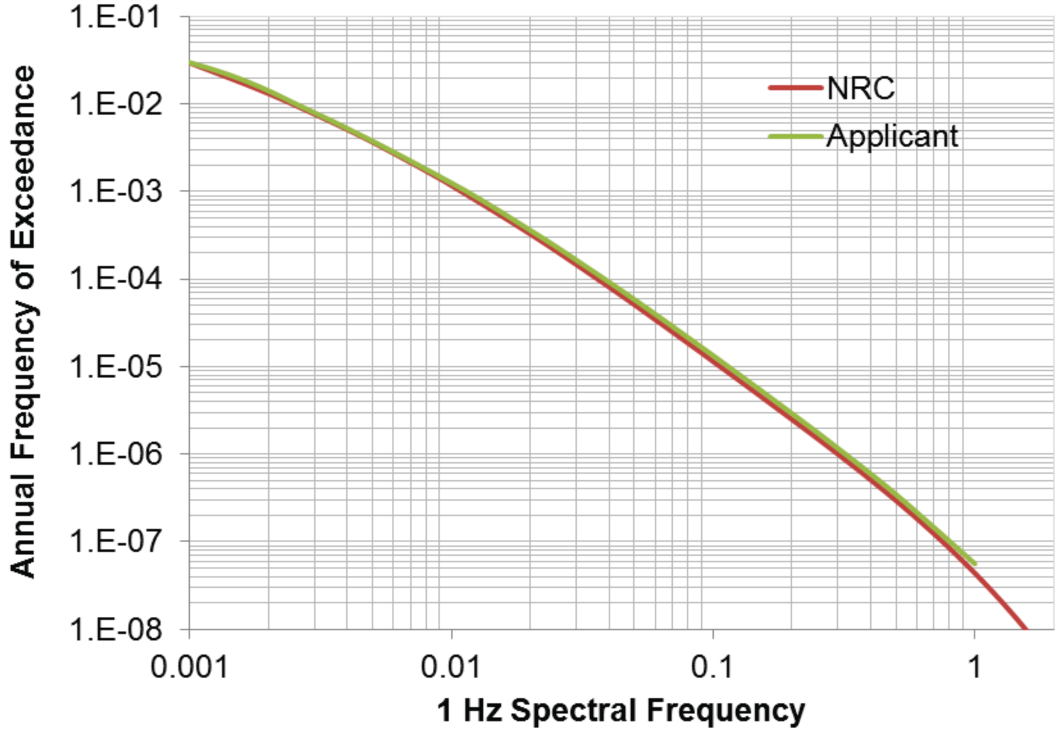


Figure 2.5.2-9 Plot Comparing the Staff's and the Applicant's 1-Hz Total Mean Hazard Curves for the Distributed Seismicity Source Zones

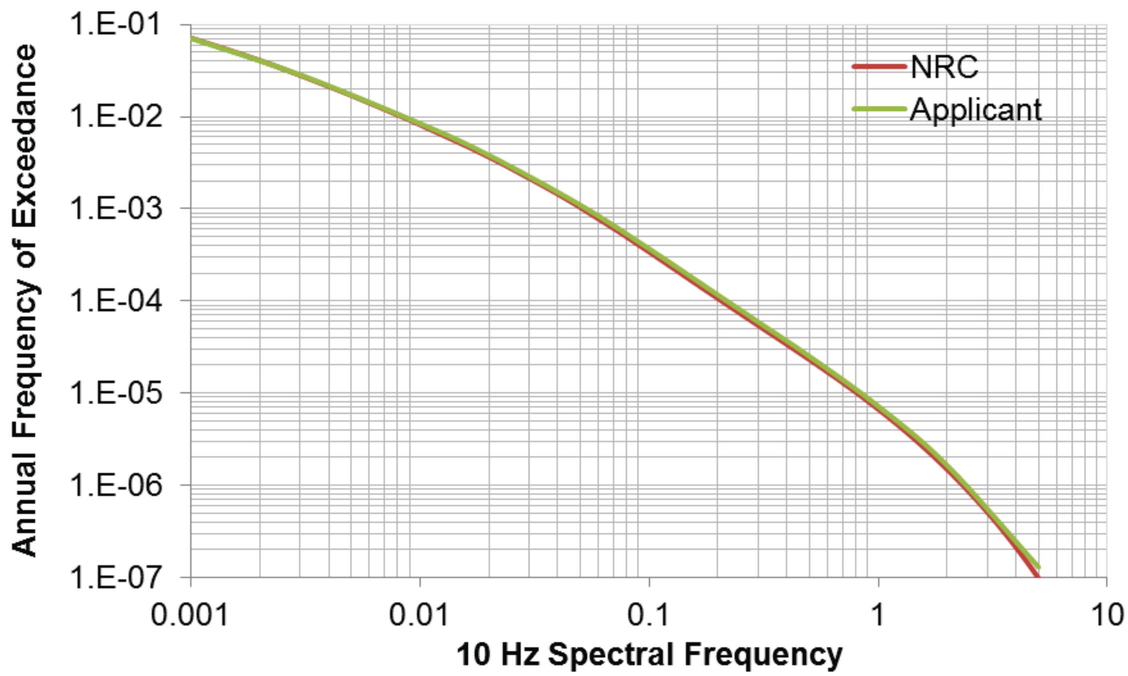


Figure 2.5.2-10 Plot Comparing the Staff's and the Applicant's 10-Hz Total Mean Hazard Curves for the Distributed Seismicity Source Zones

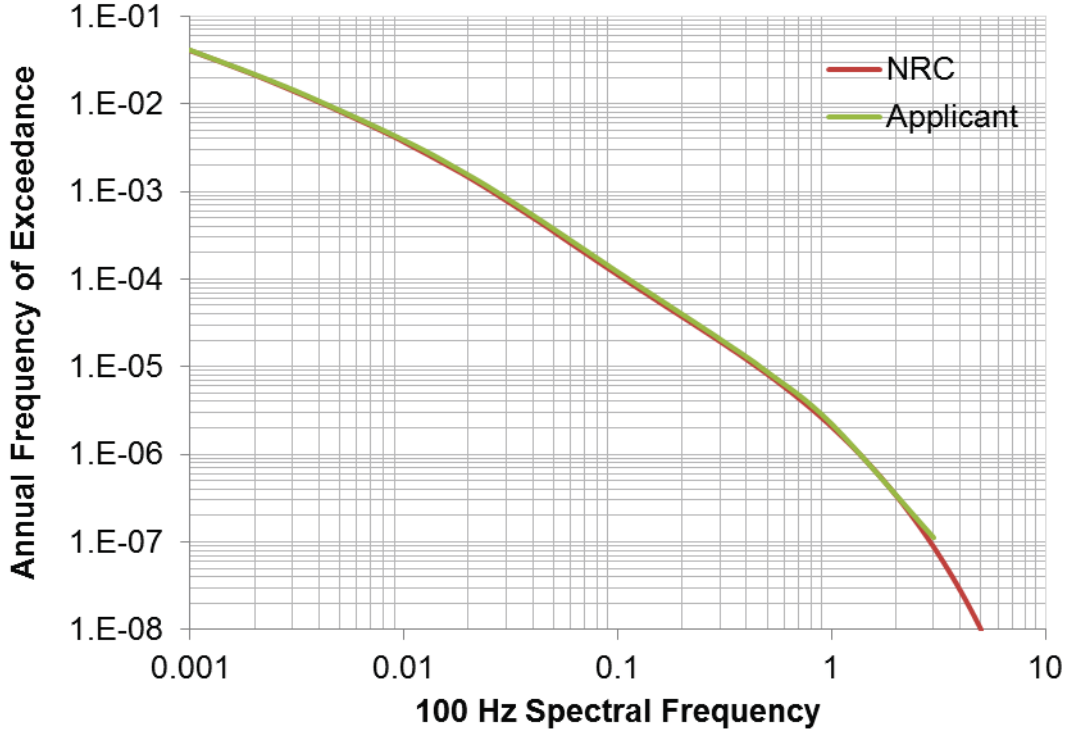


Figure 2.5.2-11 Plot Comparing the Staff's and the Applicant's 100-Hz Total Mean Hazard Curves for the Distributed Seismicity Source Zones

Based on the above assessment, the staff concluded that the applicant's PSHA calculations adequately characterize the seismic hazard at the Fermi 3 site in terms of the contribution from the distributed seismicity sources. Because the staff's calculation did not include the RLMEs, the staff determined that the applicant had selected the appropriate RLME sources (i.e., the NMFS, WA, CHV, and CHS) based on their contribution of 1 percent or greater to the total mean hazard.

Controlling Earthquakes

To determine the low- and high-frequency controlling earthquakes, the applicant used a procedure called deaggregation of the seismic hazard. The applicant followed the deaggregation procedures in RG 1.208, Appendix D. The deaggregation results showed that local seismic sources within approximately 30 km (18.6 mi) of the Fermi site are the primary contributors to the high-frequency seismic hazard at the site, while the NMFS RLME is a significant contributor to the low-frequency seismic hazard at the Fermi site. Table 2.5.2-1 of this SER shows the applicant's deaggregation results for the mean 10^{-4} and 10^{-5} PSHA results. Because the applicant used the guidance in RG 1.208 to determine the reference and deaggregation earthquakes and their magnitudes and distances, the staff concludes that the procedures used by the applicant are adequate and the resultant deaggregation earthquake parameters are representative of the deaggregation earthquakes in this region.

In FSAR Subsection 2.5.2.4.4.3, the applicant also described how it developed smooth response spectra to represent each reference earthquake and deaggregation earthquake listed in FSAR Table 2.5.2-212, for the purpose of developing input time histories for the site response analysis, which is reviewed by the staff in Subsection 2.5.2.4.5 of this SER. The applicant used the EPRI (2004, 2006) GMM as well as the spectral shape functions (specifically, the average of the single and double corner spectral shape models) for CEUS ground motions developed in NUREG/CR–6728. The applicant also used Baker and Cornell's (2006) response spectral correlation method to extrapolate spectral shapes. However, the Baker and Cornell method used worldwide recordings from both the National Earthquake Hazards Reduction Program (NEHRP) B/C (rock/very dense soil and soft rock) type soil boundary and the first story of structures. In RAI 02.05.02-6, the staff thus requested the applicant to (1) explain why the free-field and first-story recordings can be mixed together to predict the correlation; and (2) why the correlation from the B/C boundary can be used to represent the other soil types.

In the response to part (1) of the RAI dated January 11, 2010 (ADAMS Accession No. ML100130382), the applicant explained that Baker and Cornell's method requires a model for correlation between response spectral amplitudes at different spectral periods. The applicant used Baker and Jayaram (2008), which uses all of the residuals resulting from the NGA GMPE development (i.e., the correlation model is not specific to the B/C boundary condition). Furthermore, Baker and Jayaram (2008) determined that the correlation is not sensitive to site subsurface conditions.

In the response to part (2) of the RAI, the applicant stated that the NGA GMPE developers included recordings from instrument shelters and first-story recordings in small buildings (i.e., light one-to-two story structures without basements) in their data sets that were used to develop ground motion models for free-field conditions and indicated that recordings in larger buildings are not representative of free-field motions. Furthermore, the applicant stated that it is common practice to include recordings from the first floor of small buildings in data sets used to develop empirically based, free-field ground motions (e.g., Boore et al. 1997; Campbell 1997; Sadigh et al. 1997; Spudich et al. 1997; and Campbell and Bozorgnia 2003).

After reviewing the applicant's responses to both questions in this RAI, the staff agreed with the applicant that because the correlation models are not sensitive to site subsurface conditions and the NGA developers used the instrument recordings from the first story of small buildings, it is appropriate to develop the correlation model using those relevant data sets. Therefore, the staff concludes that the applicant developed appropriate response spectra to represent the reference and controlling earthquakes resulting from the PSHA calculations. Therefore, RAI 02.05.02-6 is closed.

<u>NRC Staff's Conclusions Regarding the PSHA and Controlling Earthquakes</u>

The staff concludes that the applicant's PSHA inputs, methodology, and results (including the resulting reference and deaggregation earthquakes) are acceptable because the applicant's PSHA calculation followed the general guidance in RG 1.208. The staff's confirmatory analysis also indicated that the applicant's results are adequate. Thus, the staff concludes that the applicant's seismic hazard calculation meets the requirements of 10 CFR 52.79 and 10 CFR 100.23.

2.5.2.4.5 Seismic Wave Transmission Characteristics of the Site

FSAR Subsection 2.5.2.5 describes the method the applicant used to develop the Fermi 3 site free-field UHRS. The applicant's seismic hazard curve calculations are defined for generic hard rock conditions characterized by a shear-wave velocity of at least 2.8 km/s (9,200 fps). According to the applicant, these hard rock conditions exist at a depth of about 130 m (425 ft) below the ground surface at the Fermi 3 site. To determine the impact of the soil column between the hard rock and the surface, the applicant performed a site response analysis. The output of the applicant's site response analysis is site amplitude functions (AFs), which are then used to determine the soil UHRS at three hazard levels (10^{-4}, 10^{-5}, and 10^{-6} annual frequency of exceedances).

The Fermi 3 site consists of thin layers of fill, lacustrine deposits and glacial till overlying dolomite of the Bass Islands and Salina groups. The applicant intends to remove the upper ~4 m (13 ft) of fill, ~1.5 m (5 ft) of low-velocity lacustrine deposits, and ~3.4 m (11 ft) of glacial til, and proposed to locate the GMRS at the top of the Bass Islands group, which corresponds to an average elevation of 168.2 m (551.7 ft) NAVD 88. The staff noted that in previous FSAR revisions, the applicant had defined the GMRS at the top of the glacial till. With this change in the GMRS location, several of the staff's earlier RAIs related to glacial till are no longer relevant and were closed. The staff's evaluations of those RAIs are therefore not part of this SER.

Additionally, the staff noted that the applicant's site response calculations for the RB/FB, CB, and FWFC FIRS are in FSAR Section 3.7.1 instead of in FSAR Section 2.5.2, as in earlier revisions of the FSAR. Therefore, the staff's evaluations of RAIs 02.05.02-20 and 02.05.02-21 are in Subsection 3.7.1.4 of this SER. In Subsection 2.5.2.4 of this SER, the staff noted that many earlier RAIs have become irrelevant or closed as a result of the applicant's significant revisions of the COL FSAR as a result of the replacement of the EPRI (1986) seismic source models previously used in the seismic hazard calculations with the newly published CEUS-SSC model. With this change in the base seismic source model, several of the earlier RAI responses related to the applicant's site response calculations also needed to be revised. Instead, however, the staff performed detailed site response confirmatory analyses to determine the adequacy of the applicant's site response inputs and calculations. These calculations are discussed below in Subsection 2.5.2.4.5.2, while Subsection 2.5.2.4.5.1 of this SER presents the staff's evaluation of the original RAIs that are still applicable to the staff's review.

<u>Site Response Model</u>

FSAR Subsection 2.5.2.5.1 summarizes the applicant's low-strain S-wave velocity, material damping, and strain-dependent properties of the base case soil and rock profile, which the applicant used as the input model for the site response calculations. The applicant performed P-S suspension logging, downhole seismic testing, and spectral analysis of surface wave (SASW) surveys to obtain an S-wave velocity profile for the Fermi 3 site, which is shown in Figure 2.5.2-5 of this SER. The applicant used the P-S suspension logging results to obtain the S-wave velocities of the soil and bedrock units. The applicant also used the downhole seismic testing results to obtain bedrock S-wave velocities, while the SASW survey results provided S-wave velocities for the glacial till. The applicant encountered CEUS generic hard rock conditions (i.e., an S-wave velocity of about 2.8 km/s [9,200 fps]) at a depth of approximately 143.3 m (470 ft) or an elevation of 48 m (156 ft), which corresponds to the Salina Group Unit B.

The applicant stated that the site response profile consists of dolomites and claystones with S-wave velocities exceeding 910 m/s (3,000 fps). The applicant expects the behavior of these materials to remain essentially linear at the expected levels of shaking (as defined by the rock hazard). The applicant determined the damping within these materials by using the following procedure that involved kappa, a near-surface damping parameter that is an estimate of the dissipation of seismic energy of the site during an earthquake due to damping within soil/rock layers and waveform scattering at layer boundaries. The applicant used estimates of kappa to determine an appropriate damping ratio value for the rock layers below the glacial till.

In FSAR Subsection 2.5.2.5.1.2, the applicant stated that ground motion models for the CEUS assume a shallow crustal kappa value of 0.006 seconds, which refers to the point at the elevation of 48 m (156 ft) at the Fermi 3 site. The FSAR further states that the material above this elevation will contribute additional damping and add to the total site kappa value. The applicant used Equation 11 in FSAR Section 2.5.2 Revision 5, (or Equation 5 in the FSAR markups in the March 15, 2013, response to RAI 01.05-1), to calculate an additional kappa value of 0.013 seconds based on an average S-wave velocity of 1,737 m/s (5,700 fps) for the materials above an elevation of 48 m (156 ft). The applicant then subtracted the hard rock kappa value of 0.006, which yielded a remaining kappa of 0.007 seconds. In RAI 02.05.02-13, the staff asked the applicant to confirm whether the kappa value of 0.013 seconds represents an additional damping contribution from the material above the elevation of 48 m (156 ft); and why the two kappa values were then subtracted.

Based on the applicant's response to RAI 02.05.02-13 dated August 6, 2010 (ADAMS Accession No. ML102210351), FSAR Equation 5 represents the relationship between the average S-wave velocity and the total site kappa value—not an additional damping contribution from the material above the elevation of 48 m (156 ft). Therefore, a shallow crustal kappa value was subtracted from the total kappa and the difference of 0.007 seconds is the kappa contributed by the materials above an elevation of 48 m (156 ft). The staff concluded that RAI 02.05.02-13 is closed because the applicant has provided adequate clarification regarding how the kappa value was obtained for the materials above an elevation of 48 m (156 ft). Furthermore, the staff calculated a kappa value for the material above an elevation of 48 m (156 ft) and assumed a quality factor, Q_s, of 40 (EPRI 2013). The resulting kappa value of 0.00774 seconds is very similar to the applicant's value of 0.007 seconds. Figure 2.5.2-13 in this SER shows that the effect of using a kappa value based on Q_s of 40 is similar to the applicant's kappa value in the site response calculations.

The applicant used an updated version of the SHAKE computer program to calculate the Fermi 3 site response. The use of the time series approach is mentioned in RG 1.208 as an acceptable approach given that an appropriate set of earthquake time histories for each of the target response spectra is used, and a sufficient number of time histories are used to obtain a consistent behavior from the dynamic site response analysis. FSAR Subsection 2.5.2.4.4.3 states that the applicant developed 30 time histories for each target DE, which equated to a total of 3 DEs for each HF and LF 10^{-3}, 10^{-4}, 10^{-5}, and 10^{-6} hazard level. The applicant then selected time histories from NUREG/CR–6728 and scaled them to approximately match the target DE spectrum using the routine RSPM06, which implements the time domain spectral matching approach developed by Lilhanand and Teng (1988). The applicant concluded that the weak scaling produced records that have, in general, the desired relative frequency content of the DE spectra, while maintaining a degree of natural variability. The staff performed confirmatory site response calculations in order to determine the adequacy of the applicant's approach. In comparison, the staff used a Random Vibration Theory (RVT) method that characterizes the input rock motion using a Fourier amplitude spectrum, instead of earthquake time histories. The use of the RVT in site response calculations is mentioned in RG 1.208 as an acceptable alternative to the time series approach. As shown in Figure 2.5.2-12 of this SER, the staff's site amplification calculated using RVT is very similar to the applicant's time history-based results.

FSAR Subsection 2.5.2.5.1.3 describes the randomized S-wave velocity profiles used in the site response analyses to account for variations in these profiles. The correlation model described in Silva et al. (1996) is the model developed from analyses of shear wave data taken at the Savannah River site, a relatively deep soil site (composed primarily of sands, silty sands, and silts) of approximately 244 m to 305 m (800 ft to 1,000 ft) depth over hard rock. In

RAI 02.05.02-17, the staff asked the applicant to explain why this model is appropriate for use at the Fermi site and to also evaluate the impact on site amplification. In the response to this RAI dated March 1, 2012 (ML12065A194), the applicant stated that since the principal geologic units that immediately underlie the Fermi 3 site are relatively flat-lying sedimentary rocks that have not been subject to severe deformation, the current correlation structure for S-wave velocities is expected to reflect the correlation structure present when the sediments were first deposited. For this reason, the applicant selected the correlation model described in Silva et al. (1996) for USGS Category C, a relatively deep soil site, rather than the model for rock sites —USGS Category A. In Figure 1 of the RAI response, the applicant compared the predicted correlations between the natural log of the S-wave velocity in two adjacent layers for the stiff soil site model used in FSAR Subsection 2.5.2.5.1.3 with those predicted by the model developed by Silva et al. (1996) for rock sites (USGS Category A). The applicant stated that the USGS Category C model used in the FSAR shows higher correlations than the rock site model for USGS Category A. Furthermore, the applicant stated that a fully correlated model is not supported by the subsurface S-wave velocity data collected at the Fermi 3 site. The applicant added that Figure 2 in the RAI response, which shows velocity profiles for the four borings in which the individual P-S suspension log data were used to compute hyperbolic mean (travel time averaged) velocities for individual sublayers, shows that the S-wave velocity profiles cross each other frequently indicating that the Fermi 3 site profile is not fully correlated.

The staff also performed confirmatory site response calculations in order to investigate the effect of using a fully correlated model. The staff performed calculations comparing the correlation model for USGS Category C and USGS Category A, which are shown by the red and purple curves, respectively, in Figure 2.5.2-13 in this SER, and found that the resulting amplification functions are very similar. As shown in Figure 2.5.2-13 in this SER, differences in mean amplification observed in the frequency range of 4 to 6 Hz is less than 7 percent. Thus, the staff concluded that RAI 02.05.02-17 is closed, because the staff's sensitivity calculations demonstrated that the correlation model used does not significantly impact the amplification functions when compared to a fully correlated model.

<u>NRC Site Response Confirmatory Analyses</u>

To determine the adequacy of the applicant's site response calculations, the staff performed confirmatory site response calculations. As input, the staff used the static and dynamic soil properties in FSAR Section 2.5.4 and summarized in FSAR Table 2.5.2-213. The staff performed site response calculations using the RVT methodology with 7 spectral frequencies and 11 input rock amplitudes. The use of RVT in site response calculations is mentioned in RG 1.208 as an acceptable alternative to the time series approach. The staff's site amplification function results are compared with the applicant's results in Figure 2.5.2-12 in this SER.

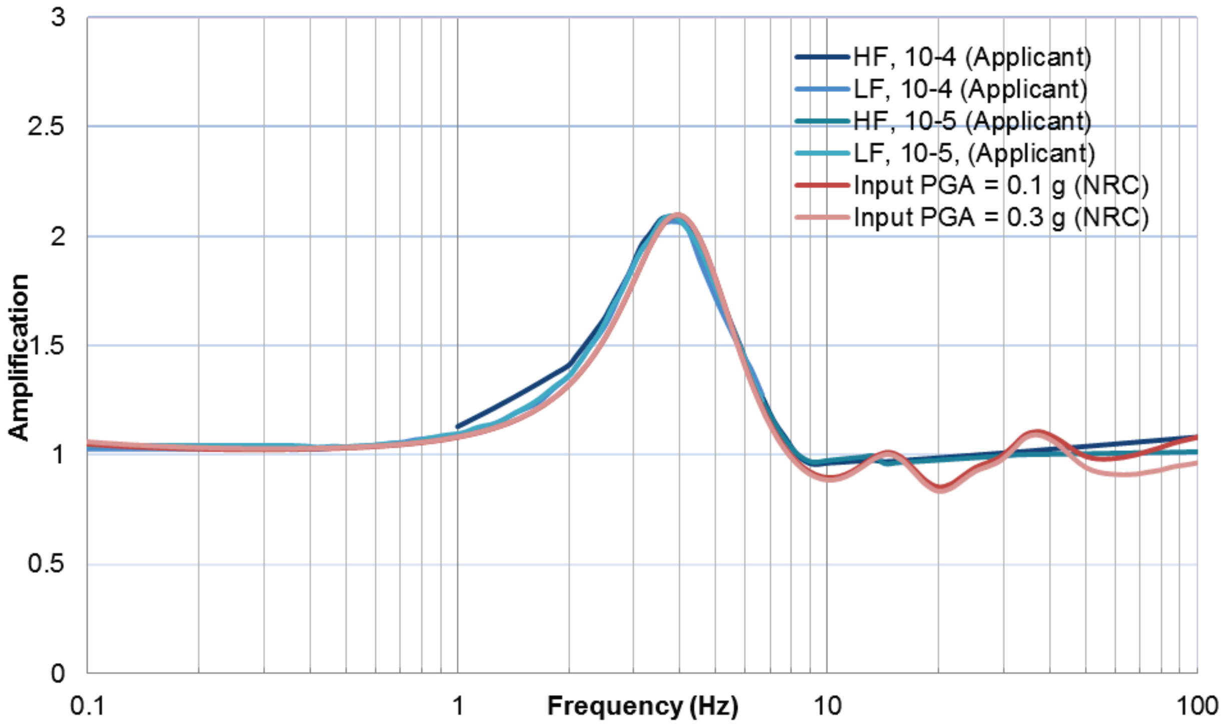


Figure 2.5.2-12 Comparisons of the Staff's Site Response Amplification Functions with the Amplification Functions Determined by the Applicant

[Note: The staff's amplification functions for respective input PGA values of 0.1 g and 0.3 g are depicted by the light and dark red lines, and the COL applicant's results are depicted by the blues lines.]

As Figure 2.5.2-12 in this SER shows, the applicant's amplification functions are similar to the staff's confirmatory calculations; and the very small difference observed between ~1 and 100 Hz are within the limits of uncertainties. Similar to the applicant's results, the staff's confirmatory calculations also show that the Fermi 3 site response is not strongly sensitive to the level of input motion. Figure 2.5.2-12 also shows that there are only small differences in the site amplification (at frequencies greater than ~40 Hz) using input PGAs of 0.1 g and 0.3 g.

In addition to confirming the applicant's calculations, the staff conducted an additional sensitivity calculation to confirm the applicant's selected damping values in FSAR Table 2.5.2-214. Figure 2.5.2-13 in this SER compares the staff's amplification functions calculated using the applicant's damping values, with the staff's amplification functions calculated assuming a shear-wave quality factor, Q_s, of 40. Because the average S-wave velocity of the material above an elevation of 48 m (156 ft) is 1,737 m/s (5,700 fps), and the thickness of these materials is only ~121 m (396 ft), the kappa contributed by the profile can be computed by assuming a Q_s of 40 according to EPRI Report 1025287, "Seismic Evaluation Guidance," (EPRI 2012). As illustrated in Figure 2.5.2-13 of this SER, the staff's amplification functions calculated by assuming a Q_s of 40 is only slightly higher than the staff's calculated amplification functions that used the damping values developed by the applicant between frequencies of ~3 to 5 Hz and at frequencies above 30 Hz.

The staff's results are slightly higher than the applicant's at frequencies between 3 and 5 Hz. However, these differences are less than 10 percent.

Based on the above assessment, the staff concludes that the applicant's site response calculations adequately characterize the Fermi 3 site effects.

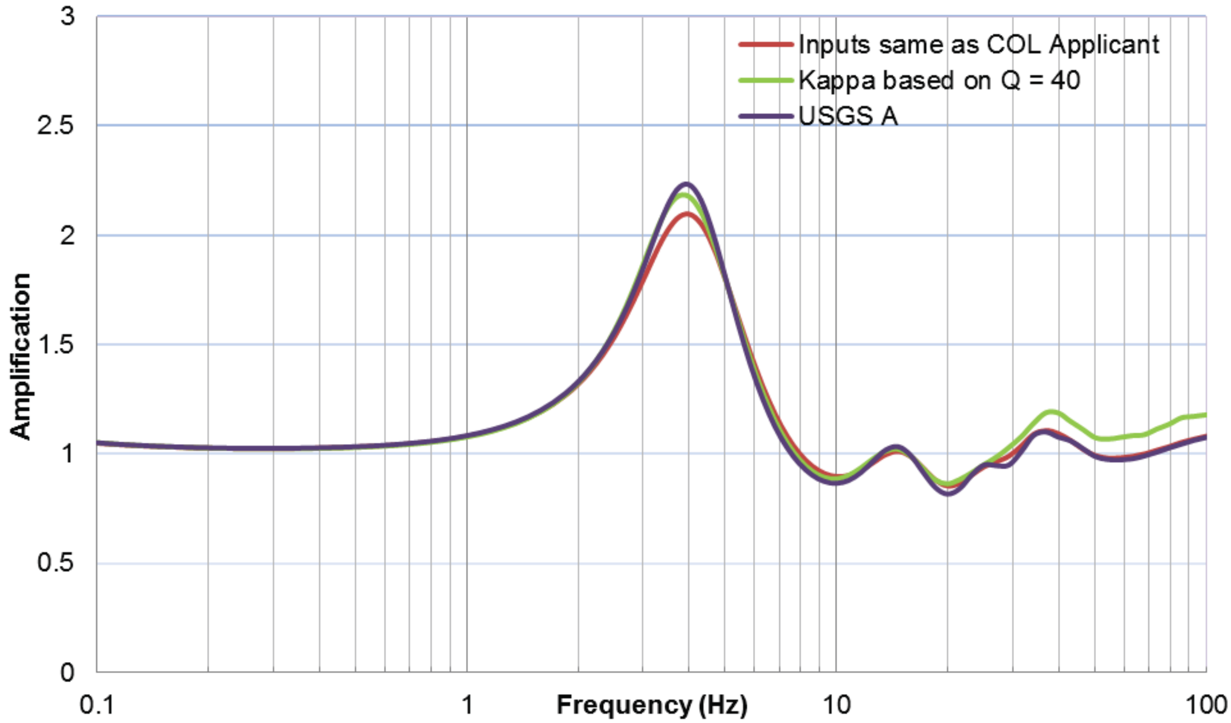


Figure 2.5.2-13 Comparisons of the Staff's Site Response Amplification Function Using Damping Values Selected by the Applicant with the Staff's Site Response Amplification Functions Based on a Q_s of 40 and also Using a Correlation Model for USGS Category A

[Note: The staff's amplification functions using the same inputs as COL applicant used are depicted by the red lines; and the staff's amplification functions based on a Q_s of 40 and a correlation model for USGS Category A are depicted by the green and purple lines, respectively.]

NRC Staff's Conclusions Regarding Seismic Wave Transmission Characteristics of the Site

The staff concludes that the applicant's site response methodology and results are acceptable, because the applicant has followed the general guidance in RG 1.208 in the site response calculations and used an adequate range of input parameters. The staff's confirmatory analysis also indicates that the COL applicant's results are adequate.

2.5.2.4.6 Ground Motion Response Spectra

FSAR Subsection 2.5.2.6 describes the method the applicant used to develop the horizontal and vertical, site-specific GMRS. As stated in Subsection 2.5.2.1 of this SER, RG 1.208 defines the GMRS as the site-specific SSE to distinguish it from the CSDRS (certified seismic design response spectra), the design ground motion for the ESBWR certified design.

FSAR Subsection 2.5.2.6 describes the method the applicant used to develop the horizontal and vertical site-specific GMRS. To obtain the horizontal GMRS, the applicant used the performance-based approach in RG 1.208 and ASCE/SEI Standard 43-05. FSAR Subsection 2.5.2.6 states that the horizontal GMRS (for each spectral frequency) is obtained by scaling the soil 10^{-4} UHRS by the design factor specified in RG 1.208. To develop the vertical GMRS, the applicant multiplied the horizontal GMRS by V/H ratios for generic CEUS hard rock sites in NUREG/CR–6728. Because the S-wave velocity of the Fermi 3 site is relatively high, and the assessed site kappa value is not much greater than the generic hard rock value, the staff concludes that the applicant's use of V/H ratios for generic CEUS hard rock sites is appropriate.

NRC Staff's Conclusions Regarding the Ground Motion Response Spectra

The applicant used the standard procedures outlined in RG 1.208 to calculate the final horizontal and vertical GMRS. The staff thus concludes that the applicant's GMRS adequately represents the site ground motion, and the applicant's calculated GMRS meets the requirements of 10 CFR 100.23.

2.5.2.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.5.2.6 *Conclusion*

NRC staff reviewed the COL application and confirmed that the applicant has adequately addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COL application to the relevant NRC regulations, the guidance in Section 2.5.2 of NUREG–0800, and applicable NRC regulatory guides. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff determined that the applicant has adequately addressed COL Item COL Item EF3 2.0-27-A related vibratory ground motion.

2.5.3 Surface Faulting

2.5.3.1 *Introduction*

This FSAR section describes the potential for surface deformation due to faulting, and addresses the following topics related to surface faulting: geologic, seismic, and geophysical investigations; geologic evidence, or absence of evidence, for tectonic surface deformation; correlation of earthquakes with capable tectonic sources and characterization of those sources; ages of most recent deformation; relationships between tectonic structures in the site area and regional tectonic structures; designation of zones of Quaternary (less than 2.6 Ma) deformation in the site region; and the potential for surface deformation at the site. The applicant collected the information during site characterization investigations.

2.5.3.2 *Summary of Application*

Section 2.5.3 of the Fermi 3 COL FSAR, describes the potential for tectonic and non-tectonic surface faulting at the Fermi 3 site. In addition, in FSAR Section 2.5.3, the applicant provided the following:

COL Item

- EF3 COL 2.0-28-A Surface Faulting

To address this COL item, the applicant developed FSAR Section 2.5.3 based on reviews of relevant published geologic literature; aerial photographic interpretations; lineament analyses; interviews with experts familiar with the geology, seismology, and tectonics of the site region; a review of seismicity data; and geologic field investigations. The applicant performed field investigations that included geologic field reconnaissance, aerial reconnaissance, and geologic mapping of rock units and Quaternary deposits at the site. Also, the applicant used the previous UFSAR for the existing Fermi 2 (DTE 2006); in addition to construction reports and interactions with involved personnel to supplement recent geologic and seismic investigations on the site.

In the context of these efforts, the applicant concluded that there are no capable tectonic sources within the 8-km (5-mi) site area radius. The applicant also concluded that there is no evidence for Quaternary tectonic surface fold deformation or faulting within the 1-km (0.6-mi) radius of the Fermi site.

2.5.3.2.1 Geologic, Seismic, and Geophysical Investigations

In FSAR Subsection 2.5.3.1, the applicant described the investigations performed to evaluate the potential for surface deformation at the Fermi 3 site. The applicant compiled and reviewed existing data from the investigations for the operating Fermi 2 site, as well as published and unpublished literature regarding tectonics and geomorphology for southeast Michigan and northwest Ohio. The applicant also analyzed previous and updated seismicity data for the site vicinity, analyzed and interpreted aerial photographic and remote sensing imagery for the Fermi 3 site vicinity, and conducted multiple field and aerial reconnaissance investigations at and surrounding the site. Finally, the applicant contacted experts at the Ohio, Michigan, and Canadian geological surveys to obtain the most current information related to geologic investigations within the Fermi 3 site region.

2.5.3.2.2 Geologic Evidence, or Absence of Evidence, for Surface Deformation

FSAR Subsection 2.5.3.2 discusses the geologic evidence, or absence of evidence, for tectonic and non-tectonic surface deformation in the Fermi 3 site area. The applicant concluded that there are no faults at or close to the ground surface in the Quaternary sediments within 40 km (25 mi) of the site. Using boring and geophysical data, the applicant indicated that the faults in the subsurface of the site vicinity are in Paleozoic rocks; the closest tectonic features to the site are (1) the Bowling Green fault and the Maumee fault (within 40 km [25 mi]), (2) the Howell anticline and associated fault (45 km [28 mi]), (3) a series of folds in the subsurface bedrock units along the southeastern trend of the Howell anticline and two possible fault trends located on the southwestern flank of these folds that are possibly associated with oil and gas pools, and (4) shorter faults located in southwestern Ontario (one of which is possibly associated with oil and gas fields). The applicant observed two minor faults in the Silurian Bass Islands Group at the Denniston Quarry 16 km (10 mi) south of the Fermi 3 site; each fault has a displacement of less than 1.4 m (4.6 ft). The applicant stated that the second fault extends to the top of the Bass Island Group, but the latest Pleistocene (approximately 13–12 thousand years ago [ka]) Quaternary till and lacustrine deposits overlying the projected trends of both faults are not deformed. The applicant indicated that only one possible fault extends within the 8-km (5-mi) radius of the site, and that fault trend is associated with the Sumpter Pool as mapped by Cohee

(1948) and postulated as a fault in 1962 by Ells (Ells 1962). However, there is no supporting documentation regarding the existence of this structure, and no faults were identified within the basement rocks or overlying sediments at the Fermi 2 site.

The applicant stated that non-tectonic deformation agents, such as glacial and periglacial processes, sometimes look like surface tectonic fault ruptures. However, there is no evidence of surface deformation in the site associated with these non-tectonic processes. The applicant explained that other observed non-tectonic deformation processes in the Michigan basin are associated with the dissolution and subsequent collapse of carbonate rock, and there are reports of karst-related problems within the 320-km (200-mi) radius of the site.

In FSAR Subsection 2.5.3.2.3, the applicant described the lineaments in the Fermi 3 site and explained that most apparently coincide with paleoshorelines as well as with linear stream segments. The applicant concluded that no evidence indicates the presence of post-glacial surface faulting or continuing tectonic deformation.

2.5.3.2.3 Correlation of Earthquakes with Capable Tectonic Sources

In FSAR Subsection 2.5.3.3, the applicant concluded that there is no record of earthquakes or earthquake alignments within 40 km (25 mi) of the Fermi 3 site that could be associated with mapped bedrock faults.

2.5.3.2.4 Ages of Most Recent Deformations

In FSAR Subsection 2.5.3.4, the applicant concluded that the major bedrock deformation in the site vicinity occurred during the Paleozoic epoch. The applicant also stated that limited geologic history exists in the site region during the Mesozoic era, and no Mesozoic pluton or rift-related sediments are present to suggest that the Mesozoic extension affected the site region. The applicant concluded that there is no evidence of paleoliquefaction or deformation on the lacustrine plain that overlies the postulated faults within the site vicinity.

2.5.3.2.5 Relationship of Tectonic Structures in the Site Area to Regional Tectonic Sources

In FSAR Subsection 2.5.3.5, the applicant stated that folding occurred in the Silurian and Devonian rocks on the Fermi site. Folds are recognized along the southeastern margin of the Michigan basin and they coincide with the mid-Michigan gravity high, which is associated with the mid-continent rift system.

2.5.3.2.6 Characterization of Capable Tectonic Sources

In FSAR Subsection 2.5.3.6, the applicant stated that the mapped bedrock faults within a 40-km (25-mi) radius and the lineaments within the 8-km (5-mi) radius of the site are not considered capable tectonic sources. The applicant based this conclusion on the study of geomorphic evidence, determination of surface or near-surface deformation of landforms or geologic deposits, evaluation of the association with one or more moderate earthquakes and the structural association with capable tectonic structures.

2.5.3.2.7 Designation of Zones of Quaternary Deformation in the Site Region

In FSAR Subsection 2.5.3.7, the applicant stated that no zones of Quaternary tectonic deformation exist in the Fermi 3 site region.

2.5.3.2.8 Potential for Surface Tectonic Deformation at the Site

In FSAR Subsection 2.5.3.8, the applicant stated that no capable tectonic faults exist in the Fermi 3 site vicinity. The applicant added that there is no evidence of potential deformation associated with non-tectonic deformation such as glacially induced faulting, salt migration, and dissolution collapse associated with karst.

2.5.3.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the surface faulting, and the associated acceptance criteria, are in Section 2.5.3 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR 52.79(a)(1)(iii) as it relates to identifying geologic site characteristics with appropriate consideration of the most severe natural phenomena historically reported for the site and surrounding area and with a sufficient margin for the limited accuracy, quantity, and period of time that the historical data were accumulated.

- 10 CFR 100.23 as it relates to determining the potential for surface tectonic and non-tectonic deformations in the region surrounding the site.

The related acceptance criteria from Section 2.5.3 of NUREG–0800 are as follows:

- Geologic, Seismic, and Geophysical Investigations: To meet the requirements of 10 CFR 100.23 and the guidance in RG 1.208, RG 1.132, and RG 1.198, this area of review is acceptable if the discussions of Quaternary tectonics, structural geology, stratigraphy, geo-chronologic methods used for age dating, paleoseismology, and geologic history of the site vicinity, site area, and site location are complete, compare well with the studies conducted by others in the same area, and are supported by detailed investigations performed by the applicant.

- Geologic Evidence, or Absence of Evidence, for Surface Tectonic Deformation: To meet the requirements of 10 CFR 100.23 and the guidance in RG 1.208, RG 1.132, RG 1.198, and RG 4.7 "General Site Suitability Criteria for Nuclear Power Stations," this area of review is acceptable if the applicant's discussion about sufficient surface and subsurface provides information that includes the site vicinity, site area, and site location to confirm the presence or absence of surface tectonic deformation (i.e., faulting) and if present, to demonstrate the age of the most recent fault displacement and the ages of previous displacements.

- Correlation of Earthquakes with Capable Tectonic Sources: To meet the requirements of 10 CFR 100.23, this area of review is acceptable if all reported historical earthquakes within the site vicinity are evaluated with respect to accuracy of hypocenter location and source of origin, and if all capable tectonic sources that could, based on fault orientation and length, extend into the site area or site location are evaluated with respect to the potential for causing surface deformation.

- <u>Ages of Most Recent Deformation</u>: To meet the requirements of 10 CFR 100.23, this area of review is acceptable if every significant surface fault and feature associated with a blind fault, or any part of which lies within the site area, is investigated in sufficient detail to demonstrate or to allow relatively accurate estimates of the age of the most recent fault displacement and to identify geologic evidence for previous displacements (if such evidence exists).

- <u>Relationship of Tectonic Structures in the Site Area to Regional Tectonic Structures</u>: To meet the requirements of 10 CFR 100.23, this area of review is acceptable if the discussion includes the structural and genetic relationships between site area faulting or other tectonic deformation and the regional tectonic framework.

- <u>Characterization of Capable Tectonic Sources</u>: To meet the requirements of 10 CFR 100.23, this area of review is acceptable is the applicant's investigative techniques are sufficiently sensitive to identify all potential capable tectonic sources, such as faults or structures associated with blind faults, within the site area; and the discussion provides the fault geometry, length, sense of movement, amount of total displacement and displacement per faulting event, age of latest and any previous displacements, recurrence rate, and limits of the fault zone for each capable tectonic source.

- <u>Designation of Zones of Quaternary Deformation in the Site Region</u>: To meet the requirements of 10 CFR 100.23 regarding the designation of zones of Quaternary deformation in the site region, the discussion is acceptable if the zone (or zones) designated by the applicant as requiring detailed faulting investigations is of sufficient length and width to include all Quaternary deformation features potentially significant to the site, as described in RG 1.208.

- <u>Potential for Surface Tectonic Deformation at the Site Location:</u> To meet the requirements of 10 CFR 100.23, this subsection must take into account potential for surface tectonic deformation if the applicant's field investigations reveal a surface or near-surface tectonic deformation along a known capable tectonic structure (i.e., a known capable tectonic feature related to a fault or blind fault).

In addition, the geologic characteristics should be consistent with the appropriate sections from: RG 1.208, RG 1.132, RG 1.198, and RG 1.206.

2.5.3.4 *Technical Evaluation*

NRC staff reviewed the information in Section 2.5.3 of the Fermi 3 COL FSAR related to surface faulting as follows:

<u>COL Item</u>

- EF3 COL 2.0-28-A Surface Faulting

The staff reviewed the applicant's information in FSAR Section 2.5.3 addressing COL Item EF3 COL 2.0-28-A. Fermi 3 COL FSAR Section 2.5.3 addresses the potential for surface or near-surface tectonic and non-tectonic deformation within an 8-km (5-mi) radius of the Fermi 3 site.

The technical information in FSAR Section 2.5.3 resulted from the applicant's surface and subsurface geologic investigations performed for the site area and supplemented by aerial and field reconnaissance studies of the site vicinity, or within a 40-km (25-mi) radius of the site. The staff reviewed Fermi 3 COL FSAR Section 2.5.3 to determine whether the applicant had complied with the applicable regulations and had conducted investigations with an appropriate level of detail in accordance with the guidance in RG 1.208.

The staff's review focused on FSAR Section 2.5.3, which include the applicant's descriptions of previous studies and data collection and the applicant's own investigations conducted within the site area to assess the potential for surface tectonic deformation at the site. During the early site investigation stage, the staff visited the site and interacted with the applicant regarding the geologic, seismic, and geotechnical investigations conducted for the Fermi 3 COL application. To thoroughly evaluate the applicant's geologic, seismic, and geophysical information, the staff obtained additional assistance from experts at the USGS. The staff and the USGS advisors made an additional visit to the Fermi 3 site in November 2009 to confirm the applicant's interpretations, assumptions, and conclusions related to the potential for surface or near-surface faulting and non-tectonic deformation.

The staff's review of Fermi 3 COL FSAR Section 2.5.3 is presented below.

2.5.3.4.1 Geologic, Seismic, and Geophysical Investigations

NRC staff reviewed the applicant's descriptions of the site geologic, seismic, and geophysical investigations in FSAR Subsection 2.5.3.1. The staff verified the results of the applicant's field investigations as well as the applicant's interpretations of existing aerial photographic and remote sensing imagery. Specifically, the staff evaluated core borings and subsurface investigation reports in addition to field imagery; the visit included field locations at and near the site during a site audit in November 2009 (ADAMS Accession No. ML14112A212). After reviewing FSAR Subsection 2.5.3.1 and verifying current literature and findings from observations made during the November 2009 site audit, the staff concluded that the applicant has performed adequate investigations to evaluate the potential for surface deformation at the Fermi 3 site. The staff further concluded that the applicant's information in FSAR Subsection 2.5.3.1 is adequate to support the Fermi 3 COL application. The applicant's information is in accordance with the guidance in RG 1.208 and meets the requirements of 10 CFR 100.23.

2.5.3.4.2 Geologic Evidence, or Absence of Evidence, for Surface Deformation

NRC staff reviewed the applicant's evaluations and conclusions described in FSAR Subsection 2.5.3.2 regarding geologic evidence, or absence of evidence, for surface deformation at the Fermi 3 site. The staff's review of FSAR Subsection 2.5.3.2 focused on evidence to support the applicant's conclusion that there is no record of faulting or fault-related deformation in Quaternary age (less than 2.6 Ma) sediments within the site vicinity. To verify the applicant's results, the staff performed an independent literature review; reviewed the results of the applicant's lineament analysis; and visited locations in and around the Fermi 3 site, including the Denniston Quarry. The staff also reviewed the applicant's analysis of Paleozoic age faults identified within the site vicinity (including the Bowling Green and Maumee faults), in order to verify that there is no evidence for Quaternary deformation associated with these faults.

The staff noted that although FSAR Revision 1, Subsection 2.5.3.2.1 contained a brief description of the Quaternary stratigraphy at the site, the description did not provide details of field observations that relate to deformation or lack of deformation of Quaternary deposits revealed in stratigraphic exposures. Therefore, in RAI 02.05.03-3, the staff asked the applicant to describe any field observations of the local stratigraphic exposures that would assist in constraining any post-glacial deformation that may have occurred in the last 10,000 years in the site vicinity, especially with respect to lake deposits.

The response to RAI 02.05.03-3 dated February 11, 2010 (ADAMS Accession No. ML100570307), identified publications, reports, maps, and available electronic data the applicant had compiled and used as the basis for evaluations of the stratigraphy and geomorphology at the site. The applicant used this information to determine locations for conducting field and aerial reconnaissance investigations. Part of the applicant's response to RAI 02.05.03-3 also included a collection of maps, field photographs, and soil profiles the applicant had used as part of the site evaluation of the stratigraphy. The applicant explained that good exposures to view Quaternary stratigraphic relationships in the site vicinity are limited by the low-relief topography, incision by local streams, and thick vegetation covering stream banks. The applicant evaluated more than 244 m (800 ft.) of continuous lateral exposure of Quaternary deposits at the nearby Denniston Quarry. The applicant conducted three backhoe excavations at the quarry in December 2009 after the staff's visit to the site. During the November 2009 visit, NRC staff identified deformations in the underlying Paleozoic Bass Islands Group. As a result of RAI 02.05.01-29, which is discussed in Subsection 2.5.1.4 of this SER, the applicant provided a technical report that comprehensively evaluated the applicant's field studies at the Denniston Quarry. The applicant identified no evidence for deformation of Quaternary age sediments in the exposures at the Denniston Quarry.

The staff reviewed the information in the applicant's responses to RAI 02.05.03-3 and RAI 02.05.01-29, including the applicant's detailed description of the exposed Quaternary deposits in the Fermi 3 site vicinity. The staff visited a number of field exposures, including local streams and the Denniston Quarry, and found no evidence at or near the site for Quaternary deformation on the field visits or in the applicant's Denniston Quarry field investigation. Based on the review of the applicant's response to RAI 02.05.03-3, the staff's independent literature review, and the staff's visit to field locations surrounding the Fermi 3 site, the staff determined that the applicant had adequately evaluated evidence for Quaternary deformation based on stratigraphic exposures at or near the Fermi 3 site. The applicant also provided a more thorough description of the Quaternary deposits at and surrounding the Fermi 3 site, including the most recent post-glacial lake deposits. Therefore, RAI 02.05.03-3 is resolved and closed.

FSAR Revision 1, Subsection 2.5.3.2.3 discussed a lineament analysis that the applicant conducted to evaluate evidence for surface deformation in the site vicinity. As part of the analysis, the applicant used the USGS 10-m (33-ft) digital elevation model to identify topographic and linear stream segments in the site vicinity. In RAI 02.05.03-4, the staff asked the applicant to discuss the vertical accuracy of the digital elevation model data and the suitability of the data in a geologic environment with low strain rates and young surficial deposits. In the response to RAI 02.05.03-4 dated February 11, 2010 (ADAMS Accession No. ML100570307), the applicant referenced Gesch (2007) and stated that the relative vertical accuracy of the USGS digital elevation model data is 1.64 m (5.38 ft) and the absolute vertical accuracy is 2.44 m (8.0 ft). The applicant further stated that the objective in performing the lineament analysis was to identify linear anomalies in the site topography that may have developed as a result of tectonic or non-tectonic deformation at or near the surface. The applicant expected that the surface rupture due to faulting would be expressed at the surface as erosional remnants or vegetation anomalies. The applicant was confident that the digital elevation model data would be suitable to identify topographic anomalies if they did exist. The applicant found no evidence of surface disruption above two postulated subsurface faults (the Sumpter Pool and the New Boston Pool faults). In addition, the applicant supplemented the digital elevation model analysis with field and aerial investigations.

The staff also asked the applicant in RAI 02.05.03-4 to discuss the availability of light detection and ranging (LiDAR) high-resolution topographic data sets for the site vicinity and whether these data would be useful for evaluating post-glacial deformation at or near the site. The applicant stated that at the time of the Fermi 3 field studies, there were no LiDAR data sets available for the site vicinity. The applicant also stated that although a small strip of LiDAR data now exists along the Lake Erie shoreline, the data would not be useful for adequately evaluating geomorphic features in the site vicinity. Additional LiDAR data were being collected for various counties surrounding the site that may be useful in future evaluations once the data become available. The applicant noted that the USGS 10-m (33-ft) digital elevation model was the highest resolution topographic data available for analyzing surface lineaments at the time that the field investigations were conducted for the Fermi 3 site.

The staff evaluated the applicant's response to RAI 02.05.03-4 and the applicant's lineament analysis conducted in support of the Fermi 3 COL application. In November 2009, the staff visited multiple locations surrounding the Fermi 3 site to verify the geomorphic features identified in the applicant's lineament analysis and in field and aerial reconnaissance investigations. The staff determined that the applicant had adequately evaluated potential surface deformation features at the site using multiple means of verification. The staff found the resolution of the USGS topographic digital elevation model to be an adequate source for evaluating potential deformation in the Fermi 3 site vicinity. RAI 02.05.03-4 is therefore resolved and closed.

In RAI 02.05.03-5, NRC staff asked the applicant to discuss any relevant marine seismic and bathymetric data for Lake Erie as a basis for evaluating the presence or absence of recent tectonic deformation in the site region. The response to RAI 02.05.03-5 dated February 11, 2010 (ADAMS Accession No. ML100570304), stated that the applicant had relied on the highest-resolution bathymetric data available for Lake Erie to characterize the Fermi 3 site. The U.S. NOAA and the Canadian Hydrographic Service developed the bathymetric data using 1-m (3.3-ft) contour intervals. The applicant also described the results of high-resolution seismic reflection data collected in the western basin of Lake Erie by the Geological Survey of Canada in cooperation with the Ohio Geological Survey. Finally, the applicant discussed seismic reflection surveys conducted in the Ohio waters of Lake Erie. These high-resolution seismic surveys focused on mapping bedrock topography, sediment thickness, and stratification. The applicant stated that the present lake bottom topography results from the latest Pleistocene and Holocene glacial and lacustrine processes and added that there is no evidence suggestive of tectonic activity. The applicant stated that the most prominent features visible in the western Lake Erie basin topography are related to shipping and dredging activities. In the response to RAI 02.05.03-5, the applicant also updated FSAR Subsections 2.5.1.1.1 and 2.5.1.2.1 with additional topographic and geomorphic information based on the bathymetric and high-resolution seismic reflection data analyses relevant to Lake Erie.

The staff reviewed the applicant's response to RAI 02.05.03-5 and performed an independent evaluation of the references cited in this response and other available literature. Based on the applicant's information in response to RAI 02.05.03-5 and the applicant's FSAR updates, the staff determined that the applicant had adequately evaluated the presence or absence of deformation features in the Lake Erie site vicinity and region. Therefore, RAI 02.05.03-5 is resolved and closed.

In FSAR Revision 1, Subsection 2.5.3.2.3, the applicant stated that paleoshoreline features in the Fermi 3 site vicinity cross possible subsurface fault trends with no apparent disruption. In RAI 02.05.03-6, the staff asked the applicant to provide additional details regarding the basis for the conclusion that paleoshoreline features do not display evidence for deformation due to faulting. The staff also asked the applicant to discuss whether there is evidence of broad-scale regional deformation expressed in the paleoshoreline data. In the response to RAI 02.05.03-6 dated February 11, 2010 (ADAMS Accession No. ML100570307), the applicant stated that strandlines (former shorelines) and related features such as wave-cut bluffs and beach ridges provide important geomorphic information for evaluating vertical deformation in the past several thousand years and more. The applicant referenced the response to RAI 02.05.01-3 for a discussion of regional glacial-related deformation. The applicant focused the response to RAI 02.05.03-6 on geomorphic characterizations of paleoshorelines in the site vicinity.

The applicant clarified that the mapped paleoshorelines in the Fermi 3 site vicinity correlate with glacial and post-glacial lake levels from the past 14,800 years, or since the last major glacial advance. The applicant's response to RAI 02.05.03-6 systematically described the shoreline features associated with each significant lake-level phase for seven lakes identified within the Fermi 3 site vicinity—Lake Maumee, Lake Arkona, Lake Whittlesey, Lake Warren, Lake Wayne, Lake Grassmere and Lake Lundy. The applicant used the USGS 10-m (33-ft) digital elevation model to evaluate evidence for possible vertical deformation of paleoshoreline features within the Fermi site vicinity. The applicant used the digital elevation model data to construct a series of topographic profiles across the locations of mapped possible faults. Specifically, the applicant focused on the possible subsurface Sumpter Pool and New Boston Pool faults. The applicant's analyses of the paleoshoreline profiles and the digital elevation model data in combination with the applicant's lineament analyses identified no evidence for tilting or deformation along paleoshorelines located in the site vicinity. The applicant's conclusion regarding the lack of deformation on these features further confirms earlier published observations that concluded there was a lack of evidence for deformation along paleoshorelines in southeast Michigan. In this response, the applicant also provided extensive revisions to the FSAR as well as supporting figure updates documenting the paleo-shoreline analysis.

NRC staff reviewed the applicant's response to RAI 02.05.03-6, conducted an independent literature review, visited paleoshoreline locations evaluated by the applicant near the Fermi 3 site, and reviewed the applicant's lineament analysis. The staff determined that the applicant has conducted a thorough and systematic review of paleoshoreline features within the site vicinity, in order to evaluate the potential for surface deformation at the site. The staff also determined that the applicant has provided sufficient information to address the staff's questions in RAI 02.05.03-6. Therefore, RAI 02.05.03-6 is resolved and closed.

Based on the review of the information in FSAR Subsection 2.5.3.2 and the applicant's responses to the staff's RAIs, the staff concluded that the applicant has adequately evaluated evidence of surface deformation at the Fermi 3 site. The staff found that the applicant has presented thorough and accurate descriptions of information related to geologic evidence, or lack of evidence, for surface deformation from tectonic or non-tectonic processes within the site vicinity to support the Fermi 3 COL application. The applicant's information is in accordance with the guidance in RG 1.208 and meets the requirements of 10 CFR 100.23.

2.5.3.4.3 Correlation of Earthquakes with Capable Tectonic Sources

In FSAR Subsection 2.5.3.4.3, the applicant stated that there is no evidence in the seismic record for earthquakes that can be associated with bedrock faults mapped within the Fermi 3 site vicinity. The applicant referenced FSAR Subsection 2.5.2.1 for a discussion of the regional seismic history. The staff reviewed FSAR Subsection 2.5.3.4.3 in combination with the applicant's review of regional and site tectonic descriptions in FSAR Subsections 2.5.1.1.4.3 and 2.5.1.2.4, and the applicant's description of the local seismicity in FSAR Subsection 2.5.2.1. Based on this review, the staff determined that the applicant has adequately evaluated the correlation of earthquakes with possible tectonic sources. The applicant's conclusion that there is no correlation between earthquakes and known faults of any geologic age within the site vicinity is reasonable. The staff concluded that the applicant has provided sufficient information in FSAR Subsection 2.5.3.3 to support the Fermi 3 COL application. The applicant's information is in accordance with the guidance in RG 1.208 and meets the requirements of 10 CFR 100.23.

2.5.3.4.4 Ages of Most Recent Deformations

In FSAR Subsection 2.5.3.4, the applicant concluded that there is no evidence for surface deformation from at least the last 200 million years within the site vicinity. The applicant also stated that there is no evidence for earthquake-induced paleoliquefaction and no geomorphic expression of surface deformation across the broad surface or along paleoshoreline features. The staff noted that throughout much of the central and eastern United States, large earthquakes tend not to produce fault ruptures at the surface but may produce liquefaction features in potentially suitable areas. The staff also noted that the combination of a high water table and the presence of interbedded fine-grained and sandy sedimentary deposits in the site vicinity could indicate optimal conditions for liquefaction.

In RAI 02.05.03-2, the staff asked the applicant to provide additional bases for the determination that there is no evidence for paleoliquefaction in the Fermi 3 site vicinity. Specifically, the staff asked the applicant to describe paleoliquefaction investigations conducted in the site vicinity to support the applicant's conclusion that such features do not exist. In the response to RAI 02.05.03-2 dated January 11, 2010 (ADAMS Accession No. ML100130382), the applicant stated that paleoliquefaction investigations were conducted in the Fermi 3 site region. However, there are no published or unpublished reports documenting paleoliquefaction investigations in the site vicinity. The applicant confirmed the findings with the Ohio and Michigan Geological Survey staffs. The applicant stated that favorable geologic conditions to support the formation, preservation, or recognition of liquefaction features are not present in the Fermi 3 site vicinity, and this conclusion was verified through the applicant's observations during field reconnaissance investigations. Furthermore, the applicant identified several key field observations that provide the basis for its conclusion—including overall low relief across the site vicinity as well as shallow, over-vegetated stream banks.

NRC staff reviewed the applicant's response to RAI 02.05.03-2 and visited multiple field locations at and surrounding the Fermi 3 site in November 2009. The staff visited floodplain and stream locations in the site vicinity to observe stratigraphic exposures and noted unfavorable conditions for conducting paleoliquefaction investigations. The staff also reviewed the applicant's field investigation results and lineament analysis and concluded that the site conditions are not conducive to the development of liquefaction features. The staff determined that the combination of limited and poor exposures, relatively shallow bedrock, and unsuitable Quaternary stratigraphy contribute significantly to the difficulty in relying on paleoliquefaction studies to evaluate strong ground shaking in the Fermi 3 site vicinity. Accordingly, the applicant provided an adequate response to RAI 02.05.03-2. Therefore, this RAI is resolved and closed.

Based on the information in FSAR Subsection 2.5.3.4, the applicant's response to RAI 02.05.03-2, the staff's independent literature review, and observations made during the staff's visit to the site in November 2009, the staff determined that the applicant has adequately evaluated the evidence for the most recent deformations at the Fermi 3 site. The staff found that the applicant's conclusion of a lack of evidence for Quaternary tectonic and non-tectonic surface deformation is reasonable, as is the conclusion that the ages of the most recent deformations in the site vicinity are older than the Quaternary Period. The staff concluded that the applicant has provided sufficient information in FSAR Subsection 2.5.3.4 to support the Fermi 3 COL application. The applicant's information is in accordance with the guidance in RG 1.208 and meets the requirements of 10 CFR 100.23.

2.5.3.4.5 Relationship of Tectonic Structures in the Site Area to Regional Tectonic Structures

NRC staff reviewed the applicant's information in FSAR Subsection 2.5.3.5 related to the correlation of Paleozoic subsurface structures in the site area with regional tectonic structures. The staff independently reviewed the geologic literature referencing Paleozoic and Precambrian structures in the site region. The applicant provided a reasonable basis to conclude that tectonic structures in the site area are related to regional tectonic structures, which preserve deformation that occurred before the Quaternary Period. The staff concluded that the applicant has provided sufficient information in FSAR Subsection 2.5.3.5 to support the Fermi 3 COL application. The applicant's information is in accordance with the guidance in RG 1.208 and meets the requirements of 10 CFR 100.23.

2.5.3.4.6 Characterization of Capable Tectonic Sources

NRC staff reviewed FSAR Subsection 2.5.3.6 and the applicant's basis for concluding that no capable tectonic sources exist in the Fermi 3 site vicinity in accordance with criteria defined in RG 1.208. The applicant noted that Paleozoic rocks older than 250 million years are overlain by glacial and lacustrine (lake) deposits that are younger than 30,000 years. The applicant identified no geomorphic evidence for deformation in the overlying glacial and lacustrine deposits.

In RAI 02.05.03-7, the staff asked the applicant to provide a more detailed discussion of the basis for concluding in FSAR Subsection 2.5.3.6 that no bedrock faults within the Fermi 3 site vicinity are capable tectonic sources. In the response to RAI 02.05.03-7 dated February 11, 2010 (ADAMS Accession No. ML100570311), the applicant explained the use of multiple observations to assess the capability of postulated faults within the site vicinity. The applicant's analyses focused on evaluating the evidence for deformation associated with two possible bedrock faults that extend into the Fermi 3 site area—the New Boston and the Sumpter Pool faults. The applicant analyzed well log data for 20 oil wells within the vicinity of these two possible structures that were useful for providing elevation constraints across the tops of Paleozoic subsurface formations. The applicant determined that there was no evidence for vertical displacement across either of these postulated faults in the Devonian age (~359 Ma) top of bedrock units associated with the Dundee Formation.

The applicant also relied on analyses of the overlying Quaternary sediments in the Fermi 3 site vicinity to evaluate the potential for surface deformation above the postulated faults. The applicant explained that a series of late-glacial lakes occupied the entire site vicinity about 12,000 to 13,000 years ago. Geomorphic and stratigraphic indicators associated with glacial lake levels are useful indicators of and evidence for vertical displacement and deformation. The applicant analyzed the lake level deposits across the site vicinity and determined that there is no evidence for deformation within these units. The results of these analyses strongly suggest a lack of deformation in the site vicinity within at least the past 13,000 years. The applicant stated that neither of these possible faults within the site vicinity shows any evidence of activity in the past 12,000 years, and the low rate and scattered pattern of seismicity further supports a conclusion that the possible New Boston and Sumpter Pool faults are not capable tectonic structures. As a result of RAI 02.05.03-7, the applicant provided Fermi 3 FSAR updates that more thoroughly document the analyses of the New Boston and Sumpter Pool faults.

NRC staff reviewed the applicant's response to RAI 02.05.03-7, the applicant's analysis of well logs, and the applicant's revisions to FSAR Sections 2.5.1 and 2.5.3. The staff determined that the applicant's response provides a thorough analysis of evidence for capable tectonic structures within the site vicinity. The applicant also clarified unclear statements in previous FSAR versions related to analyzing surface and near-surface deposits in the site vicinity. The staff concluded that the applicant's discussion in the response to RAI 02.05.03-7, including markups of the updated FSAR, adequately address the staff's concerns and provide a more thorough basis to support the applicant's conclusions. Therefore, RAI 02.05.03-7 is resolved and closed.

Based on the information in FSAR Subsection 2.5.3.6, the applicant's response to RAI 02.05.03-7, the staff's independent review, and the staff's observations during a visit to the Fermi 3 site in November 2009, the staff determined that the applicant has adequately characterized capable tectonic sources within the Fermi 3 site vicinity. The applicant provided sufficient information to support the conclusion that tectonic faults in the site vicinity have not experienced deformation since at least the Quaternary Period, thus demonstrating that these faults should not be considered capable tectonic sources. The staff concluded that the applicant has provided sufficient information in FSAR Subsection 2.5.3.6 to support the Fermi 3 COL application. The applicant's information is in accordance with the guidance in RG 1.208 and meets the requirements of 10 CFR 100.23.

2.5.3.4.7 Designation of Zones of Quaternary Deformation in the Site Region

In FSAR Subsection 2.5.3.7, the applicant concluded that there are no zones of Quaternary deformation in the Fermi 3 site region. Based on the staff's independent reviews of the FSAR and the applicant's various RAI responses related to FSAR Sections 2.5.1 and 2.5.3, literature cited in the FSAR, and the results of the field investigations performed by the applicant for the Fermi 3 site, as well as direct field observations made by staff during a site visit in November 2009, the staff determined that the applicant has adequately evaluated the Fermi site region for evidence of Quaternary deformation zones. The staff finds that the applicant's conclusion that no zones of Quaternary deformation exist in the site region is reasonable. Therefore, the staff concludes that the applicant has provided sufficient information in FSAR Subsection 2.5.3.7 to support the Fermi 3 COL application, and that this information is in accordance with regulatory guidance in RG 1.208 and regulatory requirements in 10 CFR 100.23

2.5.3.4.8 Potential for Surface Deformation at the Site

In FSAR Subsection 2.5.3.8, the applicant concluded that the potential for tectonic or non-tectonic surface deformation at the Fermi 3 site is negligible. The NRC staff reviewed the information in FSAR Sections 2.5.1 and 2.5.3 and the applicant's response to the staff's RAIs as the basis for the applicant's conclusions that negligible tectonic or non-tectonic surface deformation potential exists at the site. Based on the staff's review of the FSAR, the staff's independent literature review, the staff's review of the applicant's field investigations in the

Fermi 3 site vicinity, and the staff's observations during a site visit in November 2009, the staff determined that the applicant has adequately evaluated the Fermi 3 site for evidence of tectonic or non-tectonic surface deformation. The staff found that the applicant's conclusion that Quaternary tectonic and non-tectonic surface deformation are absent at the site is reasonable, as is the conclusion that existing structures represent deformation processes that occurred before the Quaternary Period. Thus, the applicant has reasonably supported the conclusion that there is a negligible potential for future surface deformation at the site. It is the responsibility of the applicant to perform detailed geologic mapping of the Fermi 3 excavation for nuclear island structures, to examine and evaluate geologic features in excavations for other safety-related structures, and to inform the NRC once the excavations are open for examination by NRC staff. In Subsection 2.5.3.5 of this SER, the staff defines this responsibility as License Condition 2.5.3-1. The staff concluded that the applicant has provided sufficient information in FSAR Subsection 2.5.3.8 to support the Fermi 3 COL application. The applicant's information is in accordance with the guidance in RG 1.208 and meets the requirements of 10 CFR 100.23.

2.5.3.5 *Post Combined License Activities*

The staff identified the following geologic mapping license condition as the responsibility of the COL licensee:

License Condition (2.5.3-1): The applicant shall perform detailed geologic mapping of excavations for safety-related structures; examine and evaluate geologic features discovered in those excavations; and notify the Director of the Office of New Reactors, or the Director's designee, once excavations for safety-related structures are open for examination by NRC staff.

2.5.3.6 *Conclusion*

The NRC staff reviewed the application and confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COL application to the relevant NRC regulations, the guidance in Section 2.5.3 of NUREG–0800, and applicable NRC regulatory guides. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff determined that the applicant has adequately addressed COL Item EF3 COL 2.0-28-A, as it relates to the surface faulting.

As set forth above, the staff found that the applicant has provided a thorough characterization of the potential for surface deformation at the Fermi 3 site, as required by 10 CFR 100.23 and 10 CFR 52.79(a)(1)(iii). The staff considered the information gathered by the applicant during the regional and site-specific investigations. Therefore, the staff concludes that the applicant had performed these investigations in accordance with the requirements of 10 CFR 100.23 and 10 CFR 52.79(a)(1)(iii) by following the guidance in RG 1.208. The staff concludes that the applicant has provided an adequate basis to establish that there is no potential for surface tectonic or non-tectonic deformation that may affect the design and operation of the proposed nuclear power plant. The staff concludes that the site is suitable from the perspective of surface deformation and meets the requirements of 10 CFR 100.23 and 10 CFR 52.79(a)(1)(iii).

2.5.4 Stability of Subsurface Materials and Foundations

2.5.4.1 *Introduction*

This FSAR section presents the stability of subsurface materials and foundations that relate to the Fermi 3 site. The properties and stability of the soil and rock underlying the site are important to the safe design and siting of the plant. The information in this FSAR section addresses (1) geologic features in the site vicinity; (2) static and dynamic engineering properties of soil and rock strata underlying the site; (3) the relationship of the foundations for safety-related facilities and the engineering properties of underlying materials; (4) results of seismic refraction and reflection surveys, including in-hole and cross-hole explorations; (5) safety-related excavation and backfill plans and engineered earthwork analyses and criteria; (6) groundwater conditions and piezometric pressure in all critical strata as they affect the loading and stability of foundation materials; (7) responses of site soils or rocks to dynamic loading; (8) liquefaction potential and consequences of liquefaction of all subsurface soils, including the settlement of foundations; (9) earthquake design bases; (10) results of investigations and analyses conducted to determine foundation material stability, deformation, and settlement under static conditions; (11) criteria, references, and design methods used in static and seismic analyses of foundation materials; (12) techniques and specifications to improve subsurface conditions, which are to be used at the site to provide suitable foundation conditions, and any additional information deemed necessary in accordance with 10 CFR Part 52.

2.5.4.2 *Summary of Application*

Section 2.5.4 of the Fermi 3 COL FSAR describes the stability of subsurface materials and foundations. In addition, in FSAR Section 2.5.4, the applicant provides the following:

<u>*COL Item*</u>

- EF3 COL 2.0-29-A Stability of Subsurface Materials and Foundations

In FSAR Section 2.5.4, the applicant provides site-specific information in accordance with SRP Section 2.5.4 to address COL Item EF3 COL 2.0-29-A. Specifically, the information addresses the (1) localized liquefaction potential under other than Seismic Category I structures; and (2) settlement and differential settlement.

2.5.4.2.1 Geologic Features

FSAR Subsection 2.5.4.1 refers to FSAR Section 2.5.1 for a complete description of the regional and site geology, including discussions of the potential for surface and subsurface weathering and deformation.

2.5.4.2.2 Properties of Subsurface Materials

FSAR Subsection 2.5.4.2 presents the static and dynamic engineering properties of subsurface materials based on the applicant's field investigation and sampling program and on laboratory testing. Table 2.5.4-1 of this SER summarizes the engineering properties of subsurface materials at the Fermi 3 site.

Table 2.5.4-1 Summary of Engineering Properties of Soils and Bedrocks
(Reproduced from Fermi COL FSAR Table 2.5.4-202)

Stratum	Quarry Fill	Lacustrine Deposits	Glacial Till	Bass Islands Group	Salina Group Unit F	Salina Group Unit E	Salina Group Unit C	Salina Group Unit B
USCS Symbol	GP/GW	CL/CH	CL	-	-	-	-	-
Total Unit Weight kg/m^3 (pcf)	2,002 (125)	2,082 (130)	2,162 (135)	2,402 (150)	2,402 (150)	2,402 (150)	2,402 (150)	2,402 (150)
Fines Content, %	-	93	68	-	-	-	-	-
Natural Water Content, %	-	27	15	0.1	0.4	3.9	0.9	0.2
Atterberg Limits								
Liquid Limit %	-	44	29	-	-	-	-	-
Plastic Limit %	-	17	15	-	-	-	-	-
Plasticity Index %	-	27	14	-	-	-	-	-
Adjusted SPT N60-value, bpf	11	7	47	-	-	-	-	-
Undrained Shear Strength kPa (ksf)	-	43 (0.9)	129 (2.7)	-	-	-	-	-
Effective Shear Strength Parameters								
Effective Cohesion kPa (ksf)	0	0	0	-	-	-	-	-
Effective Friction Angle	36	29	31	-	-	-	-	-
Rock Quality Designation	-	-	-	54	13	72	97	97
Unconfined Compressive Strength MPa (ksf)	-	-	-	89 (1,870)	45 (940)	84 (1,760)	86 (1,800)	73 (1,540)
Poisson Ratio	0.35	0.35/0.49	0.35/0.49	0.33	0.39	0.30	0.28	0.29
Modulus of Elasticity based on Hoek-Brown criterion								
Upper Bound Modulus MPa (ksf)	-	-	-	5,242 (109,500)	1,517 (31,700)	23,560 (492,100)	29,830 (623,000)	63,430 (1,324,700)
Mean Modulus MPa (ksf)	-	-	-	3,863 (80,700)	1,160 (24,200)	20,310 (424,200)	26,780 (559,300)	58,810 (1,228,400)

Lower Bound Modulus MPa (ksf)	-	-	-	2,868 (59,900)	924 (19,300)	16,710 (349,000)	23,080 (482,100)	52,800 (1,102,700)
Modulus of Elasticity based on Laboratory Test MPa (ksf)	-	-	-	43,030 (898,600)	25,340 (529,200)	32,150 (671,500)	36,540 (763,200)	72,050 (1,504,800)
Modulus of Elasticity based on V_s MPa (ksf)	-	-	-	26,630 (556,200)	6,350 (132,600)	36,190 (755,800)	48,240 (1,007,600)	55,390 (1,156,900)
Average V_s m/s (fps)	-	-	243 to 350 (800 to 1,150)	2,042 to 2,225 (6,700 to 7,300)	975 to 1,219 (3,200 to 4,000)	2,407 to 2,773 (7,900 to 9,100)	2,712 to 2,743 (8,900 to 9,000)	2,895 to 3,017 (9,500 to 9,900)
Average V_p m/s (fps)	-	-	-	4,023 to 4,389 (13,200 to 14,400)	2,438 to 2,865 (8,000 to 9,400)	4,663 to 4,937 (15,300 to 16,200)	4,846 to 4,907 (15,900 to 16,100)	5,334 to 5,577 (17,500 to 18,300)
Shear Modulus at very small strain levels, G_{max} MPa (ksf)	-	-	129 (2,700)	10,010 (209,100)	2,283 (47,700)	13,920 (290,700)	18,850 (393,600)	21,470 (448,400)
bpf = blows per foot; fps = foot per second; kg/m^3 = kilograms per cubic-meter; kPa = kilopascal; ksf=kip (1000 pound force) per square-foot; m/s= meters per second; MPa= megapascal; pcf = pounds per cubic-foot								

Engineering Properties of Subsurface Materials

FSAR Subsection 2.5.4.2.1 provides an overview of the subsurface soil and rock at the Fermi 3 site. The applicant stated that there are approximately 9.0 m (30 ft) of overburden material consisting of fill, lacustrine deposits, and glacial till overlying the bedrock at the site. The applicant described plans to remove all overburden material beneath and adjacent to Seismic Category I structures during excavation. The bedrock unit below the overburden consists of the Bass Islands Group and Units F, E, C, and B (from the top to the bottom) of the Salina Group. The applicant noted that the site is relatively flat with an average elevation of 177 m (581 ft) NAVD 88. Table 2.5.4-2 of this SER summarizes the approximate elevation ranges and average thickness for each of the subsurface layers. FSAR Appendix 2.5DD lists a total of 68 borings, which the applicant performed to obtain the engineering properties of both soils and rocks.

Table 2.5.4-2 Approximate Elevation Ranges for Each Subsurface Material Encountered at Fermi 3
(Reproduced from Fermi COL FSAR Table 2.5.4-201)

Subsurface Material	Approximate Range in Elevation NAVD 88, m (ft)	Average Thickness, m (ft)
Fill	177 to 173 (581 to 568)	3.9 (13)
Lacustrine Deposits	173 to 171 (568 to 563)	1.5 (5)
Glacial Till	171 to 168 (563 to 552)	3.3 (11)
Bass Islands Group	168 to 141 (552 to 462)	27 (90)
Salina Group Unit F	141 to 103 (462 to 339)	37 (123)
Salina Group Unit E	103 to 75 (339 to 246)	28 (93)
Salina Group Unit C	75 to 47.5 (246 to 156)	27 (90)
Salina Group Unit B	47.5 to * (156 to *)	*

*The bottom of the Salina Group Unit B was not encountered during the geophysical investigations.
ft= foot; m = meter

Engineering Properties of Soils

FSAR Subsection 2.5.4.2.1.1 discusses the engineering properties of the upper 30 m (90 ft) of overburden materials present at the Fermi 3 site. The applicant stated that the overburden is comprised of fill, lacustrine deposits, and glacial till, all of which will fully excavate beneath and adjacent to all Seismic Category I structures.

The applicant further stated that although the fill and lacustrine deposits are not suitable for foundation support or structural backfill, their static engineering properties are suitable for the stability analysis and design of temporary excavation support systems and slopes. Since the fill and lacustrine deposits will be removed at the site, the applicant did not consider the dynamic engineering properties of these materials in the GMRS.

Finally, the applicant considered the static and dynamic properties of the approximately 3.4-m (11-ft) thick glacial till at the base of the overburden; because this material may be used to support non-Seismic Category I structures. The applicant noted that shear wave velocity (V_s) measurements of the glacial till range from 244 to 351 m/s (800 to 1,150 fps). The applicant used these values to calculate the shear modulus behavior of the glacial till and considered the glacial till the uppermost competent material present at the Fermi 3 site.

Engineering Properties of Bedrock

FSAR Subsection 2.5.4.2.1.2 describes the characteristics, properties, and classification of the two primary bedrock units beneath the Fermi 3 site: the Bass Islands Group and Units F, E, C, and B of the Salina Group. FSAR Subsections 2.5.1.2.3.1.2 and 2.5.1.2.3.1.1 provide detailed descriptions of these units. The applicant estimated the strength and deformation characteristics of the bedrock units using the Hoek-Brown criterion (Hoek 2007).

1. Bass Islands Group

The applicant stated that it will found the Fermi 3 Seismic Category I structures on the Bass Islands Group, or on fill concrete overlying the Bass Islands Group, the uppermost bedrock unit with an elevation of approximately 168 to 141 m (552 to 462 ft) NAVD 88. Based on field testing, the applicant stated that the average rock quality designation (RQD)—a measure of the rock's integrity—is 54 percent. The applicant lab-tested 20 intact rock samples and determined an average unconfined compressive strength (q_u) and elasticity modulus (E) of 89.5 megapascals (MPa) (1,870 kips per square-foot (ksf)) and 43,000 MPa (898,600 ksf), respectively. The applicant based the Poisson's ratio, which varies from 0.33 to 0.34, on the mean V_s and compression wave velocity (V_p), which varies from 2,012 to 2,225 m/s (6,600 to 7,300 fps) and 4,023 to 4,389 m/s (13,200 to 14,400 fps), respectively.

2. Salina Group

FSAR Subsections 2.5.4.2.1.2.2 through 2.5.4.2.1.2.5 describe the general characteristics for Salina Group Units F, E, C, and B. The applicant described Salina Group Unit F as bedrock localized at an elevation of 140 to 103 m (462 to 339 ft) NAVD 88, with an average RQD of 13 percent. In order to determine the characteristics of the intact bedrock, the applicant performed thirteen unconfined compression (UC) laboratory tests to obtain an average q_u of 45 MPa (940 ksf) and an average E of about 25,300 MPa (529,300 ksf). The applicant performed an in situ pressuremeter test and obtained an average E of 996 MPa (20,800 ksf). The applicant calculated a Poisson's ratio of 0.39 to 0.40 from the mean Vp of 2,438 to 2,865 m/s (8,000 to 9,400 fps) and the mean Vs of 975 to 1,219 m/s (3,200 to 4,000 fps).

The applicant observed the Salina Group Unit E between elevation 103 and 75 m (339 and 246 ft) NAVD 88, with an average RQD of 72 percent. The applicant performed UC laboratory tests on eight intact bedrock samples with an average q_u and E of 84 MPa and 32,100 MPa (1,750 ksf and 671,400 ksf), respectively. The applicant calculated a Poisson's ratio of 0.27 to 0.32 based on the mean V_s and V_p that vary from 4,115 to 4,938 m/s (15,300 to 16,200 fps) and 2,408 to 2,774 m/s (7,900 to 9,100 fps), respectively.

FSAR Subsection 2.5.4.2.1.2.4 states that the Salina Group Unit C was found between elevations of 75 to 47.5 m (246 to 156 ft) NAVD 88, with an average RQD of 97 percent. The applicant noted that only two borings penetrated Unit C. The applicant performed an UC laboratory test on two intact bedrock samples, and the resultant q_u and E had averages of 86 MPa and 36,542 MPa (1,790 ksf and 763,200 ksf), respectively. The applicant calculated a Poisson's ratio of 0.26 to 0.28 from the mean V_p of 4,846 to 4,907 m/s (15,900 to 16,100 fps) and the mean V_s of 2,713 to 2,743 m/s (8,900 to 9,000 fps).

FSAR Subsection 2.5.4.2.1.2.5 specifies that the top of Salina Group Unit B is at an elevation of 47.5m (156 ft), but the bottom was not found during the subsurface investigation. The applicant noted that the average RQD was 97 percent and considered an average q_u of 74 MPa (1,540 ksf) and an average E of 72,000 MPa (1,504,800 ksf) to be representative of the engineering behavior of the rock mass of Salina Group Unit B. The applicant used the mean V_p, which varied from 5,334 to 5,578 m/s (17,500 to 18,300 fps); and the mean V_s, which varied from 2,896 to 3,018 m/s (9,500 to 9,900 fps), to calculate a Poisson's ratio of 0.29.

Field Investigations

FSAR Subsection 2.5.4.2.2 states that the applicant conducted field investigations in accordance with an approved quality assurance program. The applicant used two phases to complete the investigation: a hydrogeological phase and a geotechnical phase.

Hydrogeological Investigation Program

The applicant conducted a hydrogeological investigation that consisted of piezometers and monitoring wells installation, packer and slug testing, downhole geophysics and sampling, and groundwater testing. The applicant's investigation focused on the unconfined surficial groundwater and the confined Bass Islands Group aquifer. The applicant installed 17 shallow and 11 deep piezometers and monitor wells east and west of the overflow canal. The applicant utilized the shallow wells to monitor the unconfined groundwater and the deeper wells to monitor the confined Bass Islands Group aquifer. FSAR Section 2.4.12 discusses the existing Fermi piezometers and monitoring wells in greater detail. The applicant recorded the groundwater or drilling fluid level at the start of each workday for borings in progress and at the completion of drilling, in accordance with the guidance in RG 1.132. The groundwater levels were measured monthly for a period of 1 year. The applicant performed downhole logging in areas of poor bedrock core recovery to aid in the selection of packer test zones, understand the hydrology, and correlate the bedrock geology across the site. The applicant referred to FSAR Section 2.4.12 for the results of packer and slug testing performed to estimate the permeability of selected intervals of bedrock and the hydraulic conductivity in the overburden, respectively.

FSAR Subsection 2.5.4.2.2.1.7 presents the types of chemical testing conducted on the groundwater and surface water samples to establish baseline conditions at the site.

Geotechnical Investigation Program

The applicant conducted a geotechnical investigation to obtain surface information, characterize site conditions, develop site specific seismic design criteria, and evaluate the potential for geotechnical hazards.

In accordance with RG 1.132, the applicant collected soil samples at depth intervals no greater than 1.5 m (4.92 ft). The applicant used a combination of split–barrel samplers, thin-walled tubes, or sonic sampling depending on the soil type. The applicant concluded that because it will found all safety-related structures at the Fermi 3 site on bedrock or fill concrete over bedrock, the continuous sampling requirement was satisfied by the continuous sonic sampling from the ground surface to the top of the bedrock and by continuous rock coring in bedrock.

The applicant conducted P-S suspension logging, downhole seismic testing and SASW surface geophysics to obtain a V_s profile to use in a seismic response analysis of the site.

FSAR Subsection 2.5.4.2.2.2.5 describes the procedure and results of additional pressuremeter testing the applicant performed at the Salina Group Unit F location to provide a direct in situ measurement of the E for Unit F. The applicant selected rock pressuremeter locations in Boring RB-C6, at the location planned for the reactor, to test a range of bedrock qualities and types to provide a range of E values for Unit F. The applicant stated that the material being tested was a very complex geological unit consisting of interbedded limestone, dolomite, claystone, siltone, shale and breccias with variable degrees of induration. Even with the limitation of full classification of interbedded materials, the applicant successfully conducted pressuremeter testing and concluded that the test results should provide a conservative estimate of the in situ E. FSAR Table 2.5.4-219 contains the details of the test results.

The applicant backfilled the boreholes in the overburden or the Bass Islands Group with either bentonite chips within 0.3 to 0.6 m (1 to 2 ft) of the ground surface or cement/bentonite grout, and the top 0.3 to 0.6 m (1 to 2 ft) was backfilled with gravel.

Storage, Handling, and Transportation of Soil and Bedrock Samples

In FSAR Subsection 2.5.4.2.2.3, the applicant stated that the collected soil and bedrock samples were documented and stored in a way that will permit future retrieval for future examination and index testing. In addition, the applicant implemented American Society of Testing and Materials (ASTM) Standards D4220–95 and D5079–02; clearly labeled the samples; used a sample custody record form completed by a field engineer or geologist for storage and documentation; and delivered the samples to a temporary storage facility on a daily basis.

Laboratory Testing

FSAR Subsection 2.5.4.2.3 describes the goal of the laboratory testing program. The applicant stated that this program fully complies with the guidance of RG 1.138, and the testing was performed in accordance with standard test procedures. As part of the static laboratory testing, the applicant included different types of tests, such as the natural moisture content; specific gravity; Atterberg limits; mechanical sieve analysis; hydrometer analysis; percent finer than No. 200 sieve; consolidated-undrained triaxial compression test; unconsolidated-undrained triaxial compression test; unconfined compression test on soil and rock; one-dimensional consolidation test; direct shear test on soil and rock; hydraulic conductivity; and chemical analysis of soils. The applicant concluded that no dynamic testing was required for several bedrock units (the Bass Islands Group and Salina Group Units E, C, and B) because the V_s were equal to or greater than 2,042 m/s (6,700 fps). The applicant also concluded that no dynamic testing was required for Salina Group Unit F because the estimated shear strain levels were less than 0.03 percent, thus indicating a negligible modulus reduction for the Unit F bedrock. The applicant stated that because of poor core recovery and poor RQD for Salina Group F, the testable samples represent the more intact portion of the bedrock and testing under static or dynamic loading conditions will produce high values not representative of the overall unit. The applicant performed four resonant column torsional shear (RCTS) dynamic tests on samples of glacial till to obtain the modulus reduction and damping as a function of strain up to shear strain of approximately 0.3 percent. FSAR Section 2.5.4.7.3 presents the RCTS results.

2.5.4.2.3 Foundation Interfaces

FSAR Subsection 2.5.4.3 describes the geologic cross sections for Seismic Category I structures, including the detailed relationship of the foundations of structures to the subsurface materials. The applicant noted that the base of the RB/FB foundation lies in the Bass Islands Group, with an embedment depth of 20 m (65.6 ft) below the finished grade and a base elevation of 159.6 m (523.7 ft) NAVD 88. The base of the CB foundation also lies in the Bass Islands Group, with an embedment depth 14.9 m (48.9 ft) below the finished grade and an elevation of 164.7 m (540.4 ft) NAVD 88. For the FWSC, the applicant indicated an embedment depth of 2.35 m (7.7 ft) at an elevation of 177.3 m (581.6 ft) NAVD 88. The applicant will use fill concrete to backfill the gap between the RB/FB and CB and excavated bedrock up to 168.2 m (552 ft) NAVD 88. The applicant will remove and replace the glacial till underneath the TB with fill concrete to reduce the interaction between the TB and the RB as a result of the close proximity between the buildings. FSAR Appendix 2.5DD includes a list of the boring logs, monitoring well logs, piezometer logs, and test pit logs.

2.5.4.2.4 Geophysical Surveys

FSAR Subsection 2.5.4.4 refers to FSAR Subsection 2.5.4.2.2.2.4 for a list of the geophysical surveys performed. The details of the testing are discussed below in this section.

Geophysical Surveys for Dynamic Characteristics of Subsurface Materials

In FSAR Subsection 2.5.4.4.1, the applicant measured the dynamic characteristics of soils and bedrock using different types of testing that includes P-S suspension logging to obtain the V_s and V_p of the soil and bedrock; surface SASW to obtain the V_s in the soil; and downhole seismic testing to obtain the V_s and V_p in bedrocks. The applicant considered the P-S suspension logging method as the primary method for obtaining the V_s and V_p and used the downhole seismic method to validate the results.

P-S Suspension Logging and Downhole Seismic Testing in Bedrock Units

Initially the applicant experienced a repeated collapse of the boreholes at depths of 33.5 to 62.5 m (110 to 205 ft) in Salina Group Unit F that resulted in an oversized borehole and irregular borehole shapes. The applicant overcame the problem by using temporary steel casing and by conducting P-S suspension logging and downhole seismic testing below and above the borehole collapsing zone and at select locations within the Salina group Unit F.

The applicant obtained variable readings in Salina Group Unit F and in the Bass Islands Group between depths of 9.1 and 36.6 m (30 and 120 ft). The applicant compared the V_s and V_p measurements with the RQD, caliper, natural gamma, and optical televiewer (OTV) information to understand whether the measured velocities were representative of the actual subsurface conditions. FSAR Figure 2.5.4-213 and Figure 2.5.4-214 show that the variability in the measured V_p and V_s correlates with the variability in the natural gamma logs, where the lower gamma indicates the presence of dolomite or limestone, the measured V_p and V_s increase. The applicant concluded that the variability in the measured V_p and V_s is caused by geologic features and that the measured V_p and V_s are representative of the actual ground conditions. The applicant stated that the measured V_p at Fermi 3 is in agreement with the V_p measured at Fermi 2 for the Bass Islands Group and for Salina Group Units F and E. But the V_p measured at Fermi 2 for Salina Group Units C and B have a difference of less than 15 percent lower than the V_p measured for Fermi 3. Figure 2.5.4-1 of this SER shows all of the V_p and V_s measurements at different borehole locations using both the P-S and downhole seismic methods. The applicant concluded that the results from P-S suspension logging are acceptable for all purpose of analysis.

P-S Suspension Logging and Spectral Analysis of Surface Wave in Soil Layers

FSAR Subsection 2.5.4.4.1.2 states that the results of the SASW method are acceptable because the soil shear wave velocities measured using the P-S suspension method agree with the SASW method. The applicant measured the seismic wave velocities in the overburden at boring RB-C6.

Natural Gamma, 3-Arm Caliper, Heat Pulse Flowmeter, and Optical Televiewer Logging

FSAR Subsection 2.5.4.4.2 describes the details of the various logging methods used. The applicant referenced the Black and Veatch report (Black and Veatch 2008) for the results of borehole loggings using the natural gamma, the 3-arm caliper, the heat pulse flowmeter, and the OTV. The applicant conducted all of the loggings in the same 18 boreholes except for the heat pulse flowmeter logging that was performed on borings RB-C8 and TB-C5.

Borehole Deviation Survey

In FSAR Subsection 2.5.4.4.3, the applicant conducted a borehole deviation survey in 22 steel-cased boreholes and recorded a maximum deviation of less than 1.5 degrees in the borings surveyed. The applicant utilized the EZ-Trac tool with the multi-shot function for most boreholes and the OTV probe for boring locations RB-C8 and TB-C5.

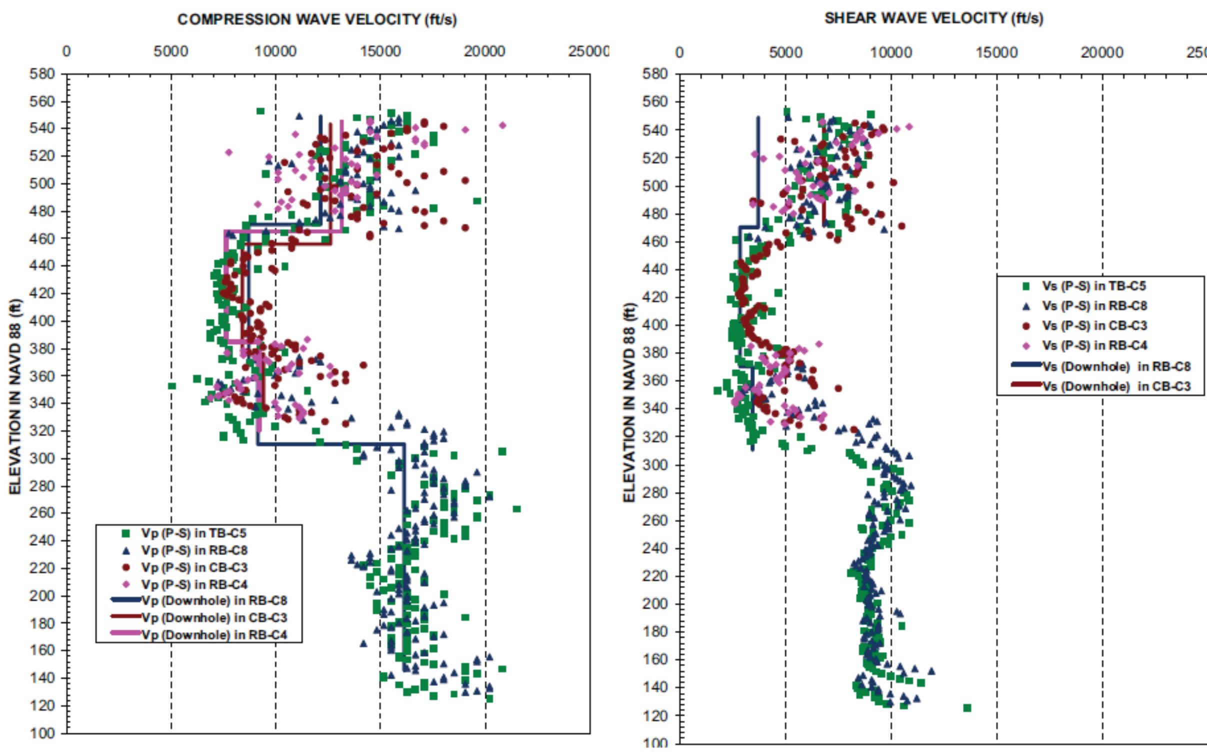


Figure 2.5.4-1 V_p and V_s measurements using P-S and Downhole Methods
(Reproduced from Fermi 3 COL FSAR Figure 2.5.4-215 and 2.5.4-216)

2.5.4.2.5 Excavation and Backfill

FSAR Subsection 2.5.4.5 describes source and quantities of backfill and borrow materials, excavation methods and stability. The applicant will commence all excavation activities for the power block structures from the existing ground surface elevation of approximately 177.1 m (581.0 ft) NAVD 88. FSAR Subsection 2.5.4.5.4.2 addresses the details of engineered granular backfill.

Source and Quantities of Backfill and Borrow Materials

In FSAR Subsection 2.5.4.5.1, the applicant indicated that the excavated material meeting gradation requirements will be used as engineered granular backfill. The applicant conducted laboratory and chemical testing and determined the static and dynamic properties to verify compliance with the design requirements of the proposed engineering granular backfill. The applicant indicated that the backfill surrounding Seismic Category I and II structures will be a *well-graded engineered granular material and fill concrete. The applicant also stated that the backfill underneath the FWSC and the TB will be fill concrete. The applicant plans to complete the site excavation using vertical side wall excavation in soils and bedrocks. The total cut volume is estimated to be 313,000 cubic meters (m³) (410,000 cubic yards [yd³]) of which 256,000 m³ (335,000 yd³) are soil excavation and 57,000 m³ (75,000 yd³) are bedrock excavation. The total estimated backfill volume for full site development is 344,000 m³ (450,000 yd³), the volume of granular backfill from onsite excavation is approximately 180,000 m³ (235,000 yd³), and the amount of the engineered granular backfill within the perimeter of the reinforced concrete diaphragm wall is approximately 153,000 m³ (200,000 yd³). Since the potential total onsite source of granular material is greater than the quantity required to backfill within the perimeter of the reinforced concrete diaphragm wall, the applicant concluded that an onsite source will be used for backfill adjacent to the Seismic Category I structures. The applicant will apply the bulking and shrinkage factor during the final design.*

Extent of Excavations, Fills, and Slopes

In FSAR Subsection 2.5.4.5.2, the applicant addressed the vertical cut-off as an excavation system possibility, which consists of a reinforced diaphragm wall system around the entire excavation. Figures 2.5.4-2 and 2.5.4-3 of this SER present the excavation site plan view and excavation cross-section D-D' for Fermi 3 using the vertical cut-off excavation system. The applicant stated that if the vertical cut-off excavation is used, this excavation system will be installed from the existing ground surface. The applicant assumed that the cut-off walls are 24.4 m (80 ft) deep with an embedment depth of 15.2 m (50 ft) into the bedrock, between elevations of 168.2 and 153.5 m (552.0 and 503.7 ft) NAVD 88. The applicant stated that the reinforced concrete diaphragm wall will act as a perimeter of the soil excavation and will provide vertical support for the portion of the excavation within the soil. FSAR Subsection 2.5.4.5.2 explains the considerations taken regarding the distance between the wall and the Seismic Category I structures. The applicant stated that the Seismic Category I structures are designed to resist all static and dynamic soil and bedrock loads and will not be adversely affected by the diaphragm wall. The applicant also stated that the concrete diaphragm wall will be designed to ensure that it will not adversely affect the seismic Category 1 structures.

Excavation Methods and Stability

Excavation in Soil

FSAR Subsection 2.5.4.5.3.1 states that the applicant may use conventional excavation methods to remove soil layers to the lines and grades shown on the excavation cross sections.

Excavation in Bedrock

FSAR Subsection 2.5.4.5.3.2 states that the applicant will use blasting, mechanical excavation, or a combination of both methods for the bedrock excavation. FSAR Figures 2.5.4-201 through 2.5.4-204 present lines and grades where the bedrock stratum will be excavated. The applicant indicated that all of the blasting will be designed by a qualified blasting professional in order to ensure the protection of all existing adjacent structures, including Fermi 2. The applicant stated that the mechanical excavation could include roadheaders, terrain levelers, rockwheels, and rock trenchers, among other excavation techniques.

Foundation Bedrock Grouting

In FSAR Subsection 2.5.4.5.3.3, the applicant indicated that a similar foundation bedrock grouting program used for Fermi 2 may be used for Fermi 3, as part of the excavation support and seepage control system. The applicant explained that for Fermi 2, the foundation bedrock grouting program was successful in reducing groundwater flow through the rock mass into the excavation during construction.

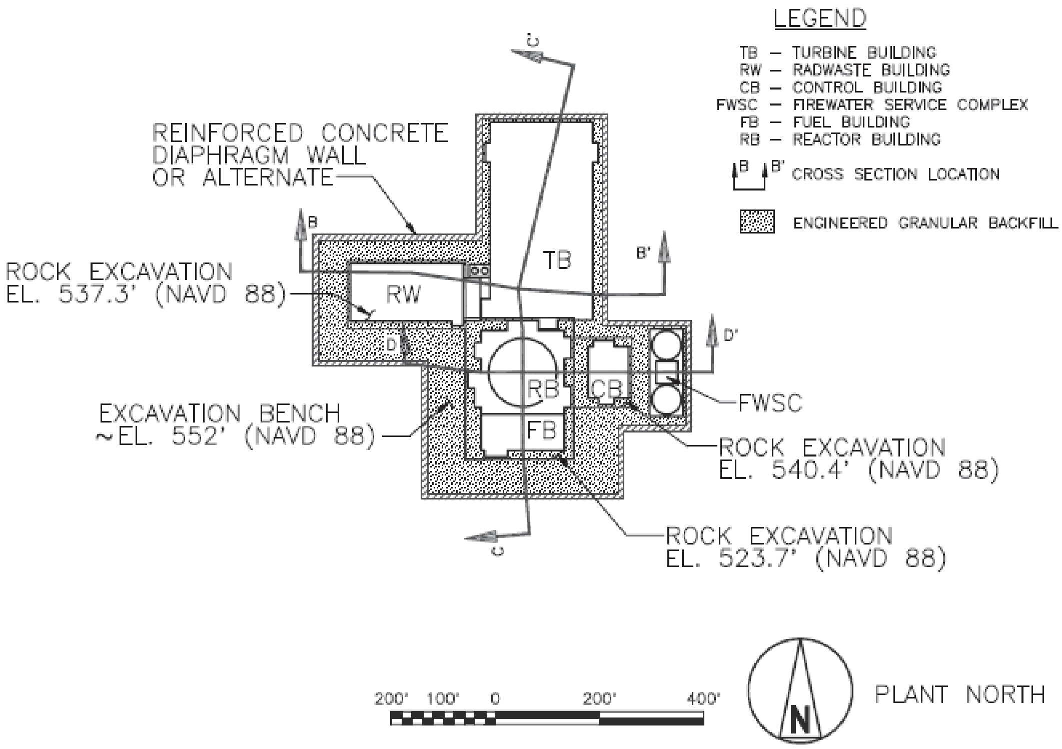


Figure 2.5.4-2 Excavation Site Plan
(Reproduced from Fermi 3 COL FSAR Figure 2.5.4-201)

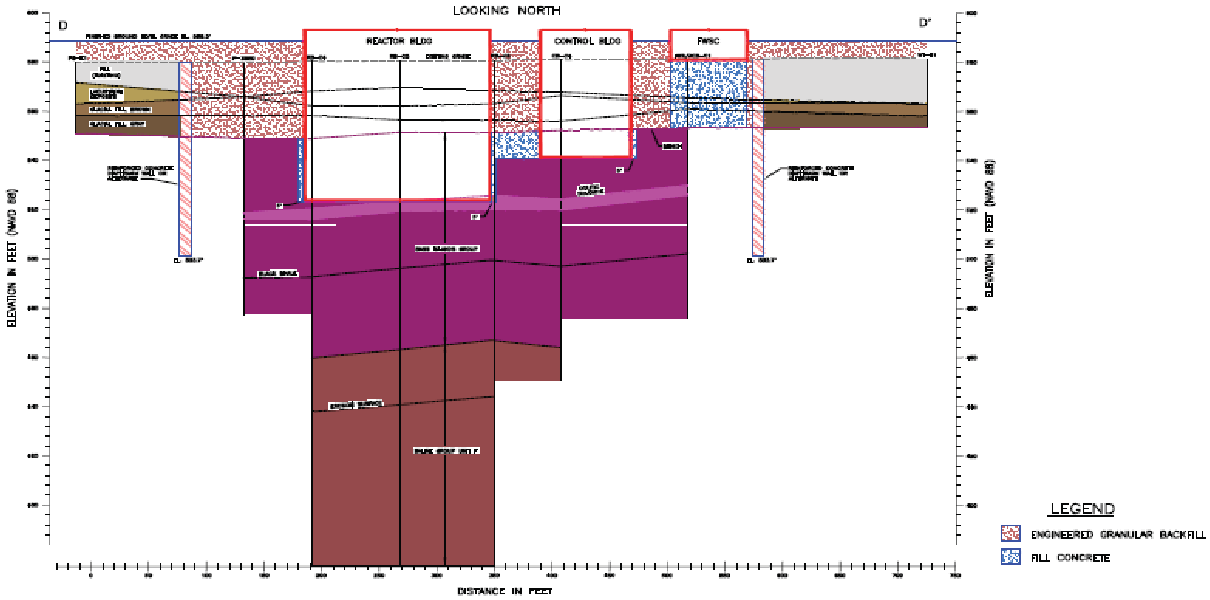


Figure 2.5.4-3 Excavation Cross Section D-D'
(Reproduced from Fermi 3 COL FSAR Figure 2.5.4-202)

<u>Compaction Specifications and Quality Control</u>

FSAR Subsection 2.5.4.5.4 describes the methods and procedures used for verification and quality control of foundation materials.

FSAR Subsection 2.5.4.5.4.1 describes methods used for quality control of foundation bedrock. FSAR states that the applicant plans to conduct a visual inspection of the final bedrock excavation surface to confirm that it conforms with the expected foundation materials based on borings loggings. In addition, the applicant will conduct visual inspections of the exposed bedrock subgrade to confirm the proper completion of the cleaning and surface preparations. The design specification includes details of quality control and quality assurance for the foundation bedrock.

FSAR Subsection 2.5.4.5.4.2 presents the consistency of the backfill materials and quality control for Fermi 3. The backfill will consist of fill concrete or a sound, well-graded granular backfill. FSAR Section 3.7.2 details the results of the site-specific SSI analyses for the RB/FB and CB, with fill concrete included as the backfill below the top of the Bass Islands Group bedrock and with and without the engineered granular backfill above the top of the bedrock. The applicant will place fill concrete as the supporting material below the FWSC, with a mean compressive strength of 31 MPa (4,500 psi). The applicant concluded that the FWSC sliding of not an issue when neglecting the engineered granular backfill surrounding the basemat, and the engineered granular backfill surrounding the basemat for the FWSC is not Seismic Category I backfill. In addition, the applicant specified that the engineered granular backfill surrounding the Seismic Category I structures will comply with the following criteria:

(a) Product of peak ground acceleration in g, α, Poisson's ratio, v, and density, γ:
α (0.95v +0.65) γ: 1220 kg/m3 (76 pcf) maximum

(b) Angle of internal friction equal to or greater than 35 degrees when properly placed and compacted

(c) Soil density, γ, is 2,000 kg/m^3 (125 pcf) minimum

FSAR Figures 2.5.4-202 through 2.5.4-204 show the extent of the fill concrete and granular backfill. The applicant will use the concrete fill to backfill the gap between the bedrock and the foundation mats of the R/FB and the CB. The applicant will use the design specifications to address the concrete fill mix design. For quality control testing requirements for the bedrock, the applicant will use visual inspection and geologic mapping. The applicant will conduct laboratory testing on the in-place engineered backfill adjacent to Seismic Category I structures during the detailed design phase in order to comply with the design requirements for the required density. The applicant will compact the engineered granular backfill surrounding the Seismic Category I structures above the top of the Bass Islands Group bedrock using a mean of 95 percent of the modified Proctor density or a mean of 75 percent of the maximum relative density. The applicant will compact the engineered granular backfill to achieve a minimum of 35 degrees for the angle of friction (φ). FSAR Subsections 2.5.4.8 and 2.5.4.10 discuss liquefaction issues related to soil backfill materials and lateral pressures applied against foundation walls, respectively. In FSAR Part 10 Section 2.4.2, the applicant described a site-specific ITAAC for backfill surrounding Seismic Category I structures which states that the engineering properties of backfill material surrounding Seismic Category I structures will be equal to or exceed the FSAR Subsection 2.5.4.5.4.2 requirements.

The applicant will follow American Concrete Institute (ACI) 349 for concrete exposed to sulfate-containing solutions and will use fill concrete with a mean 28-day compressive strength greater than 31 MPa (4,500 psi) and with a mean V_s equal or greater than 2,175 m/s (7,140 ft/s) as fill under the FWSC, Seismic Category II structures, and surrounding the RB/FB and the CB. The applicant indicated that the mix design developed for the fill concrete will control erosion and leaching and will limit settlement to specified tolerances. The quality control program for fill concrete includes requirements for compressive strength testing, and the quality control program for engineered granular backfill includes requirements for in-place field density and index testing. The applicant will adhere to the ASTM standards for testing the aggregate of concrete for deleterious expansive alkali-silica reaction. The applicant will follow ACI 207.1R, 207.2R, and 207.4R to address thermal cracking control of the fill concrete adjacent to and underneath Seismic Category I and II structures. The applicant stated that the quality control program for fill concrete includes requirements for compressive strength testing. The applicant will perform verification to confirm that compressive strength testing results comply with mix design, minimum strengths, and placement requirements. The applicant will prepare design specifications as part of the detailed design phase of the project, including the details for the quality control and quality assurance programs for the fill concrete and engineered granular backfill. In FSAR Part 10 Section 2.4.1, the applicant described a site-specific ITAAC for fill concrete under Seismic Category I Structures, which states that the compactable backfill will not be placed under Fermi 3 Seismic Category I structures and that the fill concrete placed under Seismic Category I structures to a thickness greater than 5 feet will be designed and tested as specified in FSAR Subsection 2.5.4.5.4.2.

Control of Groundwater during Excavation

FSAR Subsection 2.5.4.5.5 refers to Subsection 2.5.4.6.2 for the discussion of the control of groundwater and dewatering during excavation.

Geotechnical Instrumentation

FSAR Subsection 2.5.4.5.6 states that the instrumentation and monitoring program developed during the project's detailed design phase includes inclinometers, piezometers, seismograph survey points, and construction inspection documentation. The applicant expected a rebound or heave of less than 12.7 mm (0.5 inch) from the foundation excavation. The applicant predicted that the settlement would be within the ESBWR DCD design limits and would occur during the construction phases instead of post construction. The applicant based this prediction on the confirmation that the Seismic Category I structures are founded on bedrock that will compress elastically as the loads are applied. The applicant will confirm these settlement predictions by implementing a benchmark monitoring program.

2.5.4.2.6 Groundwater Condition

FSAR Subsection 2.5.4.6 presents information on the groundwater conditions at the site relative to foundation stability for the safety-related structures.

Groundwater Measurements

FSAR Subsection 2.5.4.6.1 refers to FSAR Subsection 2.5.4.2.2 for a discussion of the field investigation program for groundwater measurements and to FSAR Section 2.4.12, which presents the monitoring wells and piezometers data.

Construction Dewatering and Impact of Dewatering

FSAR Subsection 2.5.4.6.2 states that the applicant will use localized sump pumping systems and foundation bedrock grouting in order to control groundwater seepage through soils and bedrock during the excavation. For the sump pumping system, the applicant will place pumps at low points with water pumped to a location outside the excavation. The applicant will test the pumps and will use the results to evaluate the need for bedrock grouting before excavation. As needed, the applicant will perform foundation bedrock grouting to control groundwater inflow from zones of high permeability within the rock mass during excavation. The applicant will base the thickness of the grouted zone on the need to minimize inflow into the excavation and to resist any uplift pressures at the base of the excavations. The applicant will complete the design of the foundation grouting program during the detailed design phase of the project.

Seepage during Construction

FSAR Subsection 2.5.4.6.3 refers to FSAR Subsection 2.4.12.2.5 for a discussion of the impact of seepage into the excavation and groundwater control measures during construction. The applicant concluded that there is no potential for piping due to seepage in the bedrock, and the seepage will be minimized by excavation support and by a seepage control system. The applicant also confirmed that the potential for settlement on Fermi 2 associated with the Fermi 3 dewatering operation is negligible, because Fermi 2 has foundation on bedrock. Before beginning the construction of Fermi 3, the applicant will develop a monitoring program during the Fermi 3 design stage (Commitment COM 2.5.4-001) to assess groundwater levels and settlement at existing Fermi 2 structures.

Permeability Testing

FSAR Subsection 2.5.4.6.4 refers to FSAR Section 2.4.12 for the results of the packer and slug testing and laboratory hydraulic conductivity testing performed to estimate the hydraulic conductivity of the bedrock and soil.

Impact of Groundwater Conditions on Foundation Stability

FSAR Subsection 2.5.4.6.5 states that the applicant will found the Seismic Category I structures on bedrock or concrete fill and will found other major structures in the power block area either on bedrock or structural fill. The applicant will design the foundations of all Fermi 3 structures to account for a short-term construction with a lowered groundwater level and a long-term operational in-service condition with a rebounded natural groundwater elevation.

2.5.4.2.7 Response of Soil and Rock to Dynamic Loadings

Effect of Past Earthquakes

FSAR Subsection 2.5.4.7.1 refers to FSAR Subsection 2.5.1.1.4.3 for the discussion of the historical earthquake events. The applicant stated that no reports or studies exist on liquefaction and paleoliquefaction in the 40-km (25-mi) radius of the site vicinity.

Seismic Wave Velocity Profiles

FSAR Subsection 2.5.4.7.2 refers to FSAR Subsection 2.5.4.4 for details on the geophysical surveys used for the dynamic characterizations of soils and bedrock. The applicant generated 60 randomized soil profiles for soil amplification analyses for the RB/FB, CB, and FWSC, in order to consider variations and uncertainties in the dynamic soil profiles. The applicant sorted the iterated V_s for each layer of the 60 randomized profiles into rank order (from the lowest to highest value) and determined the 16^{th}, 50^{th}, and 84^{th} percentile V_s profiles at the seismic strains. The applicant indicated that the 16^{th} percentiles of the randomized V_s at the seismic strains represent the mean minus one standard deviation, and the 16^{th} percentiles for the foundation materials below the RB/FB, CB, and FWSC are greater than 300 m/s (1,000 fps).

Dynamic Laboratory Testing

FSAR Subsection 2.5.4.7.3 discusses the RCTS tests performed on glacial till. The applicant conducted four RCTS tests on glacial till using undisturbed samples, after evaluating sample disturbance and quality by reviewing of X-ray radiography and performing a one-dimensional consolidation test. The applicant performed RCTS tests on samples with an acceptable specimen quality designation, which indicates relatively undisturbed samples.

Shear Modulus Reduction and Damping Curves for Rocks

FSAR Subsection 2.5.4.7.4 refers to FSAR Subsection 2.5.2.5 for a discussion of the shear modulus reduction and damping curves for bedrock.

Shear Modulus Reduction and Damping for Soils

FSAR Subsection 2.5.4.7.5 explains the shear modulus reduction and damping on soils even though Fermi 3 does not have a Seismic Category I structure founded on soil. The applicant performed RCTS testing for the glacial till to provide measured shear modulus reduction and damping data. FSAR Figure 2.5.4-226 provides the glacial till shear modulus reduction and damping data.

Shear Modulus Reduction and Damping Curves for Granular Backfill and Fill Concrete

FSAR Subsection 2.5.4.7.6 states that engineered granular backfill is not used to support any Seismic Category I structures. The applicant will use engineered granular backfill to surround the embedded walls of structures or to backfill beneath other structures with foundation levels above bedrock, except Seismic Category II structures, which will be founded on fill concrete. FSAR Subsection 3.7.1.1.4.1.1 discusses related information for fill concrete and engineered granular backfill.

Ground Motion and Response Spectra

FSAR Subsection 2.5.4.7.7 refers to FSAR Subsection 2.5.2.6 and Section 3.7.1 for a discussion of the GMRS and FIRS, respectively. The applicant's calculations of the GMRS and FIRS are based on the seismic velocity profiles in FSAR Figures 2.5.4-220 through 2.5.4-225.

2.5.4.2.8 Liquefaction Potential

FSAR Subsection 2.5.4.8 states that the bedrock and concrete fill are not susceptible to liquefaction. The applicant did not consider the upper 4 m (13.1 ft) of the engineered granular backfill for a liquefaction potential, because the maximum historical groundwater level is approximately 4 m (13.1 ft) below the plant grade. The applicant conducted a liquefaction analysis based on a standard penetration test (SPT) that considered the engineered granular backfill. The applicant estimated N_{60} to be 30 blows per foot (bpf) at the ground surface that increased linearly to 60 bpf at a depth of 19.8 m (65 ft). The applicant used this distribution and a groundwater level at 0.61 m (2 ft) below the finished ground level grade to conclude that at all engineered granular backfill depths, N_{60} was greater than 30 bpf for the full depth of the deepest Seismic Category I structures. Therefore, the granular backfill adjacent to all Seismic Category I structures is not susceptible to liquefaction. The applicant stated that liquefaction analyses were not necessary for the existing fill, lacustrine deposits, and glacial till because they will be removed from under and adjacent to all Seismic Category I structures. The applicant stated that because the backfill below Seismic Category II structures from the base of the foundation to the top of bedrock is fill concrete, a liquefaction analysis for soil below Seismic Category II structures is not necessary. The applicant will use glacial till and/or engineered backfill as the foundation support under non-Seismic Category I and II structures that cannot strike a Seismic Category I structure in case of a seismic event. The applicant stated that glacial till is not susceptible to liquefaction because it is classified as lean clay with fine contents greater than 30 percent.

2.5.4.2.9 Earthquake Design Basis

FSAR Subsection 2.5.4.9 states that the top generic bedrock is 129 m (425 ft) below the existing ground surface where the V_s of the bedrock in Salina Group Unit B is greater than 2.8 km/s (9,200 fps). The applicant performed a site response analysis to develop the GMRS, and FSAR Subsection 2.5.2.6 describes the development of the GMRS.

2.5.4.2.10 Static Stability

FSAR Subsection 2.5.4.10 evaluates the static stability of safety-related structures. The applicant conducted analyses of the foundation-bearing capacity, settlement, excavation rebound, lateral earth pressures, and hydrostatic pressures.

Bearing Capacity

In FSAR Subsection 2.5.4.10.1, the applicant conducted a bearing capacity analysis for the Bass Islands Group and Salina Group Unit F. The two independent methods the applicant used to evaluate the bearing capacity are (1) ultimate bearing capacity using Terzaghi's approach in the UASCE EM 1110-2908 (USACE 1994); and (2) an allowable bearing pressure using the Uniform Building Code (Peck, Hanson, and Thornburn 1974). The applicant used Terzaghi's approach to compute the ultimate bearing capacity for the FWSC:

$$q_{ult} = cN_c + 0.5\gamma' B N_\gamma + \gamma' D N_q \qquad \text{(Equation 1)}$$

Where:

- q_{ult} = the ultimate bearing capacity
- γ' = effective unit weight
- B = width of the foundation
- D = depth of foundation below the ground surface
- C = cohesion intercept for the bedrock mass

N_c, N_γ, and N_q are the bearing capacity factors dependent on the internal angle of friction, which the applicant assumed to be 52 degrees for the Bass Islands Group and 28 degrees for the Salina Group. For the ultimate bearing capacity of the RB/FB and the CB, the applicant indicated that because the bedrock contained fractures, cohesion was not relied upon to provide a resistance to failure. Thus, the applicant used Terzaghi's equation excluding the first term (cN_c) in Equation 1 above. The applicant used the Uniform Building Code as a second method to calculate the allowable bearing pressure on rock as 20 percent of q_u. In FSAR Table 2.5.4-227, the applicant reported 13,450 kPa (281 ksf) as the ultimate bearing capacity for the RB/FB using Terzaghi's approach and the allowable bearing capacity of 12,400 kPa (259 ksf) using the Uniform Building Code method. The applicant concluded that the allowable bearing capacities calculated using both methods were greater than the maximum static bearing demand required in the ESBWR DCD. The applicant also concluded that the allowable dynamic bearing demand based on Terzaghi's approach is greater than the maximum dynamic bearing demand required in the ESBWR DCD and in the site-specific SSI dynamic bearing demand. Table 2.5.4-3 of this SER provides a comparison of the results for both methods to those listed in the ESBWR DCD.

Table 2.5.4-3 Results of Bearing Capacity Analysis
(Reproduced from Fermi COL FSAR Table 2.5.4-227)

Structure	Terzaghi Approach			Uniform Building Code	Required Maximum Static and Dynamic Bearing Demand from DCD	
	Bearing Capacity					
	Ultimate	Allowable Under Static Loading	Allowable Under Dynamic Loading	Allowable Loading Condition	Static Loading Condition	Dynamic Loading Condition
Reactor Building/Fuel Building	13,450 (281)	4,500 (94)	5,985 (125)	12,400 (259)	699 (14.6)	1,101 (23)
Control Building	42,090 (879)	14,030 (293)	18,720 (391)	17,910 (374)	292 (6.1)	421 (8.8)
Firewater Service Complex	4,596 (96)	1,530 (32)	2,060 (43)	2,060 (43)	165 (3.45)	1,201 (25.1)
*All units are kPa (ksf); Ksf = kip per square-foot; kPa = kilopascal						

Rebound due to the Excavation and Settlement Analysis

FSAR Subsection 2.5.4.10.2 states that because all Seismic Category I structures are founded on bedrock or lean concrete overlying bedrock, the applicant only considered a linear elastic deformation for the settlement analysis in which the parameter of interest is E (elastic modulus). For the settlement analysis, the applicant selected the lower bound E based on the Hoek-Brown criterion (Hoek 2007) for each bedrock unit.

Because the arrangement and loading conditions of the Seismic Category I structures were not symmetrical, the applicant conducted a finite element analysis using the PLAXIS 3D Version 2.1 foundation computer program in order to estimate the settlements of Seismic Category I structures. The first stage of the analysis was used to define the initial states of stress in the ground. The second stage simulated the rebound associated with the load removal when the excavation was performed to foundation elevations or to the top of bedrock. The remaining stages were simulated to estimate settlement after applying the loadings. The applicant stated that there is no long-term or post-construction settlement anticipated at the Fermi 3 site.

FSAR Subsection 2.5.4.2.1.2 explains the E of bedrock selected for rebound and the settlement analysis. Table 2.5.4-4 of this SER presents the settlement analysis results for excavation rebound and the total foundation settlements.

Lateral Earth Pressures

FSAR Subsection 2.5.4.10.3 describes the static and seismic lateral earth pressures applied to the site's below-ground walls. The applicant concluded that the lateral at-rest pressure applied to the RB/FB and the CB does not cause yielding in the buildings. Therefore, the applicant conducted an analysis that assumed the engineered granular backfill was resting on the RB/FB and CB walls from the finish grade to the bottom of the foundations. For this assumption, the applicant used a 35-degree angle of internal friction and a saturated and unsaturated unit weight of 21.2 and 20.4 kilonewtons per cubic-meter (kN/m³) (135 and 130 pcf), respectively.

Table 2.5.4-4 Settlement Results for Excavation Rebound and Total Foundation Settlements

(Reproduced from Fermi COL FSAR Tables 2.5.4-230 and 2.5.4-231)

Building	Northwest Corner	Southwest Corner	Southeast Corner	Northeast Corner	Average of Four Corners	Center or close to Center
Rebound due to Excavation at Foundation Corners and Center, cm (in.)						
Reactor Building/Fuel Building	0.78 (0.31)	0.63 (0.25)	0.78 (0.31)	0.81 (0.32)	-	1.09 (0.43)
Control Building	0.84 (0.33)	0.89 (0.35)	0.74 (0.29)	0.71 (0.28)	-	0.86 (0.34)
Firewater Service Complex	0.66 (0.26)	0.66 (0.26)	0.53 (0.21)	0.53 (0.21)	-	0.61 (0.24)
Total Settlements due to Backfilling and Applied Loads, cm (in.)						
Reactor Building/Fuel Building	1.19 (0.47)	1.06 (0.42)	1.32 (0.52)	1.29 (0.51)	1.22 (0.48)	1.91 (0.75)
Control Building	1.29 (0.51)	1.42 (0.56)	1.04 (0.41)	0.99 (0.39)	1.19 (0.47)	1.19 (0.47)
Firewater Service Complex	0.41 (0.16)	0.46 (0.18)	0.30 (0.12)	0.29 (0.11)	0.35 (0.14)	0.38 (0.15)
cm= centimeter; in. = inch						

Static Lateral Earth Pressures

The applicant used the following equation to calculate the at-rest static lateral earth pressure:

$$\sigma_h = K_0 \sigma'_0 + u \qquad \text{(Equation 2)}$$

Where:

K_0 = coefficient of at-rest earth pressure = 1-sin φ
φ = angle of internal friction
u = pore water pressure
σ'_0 = effective vertical subsurface stress

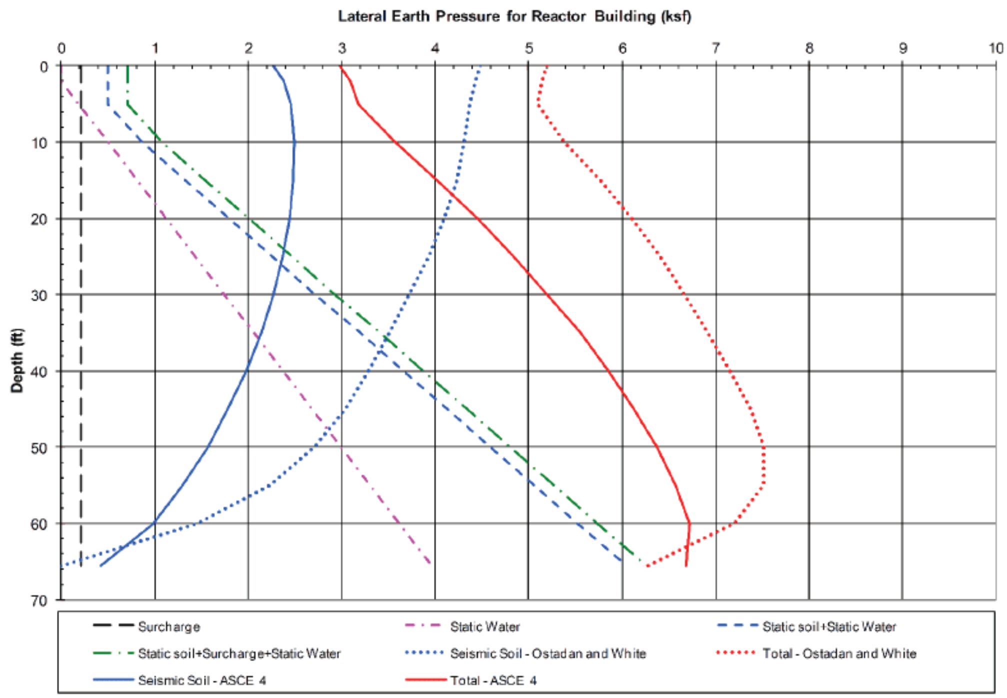
Dynamic Lateral Earth Pressures

The applicant used Ostadan and White (1988), and ASCE 4-98 methodologies to compute seismic lateral earth pressure on RB/FB and CB embedded walls. For the Ostadan and White method the applicant used a peak response horizontal ground acceleration of approximately 0.41g for both the RB/FB and CB. For the ASCE 4-98 method, the applicant used a peak ground acceleration of 0.24g at the finished ground level grade to compute seismic lateral earth pressure on RB/FB and CB embedded walls.

The applicant stated that for both methods, the engineered granular backfill is considered to extend the full depth of the RB/FB and CB; and that below the top of the Bass Islands Group bedrock the excavations will be backfilled with fill concrete. The applicant stated that once cured, the fill concrete will not apply lateral pressure to the RB/FB or CB.

<u>Results of Lateral Earth Pressures Analyses</u>

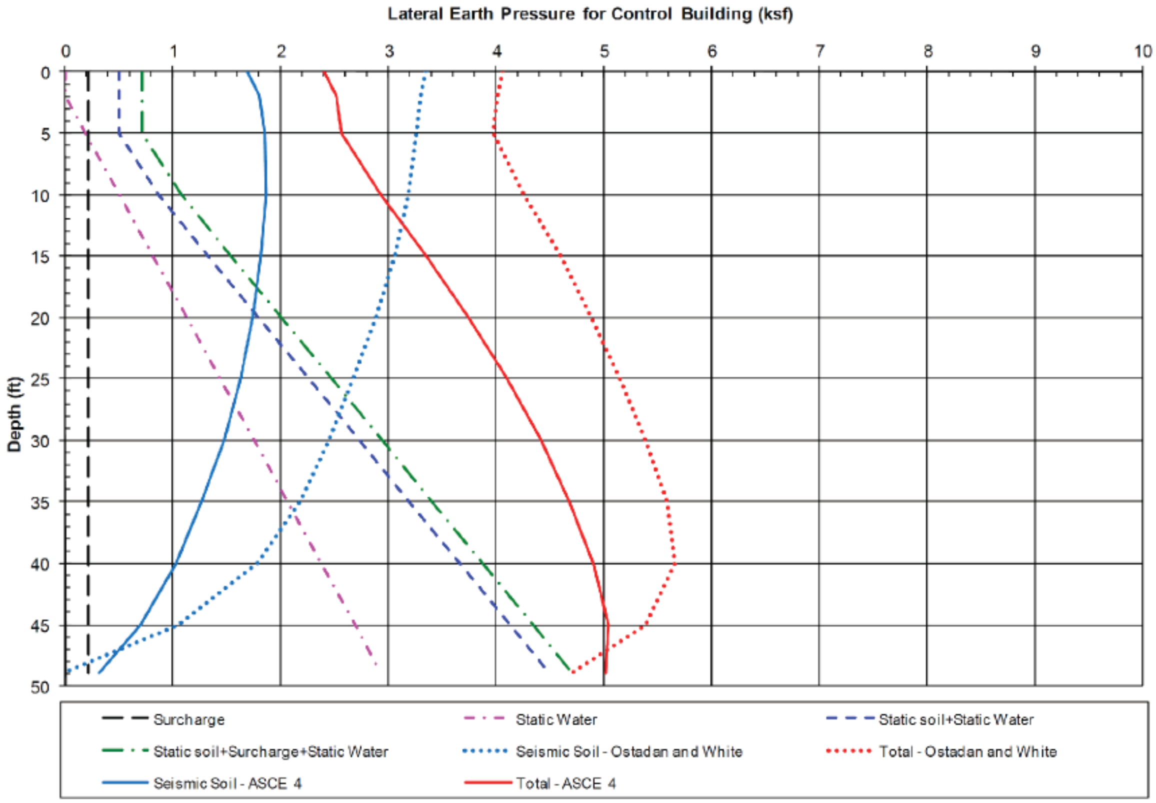
Figures 2.5.4-4 and 2.5.4-5 of this SER present the results of the static soil and seismic soil lateral earth pressures for the RB/FB and CB. The applicant stated that the results of the Ostadan and White method are generally greater than the ASCE 4-98 method, because a higher acceleration is used with the Ostadan and White method.



Notes:

1. Lateral load of 500 psf due to compaction is included in the static soil pressure.
2. Total = Static Soil + Static Water + Surcharge + Seismic Soil.

Figure 2.5.4-4 Lateral Earth Pressures on Reactor Building Walls
(Reproduced from Fermi 3 COL FSAR Figure 2.5.4-229)



Notes:

1. Lateral load of 500 psf due to compaction is included in the static soil pressure.
2. Total = Static Soil + Static Water + Surcharge + Seismic Soil.

SER Figure 2.5.4-5 Lateral Earth Pressures on Control Building Walls
(Reproduced from Fermi 3 COL FSAR Figure 2.5.4-230)

2.5.4.2.11 Design Criteria

FSAR Subsection 2.5.4.11 refers to ESBWR DCD Table 2.0-1 for a description of standard site parameters such as the allowable static and dynamic bearing capacities, liquefaction potential, angle of internal friction, maximum settlement values, and V_s. FSAR Subsection 2.5.4.10.1 addresses the criteria for minimum static and dynamic bearing capacities. The applicant concluded that the factor of safety (FS) for the static bearing capacity is at least 3, and it is at least 2.25 for the dynamic bearing capacity. FSAR Subsection 2.5.4.7.2 presents the minimum V_s of greater than 300 m/s (1,000 fps) for the supporting foundation material associated with seismic strains for lower bound soil properties at minus one sigma from the mean. The applicant indicated that the fill concrete surrounding the RB/FB and the CB embedded walls below the top of the bedrock and below the FSWC meets the DCD V_s requirements. The applicant stated that based on the SSI analysis, the DCD minimum V_s requirements are not required for the backfill above the top of the Bass Island Group bedrock surrounding Seismic Category I embedded walls. The applicant will place fill concrete as the supporting material below the FWSC, with deep shear keys extending into the fill concrete. The applicant's calculations neglected the engineered granular backfill surrounding the basemat and encountered no sliding issues for the FWSC. The applicant concluded that the DCD criteria for the engineered granular backfill surrounding the FWSC are not required.

FSAR Subsection 2.5.4.10 presents the design criteria for the static stability analyses. FSAR Subsection 2.5.4.8 discusses the liquefaction potential of soils. The applicant concluded that there are no liquefiable soils under and adjacent to all Seismic Category I structures. FSAR Subsection 2.5.4.10.2 discusses the design criteria for the foundation settlements. The applicant concluded that the calculated foundation settlements were less than the maximum specified in the ESBWR DCD.

2.5.4.2.12 Techniques to Improve Subsurface Conditions

Based on the stability analysis in FSAR Subsection 2.5.4.10, the applicant concluded that no subsurface improvement is needed. In FSAR Subsection 2.5.4.12, the applicant stated that the exposed foundation bedrock in the RB/FB and the CB will be examined by a qualified geologist to ensure that no excessive natural fracturing or blasting back-break exists and areas with open fractures will be filled with concrete backfill. The applicant will remove and replace all of the soils from below the foundation to the top of the bedrock with fill concrete for the FWSC and the Seismic Category II structures.

2.5.4.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the stability of subsurface materials and foundations, and the associated acceptance criteria, are in Section 2.5.4 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR Part 50, Appendix A, GDC 2, "Design bases for protection against natural phenomena," relates to a consideration of the most severe natural phenomena historically reported for the site and surrounding area with a sufficient margin for the limited accuracy, quantity, and period of time when the historical data were accumulated.

- 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," applies to the design of nuclear power plant structures, systems, and components important to safety to withstand the effects of earthquakes.

- 10 CFR 100.23 provides the nature of the investigations required to obtain the geologic and seismic data necessary to determine site suitability and to identify geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants.

The related acceptance criteria from Section 2.5.4 of NUREG–0800 are as follows:

- Geologic Features: To meet the requirements of 10 CFR Parts 50 and 100, the section defining geologic features is acceptable if the discussions, maps, and profiles of the site stratigraphy, lithology, structural geology, geologic history, and engineering geology are complete and are supported by site investigations sufficiently detailed to obtain an unambiguous representation of the geology.

- Properties of Subsurface Materials: To meet the requirements of 10 CFR Parts 50 and 100, the description of properties of underlying materials is considered acceptable if state-of-the-art methods are used to determine the static and dynamic engineering properties of all foundation soils and rocks in the site area.

- Foundation Interfaces: To meet the requirements of 10 CFR Parts 50 and 100, the discussion of the relationship of foundations and underlying materials is acceptable if it includes (1) a plot plan or plans showing the locations of all site explorations such as borings, trenches, seismic lines, piezometers, geologic profiles, and excavations with the locations of the safety-related facilities superimposed thereon; (2) profiles illustrating the detailed relationship of the foundations of all Seismic Category I and other safety-related facilities to the subsurface materials; (3) logs of core borings and test pits; and (4) logs and maps of exploratory trenches in the COL application.

- Geophysical Surveys: To meet the requirements of 10 CFR 100.23, the presentation of the dynamic characteristics of soil or rock is acceptable if geophysical investigations are performed at the site and are presented in detail.

- Excavation and Backfill: To meet the requirements of 10 CFR Part 50, the presentation of the data concerning excavation, backfill, and earthwork analyses is acceptable if (1) they identify the sources and quantities of backfill and borrow and show that they were adequately investigated by borings, pits, and laboratory property and strength testing (dynamic and static) and the data are included, interpreted, and summarized; (2) they clearly show the extent (horizontally and vertically) of all Category I excavations, fills, and slopes on plot plans and profiles; (3) they justify compaction specifications and embankment and foundation designs by field and laboratory tests and analyses to ensure stability and reliable performance; (4) they incorporate the impact of compaction methods into the structural design of the plant facilities; (5) they discuss the quality control methods and describe and reference the quality assurance program; and (6) they describe and reference the control of groundwater during excavation to preclude the degradation of foundation materials and properties.

- Groundwater Conditions: To meet the requirements of 10 CFR Parts 50 and 100, the analysis of groundwater conditions is acceptable if the information in this subsection or cross-referenced to the appropriate subsections in SRP Section 2.4 of the SAR includes (1) a discussion of critical cases of groundwater conditions relative to the foundation settlement and stability of the safety-related facilities of the nuclear power plant; (2) plans for dewatering during construction and the impact of the dewatering on temporary and permanent structures; (3) an analysis and interpretation of seepage and potential piping conditions during construction; (4) records of field and laboratory permeability tests as well as dewatering-induced settlements; and (5) a history of groundwater fluctuations determined by the periodic monitoring of 16 local wells and piezometers.

- Response of Soil and Rock to Dynamic Loading: To meet the requirements of 10 CFR Parts 50 and 100, descriptions of the soil and rock responses to dynamic loading are acceptable if (1) an investigation is conducted and discussed to determine the effects of prior earthquakes on soils and rocks in the vicinity of the site; (2) there are field seismic surveys (surface refraction and reflection and in-hole and cross-hole seismic explorations) and the data are presented and interpreted to develop bounding P and S wave-velocity profiles; (3) dynamic tests are performed in the laboratory on undisturbed samples of the foundation soils and rocks and they are sufficient to develop strain-dependent modulus reductions and hysteretic damping properties of the soils and the results are included.

- Liquefaction Potential: To meet the requirements of 10 CFR Parts 50 and 100, the foundation materials at the site adjacent to and under Category I structures and facilities are saturated soils; the water table is above the bedrock; and a required analysis of the liquefaction potential at the site is conducted.

- Static Stability: To meet the requirements of 10 CFR Parts 50 and 100, the discussions of static analyses are acceptable if the stability of all safety-related facilities were analyzed from a static stability standpoint that included bearing capacity; rebound; settlement; differential settlements under dead loads of fills and plant facilities; and lateral loading conditions.

- Design Criteria: To meet the requirements of 10 CFR Part 50, the discussion of the criteria and the design methods is acceptable if the discussion describes the criteria used for the design; the design methods; and the factors of safety obtained in the design analyses and presents a list of references.

- Techniques to Improve Subsurface Conditions: To meet the requirements of 10 CFR Part 50, the discussion of techniques to improve subsurface conditions is acceptable if it describes plans; summaries of specifications; and methods of quality control for all techniques used to improve foundation conditions (such as grouting, vibroflotation, dental work, rock bolting, or anchors).

In addition, geologic characteristics should be consistent with the appropriate sections in RG 1.27 Revision 2, “Ultimate Heat Sink for Nuclear Power Plants”; RG 1.28, Revision 3, “Quality Assurance Program Requirements (Design and Construction)”; RG 1.132; RG 1.138; RG 1.198; and RG 1.206.

2.5.4.4 *Technical Evaluation*

NRC staff reviewed Section 2.5.4 of the Fermi 3 COL FSAR related to the stability of subsurface materials and foundations. The staff reviewed Fermi 3 COL FSAR Section 2.5.4 to determine whether the applicant has complied with the applicable regulations and has conducted its investigations at an appropriate level of detail, in accordance with RG 1.132 as described below:

COL Item

- EF3 COL 2.0-29-A Stability of Subsurface Materials and Foundations

NRC staff reviewed COL Item EF3 COL 2.0-29-A included in Fermi 3 FSAR Section 2.5.4. This COL item addresses site-specific information that includes (1) localized liquefaction potential under other than Seismic Category I structures, and (2) settlement and differential settlements at the site. The NRC staff’s evaluation of COL Item EF3 COL 2.0-29-A is presented below.

2.5.4.4.1 Geologic Features

FSAR Subsection 2.5.4.1 refers to FSAR Section 2.5.1 for a complete description of the regional and site geology. Subsection 2.5.1.4 of this SER presents the staff’s evaluation of the regional and site geology.

2.5.4.4.2 Properties of Subsurface Material

FSAR Subsection 2.5.4.2 describes the static and dynamic engineering properties of the soil and rock strata underlying the Fermi 3 site, as well as the methods the applicant used to determine the site engineering properties including field investigations and laboratory testing. The staff conducted a geology/seismology/geotechnical site audit from November 3, 2009, to November 5, 2009 (ADAMS Accession No. ML14112A212). During the audit, the geotechnical staff looked at core samples that included the units of the Bass Islands Group, Salina Group Unit F, and Salinas Group Unit E, as well as oolitic dolomite samples to confirm the FSAR's descriptions. The staff specifically checked full core samples from RB-C8 and some core samples from TB-C5, RB-C4, and CB-C2. The staff also discussed specific details on shear wave velocity determinations, settlement calculations, slope stability analyses, lean concrete backfill, and the process for excavation to reach the Bass Islands foundation layer. The staff reviewed sample calculations of complete settlement and earth pressure against embedded walls (static and dynamic) and the engineering properties used to perform settlement analysis and dynamic and static earth pressure analysis. The staff also reviewed shear wave velocity data from downhole and SASW investigations.

During these reviews, the staff issued several RAIs addressing specific technical issues related to the Fermi 3 site investigations. The staff's evaluations of the applicant's responses to these RAIs are discussed below. The staff also prepared a number of editorial RAIs and clarification RAIs that the staff does not discuss in the technical evaluation. Because of the applicant's FSAR revisions several RAIs are no longer applicable and are not discussed in further detail in this technical evaluation.

Engineering Properties of Subsurface Materials

FSAR Subsection 2.5.4.2.1 discusses the engineering properties of soils and rocks at the Fermi 3 site based on 68 borings that the applicant performed. FSAR Figures 2.5.1-235 and 2.5.1-236 show the locations of the borings drilled for the COL application. The boring logs are in FSAR Appendix 2.5DD. The applicant stated that fill, lacustrine deposits, and glacial till comprise the site overburden deposits, all of which the applicant will fully excavate beneath and adjacent to all Seismic Category I structures. If needed, the applicant can process the fill material to produce gradation suitable for use as engineered granular backfill surrounding Seismic Category I structures.

Engineering Properties of Soils

The staff reviewed FSAR Subsection 2.5.4.2.1.1 related to the engineering properties of soils at the Fermi 3 site. The staff issued RAIs 02.05.04-1, 02.05.04-14a, 02.05.04-17, and 02.05.04-28b related to the general gradation constraints needed for processing the fill that the applicant may reuse for engineered granular backfill. These RAIs also address the expected static and dynamic properties of the as-specified compacted borrow material including compaction ratio, density, shear strength, and V_s. The staff asked the applicant to justify whether the static and dynamic properties of the processed fill would affect the results of the safety analysis in FSAR Section 2.5.4.

In the responses to RAIs 02.05.04-1, 02.05.04-14a, and 02.05.04-17 dated January 11, 2010 (ADAMS Accession No. ML100130382); and RAI 02.05.04-28b dated February 15, 2010 (ML100540502); the applicant stated that it will follow the DCD requirements to perform tests to verify the gravel backfill and will establish gradation constraints for the backfill. The applicant indicated that the rebound, settlement, and bearing capacity results in FSAR Subsection 2.5.4.10 are not affected by the engineered granular backfill material properties because the Fermi 3 Seismic Category I structures will be directly founded on the Bass Islands Group or on the fill concrete overlying the Bass Islands Group. The applicant stated that the change in the angle of internal friction for the engineered granular backfill affects the at-rest static lateral earth pressure. Also, the applicant mentioned that the change in the V_s affects the soil column frequency and the resulting horizontal ground acceleration. The applicant stated in revised FSAR Subsection 2.5.4.10.3.2 that the peak response horizontal ground acceleration based on the FIRS for the RB/FB and the CB is approximately 0.58 g based on revised FSAR Figure 3.7.1-228 and Figure 3.7.1-229. The applicant further stated that acceleration of 0.41g was used with the Ostadan and White method for the seismic lateral earth pressure calculation by considering a correction factor of 0.7. The applicant also used the ASCE 4 method with the peak ground acceleration of 0.2368 g at the finished ground level grade, from FSAR Table 3.7.1-205, to compute seismic lateral earth pressure on RB/FB and CB embedded walls.

The staff reviewed the responses to RAIs 02.05.04-1, 02.05.04-14a, 02.05.04-17, 02.05.04-28b, and the revised FSAR Subsections 2.5.4.10.3.2 and 3.7.1.1.4.4. The staff noted that the applicant plans to crush the excavated fill and bedrock to a well-graded, angular/sub-angular gravel backfill that will meet the requirements specified in ESBWR DCD Table 2.0-1. The staff also noted that within confined areas or close to the foundation walls, the applicant plans to use smaller compactors to prevent excessive lateral pressures against the walls due to the stress caused by heavy compactors.

As for using the Ostadan and White (1988) method to compute seismic lateral earth pressure, the staff acknowledged that the acceleration response spectrum at the basemat level in the free-field at 30 percent damping needs to be developed for applying this method. The staff reviewed the site-specific horizontal FIRS of RB/FB and CB shown on FSAR Figure 3.7.1-228 and Figure 3.7.1-229, and noted that the acceleration response spectra are associated with 5 percent damping. The staff also noted, from the spectra, that the peak spectral accelerations of approximately 0.58 g of for RB/FB and CB are between frequencies of 20 Hz to 30 Hz. The staff further noted that SRP Section 3.7.2 limits the composite modal damping to a maximum of 20 percent. The staff reviewed the applicant's cited reference ("Damping Correction Factors for Horizontal Ground-Motion Response Spectra," by Cameron, W.I. and Green, R.G, [2007]). Based on this review, the staff agrees that damping correction factors (DCFs), as a function of general site classification, earthquake magnitude, and tectonic setting, can be reasonably applied to adjust response spectral values corresponding to damping 5 percent of critical to other damping levels. The staff confirmed that a DCF of 0.7, as suggested by the applicant, is in accordance with the recommendation from cited reference for a ratio of 20 to 5 percent damping. Because of the SRP Section 3.7.2 limitation in which the damping is to a maximum of 20 percent, the staff concluded that a DCF of 0.7 developed from a 20 percent damping will lead to a conservative computation on seismic lateral earth pressure against a DCF developed by a 30 percent damping. Therefore, the staff agrees that it is appropriate to use a peak response horizontal ground acceleration of approximately 0.41g for the Ostadan and White method to compute seismic lateral earth pressure on RB/FB and CB embedded walls.

As a result of the RAIs, the applicant revised the seismic lateral earth pressure calculation by selecting the peak horizontal ground acceleration of 0.58 g based on the site-specific FIRS, and a DCF of 0.7, to adjust the acceleration corresponding to 5 percent damping to 20 percent level in order to simulate the maximum seismic pressures that can develop at the Fermi 3 site. The staff confirmed that this adjustment leads to reasonable and conservative estimates of seismic lateral soil pressures, and Fermi 3 FSAR reflects the adjustment. In addition, the staff verified the applicant's seismic lateral earth pressure calculations. The staff concluded that the applicant's method and procedures used for the calculations are appropriate, because they are based on the current knowledge of computing dynamic lateral soil pressures. Finally, the staff compared the static and seismic lateral soil pressures that the applicant computed to the results in Appendix 3G to Chapter 3 of the ESBWR DCD, Tier 2. The staff concurred that both the static and seismic evaluations of soil pressures are less than the lateral earth pressures required in the ESBWR DCD. The applicant demonstrated that it can achieve the DCD requirements related to backfill and static and seismic lateral pressures by using the appropriate engineered granular backfill. RAIs 02.05.04-1, 02.05.04-14a, 02.05.04-17, and 02.05.04-28b are therefore, resolved and closed.

Engineering Properties of Bedrock

FSAR Subsection 2.5.4.2.1.2 describes the two primary bedrock units beneath the Fermi 3 site: the Bass Islands Group and Salina Group Units F, E, C, and B. The applicant characterized the parameter values in terms of upper and lower bound values or minimum, maximum, standard deviation, mean, and median values. These parameters are specified in terms of a single number associated with the entire bedrock unit or for each borehole. In RAI 02.05.04-3a, the staff asked the applicant to explain why it is appropriate to provide a single value of each parameter for the entire bedrock group instead of providing an inferred spatial variation of these parameter values.

In the response to RAI 02.05.04-3a dated December 23, 2009 (ADAMS Accession No. ML100040548), the applicant stated that FSAR Figures 2.5.4-220 through 2.5.4-223 show that the V_s and V_p are relatively uniform within each bedrock unit. The staff reviewed the response to RAI 02.05.04-3a and FSAR Figures 2.5.4-220 through 2.5.4-223. The staff compared the measured V_s and V_p from P-S suspension logging and downhole seismic tests at different locations across the site. The staff noted that the relatively consistent V_s and V_p indicate the uniformity of each bedrock unit across the site. Based on this consistency, the staff concurred with the applicant's conclusion that it is appropriate to use a single value of each parameter for the entire bedrock group. Therefore, RAI 02.05.04-3a is resolved and closed.

The applicant estimated the strength and deformation characteristics of the bedrock units using the Hoek-Brown criterion (Hoek 2007). The applicant converted the Hoek-Brown criterion into the equivalent Mohr-Coulomb values. In RAI 02.05.04-3b, the staff asked the applicant to justify the use of the Hoek-Brown criterion and to describe each bedrock unit as applied to specify the Hoek-Brown parameters. The staff also asked the applicant to specify the relationship between the residual friction angle values associated with discontinuities in the Bass Islands Group and the parameters in the Hoek-Brown criterion for that material. In addition, the staff asked the applicant to explain how the effects of oolitic dolomite are reflected in the Hoek-Brown criterion for the Bass Islands Group. In RAI 02.05.04-3c, the staff asked the applicant to provide the effective confining pressure ranges and the rationale for the selected effective confining pressure range used to convert the Hoek-Brown criterion to the Mohr-Coulomb values.

In the response to RAI 02.05.04-3b dated December 23, 2009 (ADAMS Accession No. ML100040548), the applicant indicated that the Hoek-Brown criterion is based on an assessment of interlocking rock blocks and on the conditions of the surfaces between these blocks. The applicant mentioned that the shear strength along the discontinuities is not one of the input parameters used in the Hoek-Brown criterion methodology. The applicant presented the compressive strength and the elastic modulus of the oolitic dolomite and stated that these parameters are comparable with the average strength and elastic modulus of the remainder of the Bass Islands Group. The response to RAI 02.05.04-3c (ADAMS Accession No. ML100040548) included a table with the effective confining pressure ranges used to convert the Hoek-Brown criterion to the Mohr-Coulomb parameters. The applicant discussed the rationale for determining the upper limit of the confining stress (σ'_{3max}) for slopes with the selected range of effective confining pressures that adhered to the guidelines of the Hoek-Brown criterion.

The staff noted that the applicant's response to RAI 02.05.04-3 applies an equation of σ'_{3max}, and an equation developed for slopes to the evaluation of foundation behavior beneath key structures. In RAI 02.05.04-30, the staff asked the applicant to explain why the use of the σ'_{3max} equation provides an adequate representation of the Hoek-Brown criterion for evaluating the foundation behavior beneath key structures. The applicant's response to RAI 02.05.04-30 dated August 6, 2010 (ADAMS Accession No. ML102210351), is based on Hoek's (2007) two options for establishing $\sigma'_{3\mathrm{max}}$ that are a slope condition or a tunnel condition. The applicant stated that foundation of the Category I structures will be on exposed bedrock at the bottom of the excavation, thus providing a similar stress regime in the bedrock to that of the slopes exposed at the ground surface rather than a tunnel bored through the bedrock.

The staff reviewed the responses to RAIs 02.05.04-3b, 02.05.04-3c, and 02.05.04-30 and the related sections of Hoek (2007). The staff verified that the applicant has provided the appropriate information related to the Hoek-Brown criterion input parameters that were used to estimate rock mass strength for each bedrock unit. The staff verified that the applicant has based the input parameters for q_u and E on laboratory tests in accordance with ASTM D7012-07, "Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperature." The applicant obtained the input parameters of material index (m_i) and the geological strength index (GSI) based on bedrock descriptions and classifications from exploratory borings. The applicant conservatively selected the input parameter of the disturbance factor (D) based on the degree of disturbance from blast damage and stress relaxation. The staff determined that the applicant has appropriately selected these input parameters based on the laboratory tests and appropriate interpretations of the Hoek-Brown criterion.

As for the effects of oolitic dolomite reflected in the Hoek-Brown criterion for the Bass Islands Group, the staff noted that the compressive strength from the oolitic dolomite samples varies from 71 to 99 MPa (1,490 to 2,070 ksf), with an average of 82 MPa (1,707 ksf), and that the elastic modulus varies from 38,600 to 51,000 MPa (806,400 to 1,065,600 ksf) with an average of 46,660 MPa (974,400 ksf). Because the test results from the oolitic dolomite samples are analogous to the overall average compressive strength of 79 MPa (1,650 ksf) and to the overall elastic modulus of 40,330 MPa (842,400 ksf) for the Bass Islands Group, the staff found that the compressive strength and elastic modulus for the oolitic dolomite are integrated into the overall strength and modulus for the Bass Islands Group. The staff also noted that the physical descriptions of the oolitic dolomite are similar to the descriptions of the dolomite within the Bass Islands Group, as shown in the Fermi 3 boring logs. Based on the above discussion, the staff concluded that the effects of the oolitic dolomite were appropriately considered in the Hoek-Brown criterion for the Bass Islands Group.

Furthermore, the staff noted that because the geotechnical bearing capacity is calculated in terms of the Mohr-Coulomb failure criterion, it is necessary to determine equivalent angles of friction and cohesive strengths for each rock mass and stress range by fitting an average linear relationship to the curve generated by the Hoek-Brown criterion. The staff concluded that it is appropriate to follow the guidelines specified in Hoek (2007) to estimate the tensile strength of the rock mass σ_t and the upper limit of the confining stress σ'_{3max}. In addition, the staff agreed with the applicant's determination that using σ'_{3max} based on the equation developed for slopes is appropriate, because the Category I structures are founded on exposed bedrock at the bottom of the excavation. Therefore, the stress in the bedrock is similar to that of slopes exposed at the ground surface rather than a tunnel bored through the bedrock. Based on the evaluation of the applicant's responses RAIs 02.05.04-3b, 02.05.04-3c, and 02.05.04-30 are therefore, resolved and closed.

In FSAR Subsection 2.5.4.2.1.2.1, the applicant conducted 12 rock direct shear tests along sample discontinuities in the Bass Islands Group to obtain the residual friction angle along the discontinuities. The applicant's test resulted in a friction angle that ranges from 33 to 74 degrees, with a mean of 52 degrees. In RAI 02.05.04-2, the staff asked the applicant to provide information on the prevalence of these discontinuities, and whether they involve any preferential directions. In addition, the staff asked the applicant to explain the extent to which these discontinuities, which are provided by the twelve rock direct shear tests, are representative of discontinuities observed within the Bass Islands Group.

In the response to RAI 02.05.04-2 dated December 23, 2009 (ADAMS Accession No. ML100040548), the applicant provided figures that show the 12 pairs of photos of the core/discontinuity before laboratory testing along with the OTV log corresponding to the sample log. The applicant indicated that the observed orientations of discontinuities in the Bass Islands Group vary from horizontal to vertical, with near horizontal and near vertical joints dominating. However, the applicant further stated that the orientation of the discontinuities tested was nearly horizontal, except for the orientation of samples CB-C4 at 17.3 m (57.0 ft) and RB-C3 at 14.3 m (46.9 ft), which were at inclined angles. Finally, the applicant concluded that the results for the discontinuities tested were representative of the discontinuities observed within the Bass Islands Group. In RAI 02.05.04-29, the staff asked the applicant to justify why the test results from mostly horizontal discontinuities (one dominant orientation) can be representative of vertical discontinuities (another dominant orientation) and to provide the basis for this conclusion. In the response to RAI 02.05.04-29 dated August 6, 2010 (ADAMS Accession No. ML102210351), the applicant explained that because of the higher potential for weaker material and the lower roughness of the horizontal fractures, the strength along the horizontal fractures will be lower. In addition, the applicant stated that the friction angle measured on core samples is in agreement with the friction angle estimated for the bedrock mass using the Hoek-Brown criterion. The applicant concluded that this agreement with the friction angle indicates that, for the bedrock mass, the testing was representative of fractures at all orientations.

The staff reviewed the responses to RAIs 02.05.04-2 and 02.05.04-29, as well as related figures and references. The staff noted that the Bass Islands Group dolomite is an undeformed sedimentary bedrock at the site. Therefore, horizontal to near horizontal fractures formed along depositional features in sedimentary bedrock are more likely than vertical fractures are to be present. Based on the fact that most direct shear tested samples had horizontal or near horizontal fractures, the staff concluded that the results of the applicant's tests represent strength values for the horizontal fractures. The staff also noted that horizontal fractures along depositional features tend to have a more consistent orientation and less roughness, while vertical fractures break across depositional features that which most likely result in a rougher fracture surface. The staff further concluded that the rougher surfaces or irregularities produce interlocks between discontinuity surfaces, which can contribute significantly to their shear strength (Patton 1966, Barton 1973). Therefore, the staff concluded that it is reasonable to deem that the test results from samples with horizontal or near horizontal fractures are representative of the lower bound strength for the vertical fractures, because the waviness and roughness on a natural joint surface increase the shear strength. The staff further concluded that the shear strength from mostly horizontal discontinuities can be conservatively representative of vertical discontinuities. Therefore, RAI 02.05.04-2 and RAI 02.05.04-29 are resolved and closed.

In FSAR Subsections 2.5.4.2.1.2.1 and 2.5.4.2.1.2.2, the applicant indicated that the RQD of the Bass Island Group and Salina Group Unit F are low with average RQD values of 54 percent and 13 percent, respectively, indicating that in situ rock masses in these layers are highly fractured. Furthermore, in these FSAR subsections, the applicant calculated Poisson's ratios based on the mean V_p and V_s varying from 0.33 to 0.34 for the Bass Islands Group and from 0.39 to 0.40 for Salina Group Unit F. Consequently, in RAI 02.05.04-41, the staff asked the applicant to justify whether these ranges of Poisson's ratio are appropriate for such highly fractured rocks.

In the response to RAI 02.05.04-41 dated March 29, 2012 (ML12093A004), the applicant discussed the approach of the Poisson's ratio calculation for the in situ shear and compression wave velocities. The applicant compared the calculated Poisson's ratios with similar materials from literature sources, demonstrating the calculated Poisson's ratios are in the range of values provided in literature sources for both the Bass Islands Group bedrock and the Salina Group Unit F bedrock. The applicant also performed a literature search to evaluate whether the fracturing of bedrock typically results in an increase or decrease in Poisson's ratio, indicating the lack of a direct relationship between the extent of bedrock fracturing and Poisson's ratio. The applicant concluded that the Poisson's ratios calculated on the basis of measured shear and compression wave velocities are considered the most appropriate for the Fermi 3 site.

The staff reviewed the responses to RAI 02.05.04-41 and the applicant's cited references. The applicant referred to Jaeger, J.C. and Cook, N. G. W., "Fundamentals of Rock Mechanics" (1979) to indicate that bedrock fracturing can either increase or decrease Poisson's ratio based on orientation and aperture of the fracturing. Because the in situ measurements of shear and compression wave velocities represent the more general condition of rock mass, the staff concluded that the Poisson's ratios calculated using the in situ measured shear and compression wave velocities are considered appropriate for the Bass Islands Group and Salina Group Unit F bedrock. Therefore, RAI 02.05.04-41 is resolved and closed.

NRC Staff's Conclusions Regarding the Engineering Properties of Subsurface Materials

Based on the staff's review of the information in FSAR Subsection 2.5.4.2.1 and the applicant's responses to RAIs associated with the engineering properties of subsurface materials discussed above, the staff concludes that the applicant has adequately characterized the static and dynamic engineering properties of the rock layers underlying the Fermi 3 site by appropriately following the guidance in RG 1.132, Revision 2, for satisfying the applicable requirements in 10 CFR Parts 50 and 100. These layers include the Bass Islands Group and Salina Group Units F, E, C and B, which are the foundation-bearing layers for the nuclear island.

Field Investigations

The applicant employed a hydrogeological phase investigation and a geotechnical phase investigation to complete the field analyses. The hydrogeological investigation consisted of piezometers and monitoring wells installation, packer and slug testing, downhole geophysics, and sampling and groundwater testing. The applicant performed OTV logging to gather information on the bedrock where the rock core was not recovered. The applicant used the results from the downhole logging to correlate the bedrock geology across the site.

Hydrogeological Investigation Program

The staff reviewed FSAR Subsection 2.5.4.2.2.1 related to the hydrogeological investigation program at the Fermi 3 site. In RAI 02.05.04-4, the staff asked the applicant to clarify whether the results of the downhole logging provided additional information as to where the applicant did not obtain good core recovery.

In the response to RAI 02.05.04-4 dated January 11, 2010 (ADAMS Accession No. ML100130382), the applicant summarized how the results from the downhole logging were used to provide additional information in regions where there was not good core recovery. The applicant observed a poor recovery in some intervals of the Bass Islands Group, throughout most of the Salina Group Unit F, and in some intervals of the Salina Group Unit E. FSAR Figures 2.5.4-209 through 2.5.4-212 indicates that the poor RQD in the Bass Islands Group was from the fractured nature of the bedrock unit. The applicant also referenced these figures to point out a good correlation between the geologic feature and the variability of the measured compression and shear wave velocities. The applicant used the results of the OTV, the natural gamma, and the caliper logging to provide information regarding core loss; voids; cavities and tool drops that occurred in the Bass Islands Group and Salina Group Units F and E. The applicant also used the downhole logging to identify sediments in Salina Group Units E and F. The applicant confirmed the existence of joints and fractured zones using results from the OTV logging. Finally, the applicant indicated a correlation between the variability of the V_p and V_s with the natural gamma value in the selected borings within the Salina Group Unit F.

The staff reviewed the response to RAI 02.05.04-4. The staff also reviewed the OTV images shown on FSAR Figures 2.5.4-209 through 2.5.4-212, and the results from the OTV, natural gamma and caliper logging described in FSAR Section 2.5.1.2.3.1. The staffed agreed that the poor RQD was from the fractured nature; core loss was due to either soft weathered rock that washed away during drilling, or when harder layers became stuck in the core barrel and ground the softer or fractured rock; and cavities or voids were limited to a depth of 23.8 m (78 ft) below ground surface. The cavities or voids encountered were narrow, generally 3 cm (0.1 ft) along fractures. Based on the applicant's additional information related to the downhole logging, the staff concludes that the results from the OTV, the natural gamma, and the 3-arm caliper provide an acceptable alternative for understanding the bedrock geology where the applicant had not obtained good core recovery. Therefore, RAI 02.05.04-4 is resolved and closed.

FSAR Subsection 2.5.4.2.2.1.7 presents a list of the chemical tests for groundwater and surface water performed to establish baseline conditions at the site, but the subsection does not include the test results or discussions. Because the foundation and/or sub-foundation concrete may be exposed to the groundwater, the staff asked the applicant in RAI 02.05.04-5 to address whether or not the chemicals in groundwater are aggressive and to provide a discussion of these results.

In the response to RAI 02.05.04-5 dated December 23, 2009 (ADAMS Accession No. ML100040548), the applicant provided chemical test results for groundwater sulfate and chloride concentrations and indicated, based on ACI 349, that all sample results for sulfate concentrations from the monitoring wells fell into the categories of "moderate" and "severe" sulfate exposure for concrete. Therefore, in RAI 02.05.04-31, the staff asked the applicant to evaluate the potential aging effects on concrete fill resulting from groundwater conditions, to capture this evaluation in the FSAR, and to provide groundwater pH values because concrete is highly alkaline and strong acid degrades it. In addition, the staff requested the applicant to update the FSAR to ensure that the ACI 349 requirements will be followed—including cement type; the water-cement ratio; and the minimum compressive strength for concretes exposed to sulfate-containing solutions. In the response to RAI 02.05.04-31 dated August 6, 2010 (ADAMS Accession No. ML102210351), the applicant indicated that the pH of the groundwater was monitored during purging until the pH values stabilized, and the applicant had presented the last pH values measured during purging from the monitoring wells. The applicant concluded that the concrete will not be negatively impacted, because the overburden groundwater and the Bass Islands aquifer groundwater had a measured pH greater than 7.0, thus not acidic.

Regarding the potential aging effects, the applicant indicated that the only constituent of concern for concrete is the sulfate, and the concrete will not experience adverse aging effects from the high sulfates in the groundwater with the use of the correct cement—a well-designed concrete mix—and good construction control. The applicant stated that ACI 349 requirements for concrete exposed to solutions containing sulfate will be implemented during the detailed design phase.

The staff reviewed the responses to RAI 02.05.04-5 and RAI 02.05.04-31. The staff noted that based on the definition in ACI 349, all of the sampled results for sulfate concentrations from the monitoring wells fell into the categories of “moderate” and “severe” sulfate exposure for concrete. The staff also noted that the applicant will implement the ACI 349 requirements for concrete exposed to solutions containing sulfate by using a low water-to-cement ratio, an adequate cement content, a plasticizer or super plasticizer, a silica fume (fly ash), and an air entrainment. The staff found the applicant’s response acceptable and verified that the applicant had revised the FSAR to reflect that the fill concrete will meet the ACI 349 requirements for concrete exposed to solutions containing sulfate. Therefore, RAIs 02.05.04-5 and 02.05.04-31 are resolved and closed.

In RAI 02.05.04-40, the staff asked the applicant to provide the inspections, tests, and analyses and acceptance criteria (ITAAC) to be used to ensure that the fill concrete placed underneath any Category I structure to a thickness greater than 1.5 m (5 ft) meets the design, construction, and testing of the applicable ACI standards.

In the response to RAI 02.05.04-40 dated February 16, 2012 (ADAMS Accession No. ML12052A031), the applicant added the associated ITAAC to indicate that the mean 28-day compressive strength of the fill concrete will be equal to or greater than 31 MPa (4,500psi).

The staff reviewed the response to RAI 02.05.04-40, as well as FSAR Subsection 2.5.4.5.4.2. The staff noted that FSAR Subsection 2.5.4.5.4.2 includes compressive strength, shear wave velocity, and associated design and testing requirements for the fill concrete under any Seismic Category I structure to a thickness greater than 1.5 m (5 ft). In addition, the applicant committed to use the concrete fill with a 31 MPa (4.500 psi) compressive strength. The staff performed a confirmatory calculation based on the equations recommended by the ACI code. The staff found that the shear wave velocity for the fill concrete greatly exceeds the 300 m/s (1,000 ft/s) minimum shear wave velocity required in ESBWR DCD Revision 9 Table 2.0-1 for supporting foundation materials. The staff confirmed that the applicant had revised the Part 10 “ITAAC” of the application to include Section 2.4.1, “ITAAC for Fill Concrete under Seismic Category I Structures.” The staff concludes that the strength degradation of the fill concrete will be well managed because the applicant will follow the ACI 349 requirements to address the staff’s concern regarding concrete exposed to sulfate-containing solutions; and the applicant will follow the ACI 207.2R–07 requirements to address the staff’s concern regarding thermal cracking control of the fill concrete. Based on the evaluations of the shear wave velocity and the durability of fill concrete, the staff concludes that the proposed ITAAC for the fill concrete under Seismic Category I structures is acceptable. RAI 02.05.04-40 is therefore resolved and closed.

Geotechnical Investigation Program

The staff reviewed FSAR Subsection 2.5.4.2.2.2 related to the geotechnical investigation program at the Fermi 3 site. Regarding site exploration plans for safety-related foundations, Appendix D of RG 1.132 suggests that borings should be performed beneath every safety-related structure—at least one boring per 900 m^2 (10,000 ft^2) (approximately 30 m (100 ft) spacing) for larger and/or heavier structures—in addition to a number of borings along the periphery at the corners and at other selected locations. In FSAR Figure 2.5.1-236, the staff noted that for the Seismic Category I CB and FSWC, the applicant had not followed the recommendation to drill borings along the periphery at the corners. Therefore, in RAI 02.05.04-7 the staff asked the applicant to justify the limited number of borings and whether that number is sufficient to adequately characterize the CB and FWSC foundations.

In the response to RAI 02.05.04-7 dated January 11, 2010 (ADAMS Accession No. ML100130382), the applicant indicated that the subsurface investigations for both the CB and the FWSC were considered sufficient and in conformance with the guidance of RG 1.132. The applicant indicated that the stratigraphy in the immediate area of Fermi 3 is uniform, the test results are consistent with the subsurface material properties, and the density of borings in the area of the CB and the FWSC is adequate. The applicant stated that two borings are sufficient to characterize the subsurface conditions below the CB because the total area of the CB is approximately 717 m^2 (7,722 ft^2), which is less than the 900 m^2 (10,000 ft^2) specified in RG 1.1.32. The applicant concluded that one boring is sufficient to adequately characterize the foundation of the FWSC based on the uniformity of the stratigraphy and the subsurface properties.

The staff reviewed the response to RAI 02.05.04-7 with respect to the recommendations in Appendix D of RG 1.132. The staff noted that although the FWSC is classified as a Seismic Category I structure, it is listed as a nonsafety-related structure in Table 3.2-1 of the ESBWR DCD. And though there are no corner borings within the footprints of the safety-related CB and the nonsafety-related FSWC, there are two borings beneath the CB and one boring beneath the FSWC. They are therefore within the threshold of one boring beneath every safety-related structure and one boring per 900 m^2 (10,000 ft^2) as suggested in RG 1.132. In addition, the staff noted the lateral continuity of the subsurface bedding at the site from the boring data and the consistency of the subsurface material properties from the laboratory and in situ test results. Based on the above information, the staff concluded that the existing boring grid is adequate to define the site subsurface conditions, including the subsurface beneath the CB and the FSWC. Therefore, RAI 02.05.04-7 is resolved and closed.

FSAR Subsection 2.5.4.2.2.2.5.2 discusses the results from pressuremeter testing. The applicant performed three unload/reload cycles. The applicant found it reasonable to select the unload-reload modulus E_{ur} value from the last cycle as an estimate of the in situ modulus, because the condition of the bedrock at the highest pressure level was probably closer to the in situ undisturbed bedrock than at the lower pressure levels and in the previous unload/reload cycles. Also, the applicant indicated that the material being tested was a very complex geological unit consisting of interbedded limestone/dolomite/claystone/siltstone/shale and breccias with varying degrees of induration. The staff was concerned that an applicable strain range and applied unload/reload cycle could affect the values of $E_{ur,}$ and the possible effects of the macro-features may not be present within the influence zone of the pressuremeter test. Therefore, in RAI 02.05.04-8, the staff asked the applicant to provide additional information regarding the appropriate selection of E_{ur} to represent the modulus of in situ undisturbed bedrock. In addition, the staff asked the applicant to describe the use of the results and to identify the calculations that used these pressuremeter test values.

In the response to RAI 02.05.04-8 dated December 23, 2009 (ADAMS Accession No. ML100040548), the applicant compared the typical pressure-displacement behavior in Salina Group Unit F with the ideal pressure-displacement curve for a pressuremeter test. In addition, the applicant compared the ideal pressuremeter test curves with several unload-reload loops. The applicant indicated that for the ideal pressuremeter test curves, the slopes of the unload-reload of the materials that are naturally or mechanically fractured during the drilling process increase with each successive unload-reload cycle performed at higher pressures. The applicant stated that the slopes of the three unload-reload loops for Salina Unit F become progressively steeper with the increasing strain, which is an indication of a fractured material. The applicant also indicated that in the ideal pressuremeter test, for a material that was mechanically fractured during the drilling process, the slope of the unload-reload loops continues to increase as the joints are closed. The applicant encountered this same scenario in tests performed for Salina Group Unit F. The applicant concluded that the E_{ur} from the last unload-reload cycle was an appropriate representation of the modulus of in situ undisturbed bedrock for Salina Group Unit F. The applicant compared the E obtained from the pressuremeter testing with the E based on the Hoek-Brown criterion. In order to provide a bounding estimate of settlement and rebound for Seismic Category I foundations, the applicant used the E obtained from the Hoek-Brown criterion because the E from the pressuremeter testing was higher.

The staff reviewed the response to RAI 02.05.04-8 and noted that in order to keep the material in the elastic range at any stage during the pressuremeter testing, the total pressure is controlled and maintained at less than 40 percent of the maximum pressure reached. The staff acknowledged that for homogeneous materials that contain no fractures, the successive unload-reload loops that performed at different pressure levels in the elastic range will be relatively parallel. The staff further noted that for materials that are fractured during the drilling process, the slope of the unload-reload loops increases until all of the joints have closed up. Beyond this point the slope of the unload-reload loops is presumably reached, but it does not exceed the slope for homogeneous materials. Based on the above rationale, the staff agreed with the applicant that the modulus based on the slope in the final unload-reload loop in the elastic range for material naturally or mechanically fractured during the drilling process will be a conservative estimate of the in situ modulus. In addition, the staff noted that the average E, based on the pressuremeter tests in Salina Group Unit F falls within the upper and lower bound E based on the Hoek-Brown criterion, which provides cross-references for the modulus between pressuremeter tests and the Hoek-Brown criterion. Finally, because the lower bound modulus from the Hoek-Brown criterion was used, the staff concluded that the calculated settlement and rebound of Seismic Category I foundations provides conservative estimates. The staff concluded that the E_{ur} obtained from the last unload-reload cycle is an appropriate representation of the in situ modulus for the Salina Group Unit F undisturbed bedrock, and the lower bound modulus from the Hoek-Brown criterion is appropriate to use. Therefore, RAI 02.05.04-8 is resolved and closed.

<u>NRC Staff's Conclusions Regarding Field Investigations</u>

The staff reviewed FSAR Subsection 2.5.4.2.2 and the applicant's response to RAIs associated with the Fermi 3 site field investigations discussed above. The staff concludes that the applicant has appropriately followed the guidance in RG 1.132, Revision 2. The applicant conducted an adequate boring exploration program based on the location and number of borings and the number and types of tests performed, in accordance with the appropriate ASTM standards.

Laboratory Testing

The staff reviewed FSAR Subsection 2.5.4.2.3 related to the laboratory testing program performed to identify, classify, and evaluate the physical and engineering properties of the soil and the bedrock. The applicant investigated the need to perform dynamic tests on Salina Group Unit F and concluded that no dynamic testing was required because the estimated shear strain for Salina Group Unit F was approximately 0.0252 percent, and the strain level for the till induced during the design earthquake would be less than 0.3 percent. The applicant also indicated that the testable samples would have been biased toward "the more intact portions of the bedrock and hence testing under static or dynamic loading conditions would possibly give high values not representative of the overall Unit F." The staff was concerned that the potential role of "weak" zones , which are the zones experiencing low recovery, within the Salina Group Unit F might have contributed to the overall characterization and performance of this group. FSAR Figure 2.5.4-208 shows P-S suspension logging results indicating missing V_s and V_p data in a significant portion of Salina Group Unit F. Consequently, in RAI 02.05.04-9 and RAI 02.05.04-13a, the staff asked the applicant to provide information on possible alternative means of sampling Salina Group Unit F; or if sampling was not feasible, to provide a non-laboratory testing alternative to obtain data regarding the potential effects of these conditions on the characterization of Salina Group Unit F. The staff also asked the applicant to explain how the induced seismic shear strains were conservatively estimated for the Salina Group Unit F and the till in order to be consistent with the postulated earthquake shaking conditions.

In the response to RAI 02.05.04-9 dated January 11, 2010 (ADAMS Accession No. ML100130382), and the response to RAI 02.05.04-13a dated February 11, 2010 (ADAMS Accession No. ML100570311), the applicant indicated that the data in the application are sufficient to characterize Salina Group Unit F and its weaker zones. The applicant stated that because of the poor recovery in the "weaker" zones of Salina Group Unit F, the collection of undisturbed bedrock core was considered unlikely in these zones and with a minimum V_s of 549 m/s (1,800 fps), the soil samples were not considered applicable. Regarding the induced shear strain estimates, the applicant indicated that the induced seismic shear strain estimates were performed for Salina Group Unit F using an assumed peak ground acceleration of 0.25g and a minimum V_s of 549 m/s (1,800 fps), which were measured at a depth of approximately 73.2 m (240 ft). The applicant estimated a shear strain of 0.0252 percent for the Salina Group Unit F, which indicates a G/G_{max} ratio of approximately 0.91. The applicant approximated the worst case based on sand between 36.6 and 76.2 m (120 and 250 ft) that resulted in a G/G_{max} ratio larger than that estimated before, thus indicating a negligible modulus reduction of bedrock. In FSAR Figures 2.5.2-280 and 2.5.2-281 the applicant showed that within the elevation range of Salina Group Unit F, the computed shear strains in the randomized site profiles are less than 0.03 percent, which confirms the previously estimated results. For the till, the applicant estimated an average V_s of 305 m/s (1,000 fps). The applicant further stated that the results of the RCTS testing provide the dynamic response of the till up to a shear strain of approximately 0.3 percent. However, as stated in its FSAR, the applicant decided that the till will be fully excavated under and adjacent to all Seismic Category I structures and backfill consisting of fill concrete will reestablish the foundation grade. The applicant did not consider the till in the ground motion response analysis.

The staff reviewed the responses to RAI 02.05.04-9 and RAI 02.05.04-13a. The staff noted that the mean V_s and V_p of Salina Group Unit F that were obtained using the P-S suspension logging method agree with the mean V_s and V_p of Salina Group Unit F, which were obtained using the downhole seismic method. These in situ methods either directly tested weaker zones in Salina Group Unit F or tested across Salina Group Unit F and included weaker zones in the averaged measurements. Therefore the staff concludes that the applicant's data are sufficient to adequately characterize Salina Group Unit F, including the weaker zones. In addition, the staff reviewed the applicant's subsurface stability analyses and noted that these factors have been considered. Regarding the induced shear strain estimates, the staff reviewed the results of the effective shear strains computed in the site response analyses for the 10^{-4} and 10^{-5} input ground motions from FSAR Figures 2.5.2-280 and 2.5.2-281. These figures show that the computed shear strains in the randomized site profiles were all less than or equal to 0.03 percent within the elevation range of Salina Group Unit F. Because the computed Salina Group Unit F shear strain range is based on site response analyses with an assumed peak ground acceleration of 0.25 g and a minimum V_s of 549 m/s (1,800 fps), which confirmed the shear strain level of approximately 0.0252 percent, the staff concludes that the seismic shear strain for Salina Group Unit F is appropriate. Therefore, the shear modulus reduction based on this shear strain is acceptable.

The staff confirmed that the applicant's revised FSAR Subsection 2.5.4.2.3 includes more detailed clarifications of how the induced seismic shear strains were estimated for Salina Group Unit F and for the till. Because the applicant provided reasonable justifications for the proper characterizations of Salina Group Unit F, including its weaker zones and the induced seismic shear strains for Salina Group Unit F, , and decided to remove the till from the vicinity of Seismic Category I structures, RAI 02.05.04-9 and RAI 02.05.04-13a are resolved and closed.

FSAR Section 2.5.4.4.1.1 states that repeated collapse of boreholes was experienced in the 33.5 to 62.5 m (110 to 205 ft) depth range in Salina Group Unit F and resulted in oversized borehole and irregular borehole shapes. This section also states that the limited measurements were performed in Salina Group Unit F in any of the borings due to oversized holes and irregular hole shapes. The staff was concerned about any potential existence of cavities or other unstable subsurface conditions. In RAI 02.05.04-13b and RAI 02.05.04-13c, the staff asked the applicant to provide a detailed comparison of the elevations for the collapse of the boreholes under all Seismic Category I foundation bases; to discuss whether or not a repeated collapse of the boreholes might not be indicative of cavities below foundation levels; and to explain why systematic rock grouting should not be applied at this site.

In the response to RAI 02.05.04-13b and RAI 02.05.04-13c dated February 11, 2010 (ADAMS Accession No. ML100570311), the applicant provided caliper logs—a measure of the borehole diameter—for borings under and adjacent to Seismic Category I foundation bases with larger diameters that indicate the locations of borehole collapses. The applicant performed OTV logging for each of the borings with caliper logs in order to allow for a visual inspection of the borehole walls to see if voids or cavities are present at the Fermi 3 site. For boring RB-C8, the applicant compared the OTV log and the caliper log. The applicant did not identify any cavities where a borehole collapse had occurred; but the applicant did note that the larger diameter size was caused by material falling off the side of the borehole wall into the boring. FSAR Subsection 2.5.1.2.3.1 presents boring log analyses performed from the OTV logs; and natural gamma and caliper logging that the applicant used to provide information regarding core loss, voids, cavities, and tool drops that occurred in the Bass Islands Group and Salina Group Units F and E. The applicant concluded that the nature of the fracture of Salina Group Unit F resulted in the repeated collapse of boreholes as material fell off the borehole walls into the boring, rather than from the presence of cavities below foundation levels. The applicant did not propose systematic rock grouting to enhance the stability of subsurface materials because no void or cavities are present below the Fermi 3 site, and the strength and stiffness of the bedrock are sufficient to provide adequate bearing capacity and to control the settlement.

The staff reviewed the responses to RAI 02.05.04-13b and RAI 02.05.04-13c, the caliper logs for the borings under and adjacent to Seismic Category I structures, and the OTV logs. Because the applicant's analysis of boring logs regarding core loss, voids, cavities, and tool drops that occurred during the Fermi 3 subsurface investigation included the comparison of available boring logs; photos of the recovered core; caliper and gamma logs; and the downhole OTV logs to determine an explanation of the conditions that were encountered, the staff did not suspect that voids, cavities, or other unstable subsurface conditions are present beneath the Fermi 3 site. Based on the information from the applicant's analysis, observations during drilling, and a review of the OTV logs, the staff agreed with the applicant that the nature of the fracture of Salina Group Unit F resulted in repeated collapses of the boreholes as material fell off the borehole walls into the boring, rather than from the presence of cavities below the foundation levels. Therefore, systematic rock grouting is not necessary, and RAI 02.05.04-13b and RAI 02.05.04-13c are resolved and closed.

The staff reviewed the information in FSAR Subsection 2.5.4.2.3 and the applicant's responses to the RAIs associated with laboratory testing described above. The staff concludes that the applicant's laboratory testing program was conducted in accordance with an approved quality assurance program that adhered to the guidance in RG 1.138, Revision 2. The staff also concludes that the applicant had conducted sufficient laboratory tests to adequately characterize the physical and engineering properties of the subsurface materials.

NRC Staff's Conclusions Regarding the Properties of Subsurface Materials

The staff found the applicant's description of the subsurface materials acceptable in that the applicant had followed the guidance in RG 1.132, Revision 2 and RG 1.138, Revision 2. The applicant investigated and tested the subsurface materials to determine the geotechnical engineering properties of the soil and rock at the planned Fermi 3 site. Furthermore, the staff concludes that the applicant had obtained sufficient undisturbed samples to allow for the adequate characterization of each of these soil/rock groups and had determined the extent, thickness, hardness, density, consistency, strength, and engineering and static design properties. Furthermore, the staff concludes that the applicant has provided sufficient information in the form of plots, plans, boring logs, and laboratory test results that enabled the staff to determine that the applicant had adequately characterized the subsurface soil and rock materials and adequately determined the engineering and design properties.

Therefore, the staff concludes that the applicant's description of the subsurface materials and properties at the proposed Fermi 3 site is acceptable and meets the requirements of 10 CFR 100.23.

2.5.4.4.3 Foundation Interfaces

The staff reviewed FSAR Figure 2.5.1-236, which is the site explorations locations including borings, monitoring wells, piezometers and the test pit, Figure 2.5.4-201, which is the plan view of the excavation for the RB/FB, CB, FWSC, TB and RW, and FSAR Figures 2.5.4-202 through 2.5.4-204, which are geologic cross sections illustrating the detailed relationship of the structural foundations to the subsurface materials. The staff also reviewed FSAR Table 2.5.4-224, which provides the foundation elevations of the major structures in the Power Block area.

The staff concluded that the applicant has adequately investigated the subsurface materials beneath the nuclear island construction zone for the Fermi 3 site. The staff's conclusion is based on the review of the: (1) plot plans showing the locations of all site explorations, such as borings, seismic and non-seismic geophysical explorations, piezometers, geologic profiles, and the locations of the safety-related facilities; (2) the applicant presented, illustrating the detailed relationship of the foundations of all Seismic Category I and other safety-related facilities to the subsurface materials; and (3) core borings, SPT borings, V_s profiles and non-seismic geophysical logging results. Accordingly, the staff concludes that the foundation interfaces as described in FSAR Subsection 2.5.4.3 form an adequate basis for the characterization of the foundation interfaces at the Fermi 3 site and meets the requirements of 10 CFR Parts 50 and 100.

2.5.4.4.4 Geophysical Surveys

The staff reviewed FSAR Subsection 2.5.4.4 focusing on the applicant's description of the geophysical surveys performed to identify the dynamic characteristics of soils and rocks. The applicant measured the dynamic characteristics of soils and bedrock using downhole P-S suspension logging, downhole seismic testing, and SASW logging. As a result, the applicant concluded that the downhole V_s values generally agree with the values obtained using P-S suspensions logging; and the soil V_s measured using the P-S suspension method agrees with the soil V_s measured using the SASW method. In RAI 02.05.04-11, the staff asked the applicant to provide test data for V_s in addition to the average values and to discuss how these data may vary with the depth. The staff also asked the applicant whether the variability observed in downhole seismic testing and the SASW logging needs to be considered in the characterization of the soil and bedrock.

In the response to RAI 02.05.04-11 dated December 23, 2009 (ADAMS Accession No. ML100040548), the applicant provided detailed results of the V_p and V_s measurements in the Geovision Report 7297-01, Revision 0 (March 12, 2008). The applicant indicated that for the Bass Islands Group, the measured V_s and V_p were constant throughout the depth at a given boring location. For Salina Group Unit F, the applicant performed limited V_p and V_s measurements between the depths of 33.5 and 62.5 m (110 and 205 ft) resulting from oversized holes and irregular shapes of holes. The applicant measured the arrival time of the shear and compression waves above and below the interval of the oversized zones and indicated that for the RB-C8 and CB-C3 locations, the measured V_s and V_p were constant over a given interval at a given boring location. The applicant measured the V_s in the overburden using the SASW and P-S suspension logging and discussed the variability in FSAR Subsection 2.5.4.4.1.2. The applicant employed the V_s measurement using the SASW logging to establish the V_s of only the glacial till and used the P-S suspension logging to establish the bedrock V_s and V_p values for analysis. The applicant used the downhole results to validate the P-S suspension logging results. The applicant indicated that the V_p and V_s measured using the downhole method fall with the variability of the V_p and V_s measured using P-S suspension logging method. The applicant concluded that the overall results obtained from the P-S Suspension logging are acceptable for all purposes of analysis. But the staff noted that the V_s obtained from the P-S suspension logging method are generally greater than those from the downhole and SASW methods. In RAI 02.05.04-12, the staff asked the applicant to justify the exclusive use of the P-S suspension logging results rather than using the downhole, SASW, and P-S suspension logging results.

In the response to RAI 02.05.04-12 dated December 23, 2009 (ADAMS Accession No. ML100040548), the applicant indicated that the clarity of the V_s wave form was better in the P-S suspension logging data than in the downhole seismic data and the variability of the P-S suspension logging data for the V_s and V_p could correlate well with the physical features observed in the bedrock. The applicant had more confidence in the ability to interpret the P-S suspension logging V_s data.

The staff reviewed the responses to RAIs 02.05.04-11 and 02.05.04-12 and noted that the applicant had applied the downhole seismic method to measure the V_p at boring locations RB-C8, CB-C3, and RB-C4 and the V_s at RB-C8 and CR-C3. The staff also noted that the V_p and V_s in the bedrock units were measured using the downhole seismic method and fall within the variability of the V_p and $V_{s,}$ which were measured using the P-S suspension logging method except for the lower V_s, which was measured in RB-C8 in the Bass Islands Group and the applicant attributed to poor quality shear wave forms. In addition, the staff noted that the applicant had compared the V_s and V_p measurements obtained with other subsurface information such as RQD, caliper, natural gamma, and OTV logs. The staff also reviewed FSAR Figures 2.5.4-205 through 2.5.4-208 to compare the measured P-S suspension logging V_s and V_p with the RQD in boring locations TB-C5, RB-C8, CB-C3, and RB-C4, respectively. The staff also reviewed FSAR Figures 2.5.4-209 through 2.5.4-212 to compare the OTV logs and the measured velocities in boring locations TB-C5, RB-C8, CB-C3, and RB-C4, respectively. Furthermore, the staff reviewed FSAR Figures 2.5.4-213 and 2.5.4-214 to compare the natural gamma logs and the measured velocities in boring locations TB-C5 and CB-C3. The staff concurred with the applicant that the variability in the measured V_p and V_s within the Bass Islands Group is mainly caused by geologic features such as fractures, bedding planes, brecciation, oolitic rock, and a pitting of the bedrock. Because the clarity of the V_s forms was better for the P-S suspension logging data than for the downhole seismic data, and the variability of the P-S suspension logging V_s and V_p data could correlate well with the physical features observed in the bedrock, the staff concluded that the P-S suspension logging V_s data are more reliable than the V_s downhole seismic data, while the downhole results were used to validate the P-S suspension logging results. The staff further concluded that the V_s measurements using the SASW logging were used to establish the V_s of only the glacial till that will be removed from beneath the Seismic Category I structures. Therefore, RAI 02.05.04-11 and RAI 02.05.04-12 are resolved and closed.

The staff reviewed the information in FSAR Subsection 2.5.4.4 and the applicant's responses to RAIs 02.05.04-11 and 02.05.04-12. The staff concluded that the applicant has appropriately followed the guidance in RG 1.132, Revision 2, and has provided sufficient geophysical surveys to characterize the dynamic characteristics of soils and rocks.

2.5.4.4.5 Excavation and Backfill

The staff reviewed FSAR Subsection 2.5.4.5 related to the engineering granular backfill requirements, the extent of excavation fills and slopes, excavation methods, and the stability at the Fermi 3 site. Initially, the applicant was planning to use lean concrete and engineered granular fill as the backfill beneath and surrounding Seismic Category I structures. As a result of the revisions to the referenced DCD for the required soil properties surrounding Category I structures, the applicant later proposed to use roller-compacted concrete or a similar product near the ground surface to maintain the 300 m/s (1,000 ft/s) shear wave velocity. The staff issued several RAIs regarding the applicant's fills properties, criteria, and extent of excavation and backfill. However, these RAIs are not discussed in further detail in this technical evaluation because the applicant later concluded—while developing responses to the RAIs—that the design for the backfill surrounding the Category I structures would not meet the DCD soil property requirements. Consequently, the response to RAI 02.05.04-38 dated June 17, 2011

(ADAMS Accession No. ML111711175), reflects the applicant's final decision to use granular backfill to surround the Category I structures and to perform a site-specific SSI analysis to demonstrate the adequacy of the site and the standard plant design. The applicant did not credit the engineered granular fill surrounding the Category I structures for performing any safety-related function and clarified that only onsite backfill sources will be used for engineered granular backfill surrounding the Category I structures. The applicant concluded that no ITAAC are necessary for compactable backfill surrounding the embedment walls of the RB/FB and CB. The applicant also concluded that the site parameter values are not required, including the shear wave velocity requirement referenced in the DCD for compactable backfill surrounding the foundation basemat of the FWSC. In addition, the applicant decided to use fill concrete instead of lean concrete to backfill the volume between the RB/FB, CB, and excavated bedrock and to support the FWSC and TB foundations from the top of the bedrock to address the staff's concern about the chemical composition requirements for sulfate exposure conditions. For the FWSC, the applicant indicated that it is a surface-founded structure that will have no embedment walls and will be supported by concrete fill founded on top of the Bass Island Group bedrock, with a mean shear wave velocity of at least 2,175 m/s (7,140 ft/s).

Source and Quantities of Backfill and Borrow Materials

The staff reviewed FSAR Subsection 2.5.4.5.1 related to the sources of backfill and borrow materials that follow the guidance in NUREG–0800. Based on the information in the applicant's response to RAI 02.05.04-38, the staff asked the applicant in RAI 02.05.04-39 to provide the technical basis for eliminating the ESBWR DCD site parameter requirement for the product of at-rest pressure coefficient and density ($K_0\gamma \geq 750$ Kg/m^3 [47 lb/ft^3]) for backfill material surrounding Seismic Category I structures in FSAR Table 2.0-201. The staff also asked the applicant to explain why Design Commitment Item 2 in Table 2.4.2-1 of the COL application Part 10 is not applicable—engineering properties of backfill material surrounding Seismic Category I structures. The staff also asked the applicant to explain the basis for eliminating Item 2 of the site-specific ITAAC corresponding to the backfill adjacent to Seismic Category I structures.

In the response to RAI 02.05.04-39 dated February 16, 2012 (ADAMS Accession No. ML120520154), the applicant eliminated $K_0\gamma$ as a required parameter for Seismic Category I structures. Because of the strength of the bedrock and the fill concrete, the applicant did not credit the frictional resistance along the portion of the foundation and the walls of the structure parallel to the direction of sliding motion. In addition, the applicant indicated that an ITAAC for the backfill surrounding Seismic Category I structures will be included to specify the applicable requirements for the DCD backfill soil parameters.

The staff reviewed the responses to part 1 of RAI 02.05.04-38 and RAI 02.05.04-39. The staff noted that the applicant had elected to perform site-specific SSI analyses in lieu of meeting the soil property requirement in the ESBWR DCD table to maintain the 300 m/s (1,000 ft/s) shear wave velocity for backfill surrounding Seismic Category I structures. The staff also noted that the applicant had properly revised its plot plans and profiles to present the horizontal and vertical extent of all Seismic Category I fills, including the engineered granular backfill and fill concrete. The staff further noted that ESBWR DCD also allows applicants to demonstrate the adequacy of the standard plant design by performing site-specific analyses. Therefore, the staff considered the applicant's alternative approach proper and acceptable. The staff's detailed evaluation of the site-specific SSI analyses is documented is in Sections 3.7.1, 3.7.2, and 3.8.5 of this SER. The staff noted that the site-specific SSI analyses for the RB/FB and the CB were performed by considering the partial embedment of the structures into the Bass Islands Group bedrock and by not taking credit for the engineered granular backfill located above the top of the Bass Islands Group bedrock. Because the applicant's site-specific SSI analyses demonstrated the adequacy of the standard plant design, the staff agreed that the shear wave velocity requirement referenced in the DCD for the backfill surrounding Seismic Category I structures may not be considered. Consequently, the staff concurred that an ITAAC on shear wave velocity for engineered granular fill surrounding Seismic Category I structures is not necessary.

The applicant's assumption that the engineered granular backfill surrounding Seismic Category I structures are not attributed to resisting sliding forces in the site-specific SSI analyses is conservative. Furthermore, the staff reviewed DCD Tier 2, Subsection 3.8.5.5 and GEH Letter MFN 09-772 to the NRC, "Revised Response to portion of NRC RAI Letter No. 386 Related to ESBWR Design Certification Application – DCD Tier 2, Section 3.8 – Seismic Category I Structures; RAI Number 3.8-96 S05 Revision 1," dated January 20, 2010 (ADAMS Accession No. ML100220503), in order to understand the ESBWR DCD requirement for $K_0\gamma$ and how to determine the FS against sliding. The staff also reviewed FSAR Subsection 3.8.5.5.1, "Foundation Stability," to confirm that the stability calculations against sliding are executed according to the procedure in Referenced DCD Subsection 3.8.5.5. Based on the above reviews, the staff found that the DCD requirement for $K_0\gamma$ is related to at-rest soil forces that are normal to the basemat vertical surface, which develops skin friction resistance on the basement side parallel to the direction of the motion to resist sliding if necessary. The staff confirmed that the skin friction resistance force provided by the basemat side parallel to the direction of the motion is not taken into account in the applicant's analyses (i.e., $F_{us} = 0$). The staff agreed with the applicant that the great resistance force for sliding can be developed by the partial embedment of the structures into the bedrock. The staff noted that the calculated Fermi 3 site-specific FS against sliding for the Seismic Category I structures RB/FB, CB, and FWSC are 1.22, 1.10, and 15, respectively, which are equal to or greater than the minimum FS of 1.1 required by SRP Section 3.8.5. Therefore, the staff concluded that it is not necessary to take into account the DCD site parameter requirement $K_0\gamma \geq 750$ Kg/m^3 (47 lb/ft^3) for the Fermi 3 site. The staff further concluded that it is reasonable and acceptable to exclude an ITAAC item of $K_0\gamma \geq 750$ Kg/m^3 (47 lb/ft^3) from site-specific ITAAC for "Backfill Surrounding Seismic Category I Structures." Furthermore, the staff confirmed that the applicant has revised the ITAAC for "Backfill Surrounding Seismic Category I Structures" to reflect that (1) the DCD site parameter requirements of 300 m/s (1,000 ft/s) minimum shear wave velocity and $K_0\gamma \geq 750$ Kg/m^3 (47 lb/ft^3) for engineered granular fill surrounding Seismic Category I structures are no longer required design commitments; and (2) the other applicable DCD site parameter requirements for DCD backfill soil parameters are included in the ITAAC for "Backfill Surrounding Seismic Category I Structures" in Section 2.4.2 of COL application Part 10. Therefore, part 1 of RAI 02.05.04-38 and RAI 02.05.04-39 are resolved and closed.

In part 6 of RAI 02.05.04-38, the staff asked the applicant to specify the offsite backfill source(s) and to demonstrate the adequacy of the performed site and laboratory investigations.

In the response to part 6 of RAI 02.05.04-38 dated December 23, 2009 (ADAMS Accession No. ML100040548), the applicant indicated that only onsite backfill sources using materials excavated from Fermi 3 will be used for the engineered granular backfill surrounding Seismic Category I structures. This decision reflects investigations using borings and test pits, in addition to laboratory and field tests.

The staff reviewed the applicant's response to part 6 of RAI 02.05.04-38 and noted that the quantity of engineered granular backfill within the perimeter of the reinforced concrete diaphragm wall is approximately 153,000 m^3 (200,000 yd^3), and the volume of granular backfill from the onsite excavation (onsite source) of Fermi 3 is an estimated 180,000 m^3 (235,000 yd^3). The staff concluded that the quantity of material excavated from the Fermi 3 site is adequate for the engineered granular backfill surrounding the Fermi 3 Seismic Category I structures. The staff also noted that the source of the onsite backfill was investigated using borings, test pits, and laboratory and field tests; FSAR Subsection 2.5.4.2 discusses the properties of the onsite backfill materials. Based on this information, the staff found that the applicant has (1) identified the sources and quantities of the backfill; (2) adequately investigated them using borings, pits, and laboratory tests (dynamic and static); and (3) included, interpreted, and summarized the data in the FSAR. The staff concluded that the applicant has adhered to the SRP Section 2.5.4 acceptance criteria regarding backfill sources, quantities, and laboratory properties. Therefore, part 6 of RAI 02.05.04-38 is resolved and closed.

Extent of Excavation, Fills, and Slopes

The staff reviewed FSAR Subsection 2.5.4.5.2 that focuses on the extent of the excavation, fills, and slopes within the soil and bedrock. The applicant stated that vertical excavation faces within the soil and bedrock could be achieved by using an excavation system consisting of a reinforced concrete diaphragm wall system 24.4 m (80 ft) deep with an embedment depth of approximately 15.2 m (50 ft) into the bedrock around the entire excavation. The reinforced concrete diaphragm wall will act as the perimeter of the soil excavation and will provide vertical support for the portion of the excavation within the soil. Overburden soils will be excavated from the ground surface to the estimated top of the bedrock surface at elevation of 168.2 m (552 ft) NAVD 88. Bedrock will be excavated to reach the required foundation design elevations. FSAR Figure 2.5.4-201 depicts the plan view of the excavation for Fermi 3 using the vertical cut-off wall option in the soil and bedrock; Figures 2.5.4-202 through 2.5.4-204 show the cross sections of the excavation. Because the applicant is committed to a structural design of the concrete diaphragm wall that is in accordance with ACI 318, the wall will be aligned to prevent the deflected wall from encroaching on the limits of Seismic Category I structures plus any construction limitations. And because the wall will be aligned to allow sufficient space for the placement of backfill outside the Seismic Category I structures, the staff agreed with the applicant’s conclusion that there are no impacts to the completed Seismic Category I structures from the presence of the concrete diaphragm wall.

The staff reviewed FSAR Subsection 2.5.4.5.2 and FSAR Figures 2.5.4-201 through 2.5.4-204. The staff concluded that the applicant has clearly illustrated the detailed relationships among the foundations of all Seismic Category I structures, backfill materials, and excavation boundaries created by the vertical cut-off reinforced concrete diaphragm wall. Therefore, the applicant’s assessment of the extent of all Category I excavations, fills, and slopes is acceptable and meets the requirements of 10 CFR Part 50.

Excavation Methods and Stability

While reviewing FSAR Subsection 2.5.4.5.3, the staff noted that the applicant plans to use blasting, mechanical excavation, or a combination of both methods for the bedrock excavation. The applicant assured the staff that the blasting would be designed by a qualified and experienced blasting professional and controlled blasting techniques can be used to ensure the protection of all existing adjacent structures, including Fermi 2. The applicant indicated that during construction, excavated subgrades in the bedrock of safety-related structures will be mapped and photographed by a qualified and experienced geologist to evaluate any unforeseen geologic features. The staff asked the applicant in RAI 02.05.04-15 to provide the specific criteria to be used to evaluate whether the excavated faces would be acceptable as foundation material. Also, the staff asked for an explanation as to how the applicant will use a geologic evaluation of open faces to confirm the engineering properties of bedrock material and to provide specifics for any engineering property tests planned for the excavated bedrock material.

In the response to RAI 02.05.04-15 dated January 11, 2010 (ADAMS Accession No. ML100130382), the applicant indicated that the Seismic Category I structures at the Fermi 3 site are founded on bedrock or fill concrete over the bedrock. The applicant also indicated the intent to prepare during the development of the detailed design the specifications regarding the inspection and cleaning of the excavation that will ensure acceptable excavation faces. The applicant also committed to ensuring that a visual inspection of the final excavation surface will be performed to confirm that it is in general conformance with the expected foundation material based on boring logs. After fracturing from blasting, machine cleaning is followed by cleaning with hand tools and high-pressure water and air to remove unsuitable rock. The applicant pointed out that geologic mapping of the final exposed excavated bedrock surface will be performed before the placement of concrete fill and foundation concrete to determine the degree of fracturing in the excavated face after the surface has been cleaned. The applicant also stated that if the spacing between discontinuities is measured in feet, foundation treatment may be minimal or unnecessary. But if the spacing between fractures is measured in inches, removal or replacement with dental concrete or consolidation grouting may be required to improve the engineering properties of the bedrock at the excavated face. The applicant concluded by stating that the designer will identify specific engineering properties, tests, and the type and extent of the foundation treatment. The designer will thus confirm the condition of the excavation faces. The applicant added that there are no plans to test the excavated material.

The staff reviewed the response to RAI 02.05.04-15 and noted that the existing subsurface materials including fill, lacustrine, and glacial till will be removed to ensure that the Seismic Category I structures are founded on bedrock or concrete fill over bedrock. The staff also noted that the applicant will perform a visual inspection on the exposed bedrock foundation subgrade to confirm that cleaning and surface preparations were properly completed. In addition, the applicant will conduct the geologic mapping program after the surface is machine and hand cleaned and after there is a complete photographic documentation of the exposed surface to record significant geologic features. The applicant agreed to implement the foundation treatment where necessary, including removal and replacement with dental concrete or consolidation grouting to improve the engineering properties of the bedrock at the excavated face. The geologic mapping License Condition 2.5.3-1 is identified in the Subsection 3.5.3.5 of this SER as the responsibility of the COL applicant. The NRC will be notified once excavations for Fermi 3 safety-related structures are open for examination by NRC staff. Therefore, the staff found the applicant's response acceptable, and RAI 02.05.04-15 is resolved and closed.

Compaction Specifications and Quality Control

The staff reviewed FSAR Subsection 2.5.4.5.4 that focuses on the methods and procedures used for verification and quality control of foundation materials. Based on the information in the applicant's response to part 2 of RAI 02.05.04-38 (ADAMS Accession No. ML100040548), the staff confirmed that the applicant has properly revised the plot plans and profiles to present the horizontal and vertical extent of all Category I fills—including the engineered granular backfill and fill concrete. The staff noted that the engineered granular backfill surrounding the Seismic Category I structures will be compacted to 95 percent of the modified Proctor density or 75 percent of the maximum relative density. The staff concurred that the engineered granular backfill is adequate to prevent liquefaction.

The applicant identified that the sulfate concentration of the site's groundwater is in the "moderate" to "severe" sulfate exposure category based on ACI 349. In part 3 of RAI 02.05.04-38, the staff asked the applicant how the backfill on the side of and underneath the Seismic Category I structures is designed to resist chemical attack, particularly if roller compacted concrete (RCC) or controlled low-strength material (CLSM) is selected. The staff also asked the applicant to discuss control of the thermal cracking of fill materials.

In the response to part 3 of RAI 02.05.04-38 (ADAMS Accession No. ML111711175), the applicant stated that the RCC will not be used to surround Seismic Category I structures and that no CLMS will be used as backfill material for Seismic Category I structures. The applicant will follow ACI 349 to address the chemical composition requirements for sulfate exposure conditions and ACI 207.2R to address the thermal cracking control of mass concrete. The applicant concluded that the mean compressive strength for the fill concrete will be 31 MPa (4,500 psi).

The staff reviewed the response to part 3 of RAI 02.05.04-38, and verified that the applicant will not use the RCC, CLSM, or lean concrete as backfill material for Seismic Category I structures. The staff also confirmed that the fill concrete will be used to backfill the volume between the RB/FB and CB and excavated bedrock, and to support the FWSC and TB foundations from the top of the bedrock. In addition, the staff noted the ITAAC, which ensures that compactable backfill will not be placed under Fermi 3 Seismic Category I structures, and the fill concrete placed underneath any Category I structure will be a thickness greater than 1.5 m (5 ft) to the design, construction, and testing of applicable ACI standards. The staff validated that ACI 349 Chapter 4 addresses the concrete durability requirements including concrete to be exposed to sulfate containing solutions or soils. The staff verified that for a severe sulfate exposure such as the Fermi 3 groundwater condition, concrete durability can be achieved following the guidance in Table 4.3.1 of ACI 349 by providing concrete containing Type V cement; controlling a 0.45 maximum water-cementitious-material ratio; and maintaining a 31 MPa (4,500 psi) minimum concrete compressive strength. The staff further noted that ACI 207.2R-07 addresses the thermal cracking control of mass concrete by providing guidance for the selection of concrete materials, mixture requirements, and construction procedures necessary to control the size and spacing of cracks. Because the concrete durability of the fill and thermal cracking can be controlled by committing to proper ACI codes, the staff considered part 3 of RAI 02.05.04-38 resolved and closed.

<u>NRC Staff's Conclusions Regarding Excavation and Backfill</u>

The staff concluded that the applicant has (1) provided detailed information on engineered granular backfill and fill concrete properties and requirements; (2) provided applicable methods and procedures used for the verification and quality control of engineered granular backfill and concrete fill; and (3) described concrete fill properties that will ensure that the proposed fill concrete meet the strength and stability requirements. In addition the applicant provided two site-specific ITAACs that will ensure that concrete fill placed under Seismic Category I structures and compacted backfill surrounding the embedded walls for Seismic Category I structures are designed and tested as specified in FSAR Subsection 2.5.4.5.4.2 and properties of backfill material are equal to or exceed the FSAR Subsection 2.5.4.5.4.2 requirements. Therefore, the proposed fills for this site are adequate for meeting design and engineering standards. Regarding the applicant's excavation plans, the staff concluded that the applicant's plans to use conventional excavation methods (e.g., backhoe, front end loader, and dump truck) to remove soil layers and to use blasting with controlled blasting techniques (cushion blasting, pre-splitting, and line drilling; mechanical excavation including the use of roadheaders, terrain levelers, rockwheels, rock trenchers, and other mechanical excavation; or a combination of blasting and mechanical excavation) to excavate bedrock are adequate and feasible. In SER Subsection 2.5.3.5, the staff identifies License Condition 2.5.3-1 as the responsibility of the COL applicant for a detailed geologic mapping of the excavation of Fermi 3 nuclear island structures and to examine and evaluate geologic features discovered in excavations for safety-related structures. Furthermore, the staff concluded that the supporting foundation materials and/or qualified fill concrete will result in a solid foundation for the nuclear island that meets the requirements specified in ESBWR DCD Tier 1, Table 5.1-1 and 10 CFR Part 50.

2.5.4.4.6 Groundwater Conditions

FSAR Subsection 2.5.4.6 presents information on the groundwater conditions at the site relative to foundation stability for the safety-related structures. The applicant stated that a reinforced concrete diaphragm wall around the perimeter of the Fermi 3 excavation will control groundwater seepage through soils and bedrock, and localized sump pumping within the excavation may be used to supplement water control during excavation. The applicant also stated that foundation bedrock grouting may be performed at the base of the Fermi 3 excavation to aid in controlling groundwater seepage into the excavation. Regarding the impact of groundwater control measures during construction on the existing structures, the applicant stated that the potential for settlement associated with Fermi 3 dewatering operations is negligible because all Fermi 2 Seismic Category I structures are founded on bedrock. However, the applicant provided a regulatory commitment (COM 2.5.4-001) to develop a Contingency Plan for mitigating any settlement of existing Fermi 2 structures before the start of Fermi 3 construction.

The staff reviewed the groundwater information in the FSAR including the conditions before, during, and after excavation and the associated dewatering plan, as well as the proposed measures to minimize drawdown effects on the surrounding environment. The staff concluded that the applicant's assessment of groundwater conditions is acceptable and satisfies the requirements of 10 CFR Part 50 and 10 CFR 100.23.

2.5.4.4.7 Response of Soil and Rock Dynamic Loadings

FSAR Subsection 2.5.4.7 describes the response of soil and bedrock to dynamic loading and the effects of past earthquakes. In RAI 02.05.04-19, the staff asked the applicant to demonstrate that the ratio of the largest to the smallest V_s over the mat foundation does not exceed ESBWR DCD Criterion 1.7. In the response to this RAI dated February 11, 2010 (ADAMS Accession No. ML100570311), the applicant calculated the smallest and largest mean V_s for each bedrock unit (Bass Islands Group and Salina Group Units F, E, C and B) based on various boreholes. The applicant stated that the ratios obtained ranged from 1.01 to 1.44 and therefore concluded that Criterion 1.7 in the ESBWR DCD was achieved for all bedrock units in question. The staff reviewed the response to RAI 02.05.04-19, including the calculated range of ratios. The applicant demonstrated that the ratio of the largest to the smallest mean V_s for full unit thickness based on various boreholes is less than 1.7. The staff concluded that the V_s ratio over the mat foundation width is enveloped by the requirement specified in the ESBWR DCD. Therefore, RAI 02.05.04-19 is resolved and closed.

Based on the above review, the staff concluded that the applicant has developed soil and rock dynamic properties for the Fermi 3 site based on field and laboratory tests that are in accordance with the guidance in RGs 1.132 and 1.138. In addition, the staff concluded that the applicant has conducted sufficient tests to determine soil and rock dynamic properties. The applicant's analyses considered variations of these properties and parameters. Therefore, the soil and rock dynamic property parameters used in the design are appropriate.

2.5.4.4.8 Liquefaction Potential

During the review of FSAR Subsection 2.5.4.8, the staff evaluated the applicant's description of the liquefaction potential at the Fermi 3 site. The staff focused on the applicant's conclusions and justifications that fill materials placed within excavated areas are not susceptible to liquefaction. In addition, the staff's review focused on the applicant's evaluation of localized liquefaction potential under other than Seismic Category I structures.

In RAI 02.05.04-20, the staff asked the applicant to demonstrate that the backfill adjacent to Seismic Category I structures is not susceptible to liquefaction per the requirements in 10 CFR Parts 50 and 100. In the response to RAI 02.05.04-20 dated February 11, 2010 (ADAMS Accession No. ML100570311), the applicant referenced various sources. FSAR Subsection 2.5.4.5.4.2 states that all engineered granular backfills, including the ones in question, will be placed in controlled lifts and compacted. The applicant stated that the engineered granular backfill will consist of well-graded and dense granular soils that will be compacted up to a dense or a very dense consistency, thus reducing the probability of liquefaction.

To further demonstrate this point, the applicant performed a liquefaction analysis based on the SPT method. The applicant postulated that the expected N_{60} value at the ground surface will be 30 bpf and will increase linearly to 60 bpf at a depth of 20 m (65 ft). Based on Youd et al. (2001), the applicant normalized the N_{60} value to a $(N1)_{60}$ value, which is a function of a normalized overburden pressure of 100 KPa (2.1 ksf) and the effective vertical stress. The applicant found that all normalized $(N1)_{60}$ values obtained from this method were greater than 30 bpf, which greatly reduces the possibility of liquefaction according to Youd et al. (2001). Therefore, the applicant concluded that the engineered granular backfill adjacent to the Seismic Category I structures is not susceptible to liquefaction. In RAI 02.05.04-34, the staff asked the applicant to capture this liquefaction evaluation in the FSAR and to provide details of and a commitment on how it will verify the assumed N_{60} values. Also, the staff asked the applicant to provide the expected field backfill compaction and to include this commitment in the FSAR.

In the response to RAI 02.05.04-34 dated August 6, 2010 (ADAMS Accession No. ML102210351), the applicant stated that laboratory testing will be implemented during the detailed design phase to establish the required density necessary to meet the design requirements of the engineered granular backfill adjacent to Seismic Category I structures. The applicant will implement a program for in-place testing of the engineered granular backfill to confirm that the density selected is based on laboratory test results and thus satisfies the design requirements.

The staff reviewed the responses to RAI 02.05.04-20 and RAI 02.05.04-34. The staff's review focused on the liquefaction potential to ensure that engineered granular backfill adjacent to all Seismic Category I structures is not susceptible to liquefaction. The staff noted that a well-graded granular backfill will be placed in controlled lifts with compaction, which will result in a dense to very dense consistency granular backfill. The staff also noted that the applicant's liquefaction analysis indicated that the backfill adjacent to Category I structures is not susceptible to liquefaction if it is compacted to a $(N_1)_{60}$ value equal to or greater than 30 bpf. Because the granular backfill has not yet been placed, the staff found that the applicant will implement (1) the laboratory testing during the detailed design phase to establish the required density to meet the design requirements of the engineered granular backfill adjacent to Seismic Category I structures; and (2) a program to test the in-place engineered granular backfill, which could consist of the construction of one or more test pads to further confirm the density selected based on laboratory test results that meet the design requirements. The staff thus concluded that the applicant had provided reasonable assurance that the engineered granular backfill adjacent to Seismic Category I structures will not be susceptible to liquefaction. The staff further noted that the applicant has revised the FSAR to provide more information on the liquefaction assessment demonstrating that there is no liquefaction potential for engineered granular backfill adjacent to Seismic Category I structures. Therefore, RAI 02.05.04-20 and RAI 02.05.04-34 are resolved and closed.

To comply with the DCD requirement of COL 2.0-29-A, the staff asked the applicant in RAI 02.05.04-35 to evaluate the localized liquefaction potential under other than Seismic Category I structures and to assess the potential safety implications, especially for those buildings that are adjacent to Seismic Category I structures. In the response to RAI 02.05.04-35 dated September 21, 2010 (ADAMS Accession No. ML102660141), the applicant indicated that all non-Seismic Category I SSCs—including the TB, RWB, service building, and ancillary diesel building—are all designed to meet the third criterion of ESBWR DCD, Tier 2, Subsection 3.7.2.8, in order to prevent a failure under SSE ground motion conditions. The applicant also stated that they will meet the first criterion of the ESBWR DCD, Tier 2, Subsection 3.7.2.8 that specifies the requirements for all site-specific, non-Seismic Category I structures outside the scope of the DCD and assures that if they should collapse, the non-Seismic Category I SSCs will not strike any Seismic Category I SSCs.

The applicant may use the glacial till to support non-Seismic Category I structures outside the scope of the DCD. The applicant classified the glacial till as lean clay with an average fines content of 68 percent and a plasticity index of 14. The applicant verified that the glacial till satisfies the RG 1.198 guidance for liquefaction, in which cohesive soils with fines contents greater than 30 percent and fines that are classified as clays are either based on the Unified Soil Classification System or have a plasticity index of more than 30 percent and should generally not be considered susceptible for liquefaction. The applicant confirmed that if backfill is placed above the glacial till to the base of a foundation, it will be an engineered backfill with no potential for liquefaction and with quality control and testing.

The staff reviewed the response to RAI 02.05.04-35 (ADAMS Accession No. ML102660141). The staff noted that non-Seismic Category I structures within the scope of the ESBWR DCD (also called Seismic Category II structures)—including the TB, RWB, service building, and ancillary diesel building—are analyzed and designed to prevent their failure under SSE ground motion conditions in a manner where the margin of safety of these structures is equivalent to that of Seismic Category I structures. The staff further noted that non-Seismic Category I structures outside the scope of the ESBWR DCD are located at least a distance equal to its above-grade height away from Seismic Category I structures. The staff thus concluded that the collapse of any site-specific, non-Seismic Category I SSC will not strike a Seismic Category I SSC. In addition, the staff noted that for the non-Seismic Category I structures that could strike a Seismic Category I structure if the non-Seismic Category I structure were to fail during a seismic event, the subsurface and/or backfill materials founded underneath are not susceptible to liquefaction because it is fill concrete. The staff also noted that the applicant has revised FSAR Subsection 2.5.4.8 to include the assessment of the potential safety implications from localized liquefaction potential under other than Seismic Category I structures. All non-Category I structures are designed to satisfy either the first criterion specified in Subsection 3.7.2.8 of the ESBWR DCD to provide a sufficient distance between the non-Category I structures and the

Seismic Category I structures; or the third criterion to prevent a failure under SSE ground motion conditions. The staff concluded that the potential safety implications resulting from localized liquefaction under other than Seismic Category I structures are not likely to occur. Therefore, RAI 02.05.04-35 is resolved and closed.

Based on the bedrock or fill concrete under Seismic Category I structures and properties of the engineered granular backfill adjacent to Seismic Category I structures described in the above RAI responses, the applicant concluded that liquefaction is not a concern. The staff found the applicant's conclusion reasonable that the liquefaction potential for supporting materials of Seismic Category I structures will not be a concern at the site, because of the fact that the engineered granular backfill will be placed in controlled lifts and compacted to achieve a very dense consistency with relatively high blow counts and V_s value. Regarding the localized liquefaction potential under other than Seismic Category I structures, the staff concluded that the potential safety implications from localized liquefaction under other than Seismic Category I structures are not likely because all non-Seismic Category I structures outside the scope of the DCD are designed to be a sufficient distance from the Seismic Category I structures and non-seismic Category I structures in the scope of the DCD are founded on fill concrete to avoid a failure under SSE ground motion conditions. The staff further concluded that the requirement of COL Item COL 2.0-29-A to evaluate the localized liquefaction potential under other than Seismic Category I structures is met. Therefore, the staff concluded that the assessment of the liquefaction potential at the planned Fermi 3 site is adequate and satisfies the requirements of 10 CFR Part 50, Appendix A; 10 CFR Part 50, Appendix S; GDC 2, and 10 CFR 100.23.

2.5.4.4.9 Earthquake Design Basis

The applicant conducted a field exploration using geophysical testing to determine the V_s of soils and bedrock and performed a site response analysis to develop the GMRS for the site. In FSAR Subsection 2.5.4.9, the applicant referred to FSAR Subsection 2.5.2.6 for a description of the methods used to develop the performance-based, site-specific GMRS developed for the Fermi 3 site. The applicant determined the GMRS is in accordance with the guidance in RG 1.208. Subsection 2.5.2.4 of this SER provides the staff's technical evaluation and a complete description of the performance–based GMRS for the Fermi 3 site.

2.5.4.4.10 Static Stability

The staff reviewed FSAR Subsection 2.5.4.10. The staff's review focused on the applicant's analyses performed to evaluate the stability of safety-related structures, including the foundation-bearing capacity and settlement analyses, excavation rebound lateral earth pressures, and hydrostatic pressures.

Bearing Capacity

In FSAR Subsection 2.5.4.10.1, the applicant used Terzaghi (USACE 1994) and the Uniform Building Code (Peck, Hanson, and Thornburn 1974) approaches when evaluating the bearing capacity. In RAI 02.05.04-23, the staff asked the applicant to explain the appropriateness of these two methods by considering the weaker Salina Group Unit F beneath the Bass Islands Group. In the response to RAI 02.05.04-23 dated December 23, 2009 (ADAMS Accession No. ML100040548), the applicant indicated that both approaches account for the influence of Salina Group Unit F. The applicant stated that the Terzaghi approach takes into consideration the effect of the weaker zones below the Bass Islands Group and is based on general bearing capacity failure behavior. The Uniform Building Code approach considers the allowable contact pressure on unweathered bedrock under a uniaxial loading condition to assure that the foundation bedrock has sufficient capacity against rupture. In the Uniform Building Code approach, the applicant used a weighted average of the unconfined compression strength of the Bass Islands Group and Salina Group Unit F. The staff asked the applicant in RAI 02.05.04-33 to provide an additional basis for selecting these two approaches for possible failure modes of the foundation rock unit at the site. The staff asked the applicant to take into consideration that the Terzaghi approach is based on a particular class of potential failure mode that involves a homogenous material, and the Uniform Building Code approach is based on information mainly for buildings.

In the response to RAI 02.05.04-33 dated August 6, 2010 (ADAMS Accession No. ML102210351), the applicant indicated that these two methods allow evaluations of two general potential bedrock failure modes. The applicant stated that the Terzaghi approach ignores the effects of cohesion and the interlocking of bedrock blocks, which makes it a conservative method for estimating the bearing capacity. The applicant further indicated that the Terzaghi approach addresses a general shear failure, and the Uniform Building Code approach addresses the potential against a rupture of intact bedrock resulting from the foundation loading. The applicant stated that both techniques were applied to account for the variations in bedrock properties.

The staff reviewed the responses to RAI 02.05.04-23 and RAI 02.05.04-33. The staff's review focused on the applied methods for evaluating the bearing capacity, in order to ensure that the approaches are appropriate and adequate to capture bearing capacities associated with possible failure modes for the Fermi 3 site. The staff noted that the bearing capacity evaluations accounted for variations in the depth of bedrock properties by using weighted average properties of the subsurface layers within the foundation zone of influence. Because the average fracture spacing in the bedrock is much smaller than the foundation width based on the RQD for the Fermi 3 site, the staff concurred with the applicant that a general shear failure is a possible failure mode. Therefore, the Terzaghi approach is reasonably applicable. And because the effects of cohesion and the interlocking of bedrock blocks were not taken into account for the evaluation of a general shear failure, the staff found that the result from the Terzaghi approach represents a conservative bearing capacity. As for the Uniform Building Code approach, the staff noted that it encompasses an empirical relationship by using 20 percent of the unconfined compressive strength to estimate the allowable pressure on the bedrock. Finally, after reviewing the Terzaghi and Uniform Building Code approaches and the information in Table 2.5.4-3 of this SER, the staff concluded that the bearing capacities evaluated with both approaches exceed the safety margins when compared to the bearing demands of the ESBWR DCD. Therefore, RAI 02.05.04-23 and RAI 02.05.04-33 are resolved and closed.

The staff asked the applicant in RAI 02.05.04-22 to justify the use of the upper bound Hoek-Brown effective angle of friction and cohesion for the Bass Islands Group bearing capacity but the lower bound values for the Salina Group Unit F bearing capacity. In the response to RAI 02.05.04-22 dated January 11, 2010 (ADAMS Accession No. ML100130382), the applicant compared the average elastic modulus based on pressuremeter testing to the elastic modulus using the Hoek-Brown criterion for Salina Group Unit F, and concluded that the measured elastic modulus was close to the lower elastic modulus based on the Hoek-Brown criterion. However, for the Bass Islands Group, the applicant indicated that the upper bound Hoek-Brown effective angle of friction of 53 degrees matches well with the mean residual friction angle of 52 degrees, which was measured from a direct rock shear test of discontinuities.

In RAI 02.05.04-32, the staff asked the applicant to discuss why a lower value of measured effective friction angle φ'—such as mean φ' minus one standard deviation— was not used to account for the variability of the test and to provide the basis for concluding that using the upper bound Hoek-Brown cohesion is appropriate for the Bass Islands Group in terms of matching well with the measured mean φ'. In the response to RAI 02.05.04-32 dated August 6, 2010 (ADAMS Accession No. ML102210351), the applicant calculated the mean residual friction angle of the Bass Islands Group using the test results for the fractures. The applicant considered the measured values from the direct testing of bedrock discontinuities to be representative of the lower values of strength along fractures. The applicant concluded that the calculated mean residual friction angle is appropriate for establishing the design shear strength parameter, because it represents the friction angle on a fracture after enough displacement has occurred to reach the steady-state resistance along the fracture, making it representative of the lower bound value for a fracture. In addition, the applicant indicated that the disturbance of the fractures during bedrock coring and preparation for testing resulted in reduced measured friction angles, and that further reduction in the measured residual friction angles by one standard deviation is not considered necessary. The applicant conducted the bearing capacity analyses of the RB/FB and CB without considering cohesion, and therefore removed the reference to the cohesion values for the Bass Islands Group and the Salina Group Unit F bedrock.

Furthermore, in RAI 02.05.04-21, the staff asked the applicant to provide information regarding the appropriateness of normal stress values used in the direct shear stress tests and applied to find the φ' for the Bass Islands Group. In the response to RAI 02.05.04-21 dated January 11, 2010 (ADAMS Accession No. ML100130382), the applicant indicated that the applied normal stresses selected for the direct shear test were the estimated in situ vertical stresses at the time of subsurface investigation. The applicant added that the normal stress used falls within the range of confining pressure used to estimate Mohr-Coulomb parameters using the Hoek-Brown criterion.

The staff reviewed the responses to RAI 02.05.04-21, RAI 02.05.04-22, and RAI 02.05.04-32 with the focus on confirming that the Hoek-Brown criterion is properly and conservatively applied to determine the Mohr-Coulomb parameters for bearing capacity evaluations. Based on the review of the responses to RAI 02.05.04-2 and its followup RAI 02.05.04-29, as described in Subsection 2.5.4.4.2 of this SER, the staff concluded that the direct shear test results from samples with horizontal or near horizontal fractures are representative of lower bound strength within the Bass Islands Group. Accordingly, the staff also concluded that the mean residual friction angle of the Bass Islands Group that was calculated from the test results of the fractures is also appropriate and conservative for establishing the friction angle φ' parameter. The staff also noted that the measured friction angle φ' values were not available for the Salina Group Unit F bedrock because samples of representative material could not be collected. The staff further noted that the average measured elastic modulus based on pressuremeter testing is close to the lower elastic modulus based on the Hoek-Brown criterion. Therefore, the staff concluded that it is reasonable to assume the lower bound friction angle φ' from the Hoek-Brown criterion for the Salina Group Unit F bedrock. Regarding the cohesion property, the staff noted that the cohesion is not taken into account for the bearing capacity analyses of the RB/FB and the CB. As a result of the RAIs, the applicant removed the reference to the cohesion values for the bearing capacity evaluation for the Bass Islands Group and Salina Group Unit F bedrock. The staff confirmed that this change was made in the revised FSAR. The staff also reviewed the normal stress values applied to the direct shear stress tests and noted that the applied normal stresses fall within the range of lower and upper bound confining pressures estimated using the Hoek-Brown criterion. Therefore, the staff concluded that the normal stresses used represent the in situ effective vertical stresses and the direct shear test results are dependable. Finally, the staff concluded that the calculated bearing capacities based on these conservatively assumed parameters still provide large safety margins against the bearing demands. RAI 02.05.04-21, RAI 02.05.04-22, and RAI 02.05.04-32 are therefore resolved and closed.

Rebound due to Excavation and Settlement Analyses

The staff reviewed Subsection 2.5.4.10.2 related to the methods and practices used by the applicant to evaluate the excavation rebound and the potential settlement of the foundations. For the settlement analysis, the applicant selected the lower bound E based on the Hoek-Brown criterion for each bedrock unit because the average E of the bedrock units will be greater than the lower bound E from the aforementioned criterion. Therefore, in RAI 02.05.04-24, the staff asked the applicant to provide information on how the modulus values were developed and to provide the basis for the assumption that the average E of the bedrock units will be greater than the lower bound E from the Hoek-Brown criterion. Also, the staff asked the applicant to explain any unconfined compression tests conducted under the safety-related foundations, and to provide additional information on the appropriateness of the selected modulus values in affecting the result of the differential settlement evaluation and total rebound.

In the response to RAI 02.05.04-24 dated January 11, 2010 (ADAMS Accession No. ML100130382), the applicant explained the rationale as to why the average E of the bedrock units is greater than the lower bound E from the Hoek-Brown criterion (1) by providing the ratio of E based on laboratory tests to the E based on the average V_s for the Bass Islands Group and Salina Group Units F, E, C and B; and (2) by comparing the ratios to the lower and upper bound of the Hoek- Brown criterion. The applicant concluded that for Salina Group Units F, E, and C and the Bass Islands Group, the calculated E from average V_s and laboratory tests are both greater than the upper bound E based on the Hoek-Brown criterion. The applicant concluded that the calculated E based on the average V_s falls within the upper and lower bound E based on the Hoek-Brown criterion for Salina Group Unit B, which was also the same for Salina Group Unit F based on the pressuremeter test. FSAR Table 2.5.4-222 presents the unconfined compression test conducted close to or below the safety-related foundations. Table 2.5.4-5 of this SER summarizes the values of the average elastic modulus based on laboratory unconfined compression test results (E_{lab}) and the lower bound elastic modulus based on the Hoek-Brown criterion (E_{HBlow}). The applicant indicated that for bedrock with an RQD greater than 70 percent, E_{lab} is 1.4 to 1.9 times higher than E_{HBlow}. The applicant concluded that as the RQD decreases, the ratio E_{lab} / E_{HBlow} increases. The applicant also performed the settlement analysis using a 3D finite element program capable of calculating settlement caused by non-symmetrical loading induced by adjacent buildings in the power block area. The applicant reaffirmed the appropriateness and conservativeness of the selected modulus values, thus indicating that the site stratigraphy is relatively uniform; the subsurface material properties are consistent; and the obtained lower bound elastic modulus based on the Hoek-Brown criterion is significantly lower than the average elastic modulus obtained based on laboratory and in situ measurements.

Table 2.5.4-5 Average Elastic Modulus and Lower Bounds Elastic Modulus
(Reproduced from Table 1 in the response to RAI 02.05.04-24 dated January 11, 2010 [ADAMS Accession No. ML100130382])

Rock Unit		Average RQD	Average Modulus of Elasticity based on Laboratory Tests (E_{lab})	Lower Bound Elastic Modulus based on Hoek-Brown Criterion ($E_{HB,low}$)	Ratio $E_{lab}/E_{HB,low}$
		%	MPa (ksf)	MPa (ksf)	
Bass Island Group		54	43,025 (898,600)	2,870 (59,900)	15.0
Salina Group	Unit F	13	25,340 (529,200)	924 (19,300)	27.4
	Unit E	72	32,150 (671,500)	16,710 (349,000)	1.9
	Unit C	97	36,540 (763,200)	23,080 (482,100)	1.6
	Unit B	97	72,050 (1,504,800)	52,800 (1,102,700)	1.4
Ksf = kip per square-foot; MPa = megapascal					

The staff's review of the response to RAI 02.05.04-24 focused on the E values of the bedrock units to ensure that these values were realistically but conservatively estimated for settlement evaluation. The staff noted that the applicant had used four different methods to determine the E values of the bedrock units including the stress-strain curve from laboratory unconfined compression tests, the wave equation obtained by solving 3D equations of motion using mean V_s from P-S suspension, an empirical approach using the Hoek-Brown criterion, and the stress-strain curve from the results of in situ pressuremeter testing. Because these methods are commonly applied in evaluations of the rock mass E values, the staff concluded that the methods the applicant had employed to estimate E values are appropriate and adequate. The staff also found that the E values from different methods tend toward conformity as their RQD increases, which indicates that the applied methods are reliable. The staff further noted that among the four different methods, the lower bound E from the Hoek-Brown criterion provides the lowest value, as indicated in Table 2.5.4-6 of this SER. Accordingly, the staff concluded that it is conservative to estimate the settlements using the lower bound elastic modulus obtained based on the Hoek-Brown criterion. In addition, the staff noted that unconfined compression tests were conducted with bedrock samples from ten borings that are located close to or below the safety-related foundations based on the sample depths. Therefore, the staff also agreed with the applicant that the settlement estimates based on the lower bound elastic modulus obtained using the Hoek-Brown criterion represent the upper limit estimates, which meet the acceptance criteria required in the ESBWR DCD. Therefore, RAI 02.05.04-24 is resolved and closed.

The applicant based the settlement calculation on the referenced excavated level (rebounded position). Because the soil under the FWSC to the top of the bedrock will be removed, and noting that the referenced position is important to determine the FWSC settlements, the staff asked the applicant in RAI 02.05.04-25 to provide the rebound values at the excavated level and to clarify the referenced position of the settlement analysis for the FWSC. The staff also asked the applicant to describe the loading and construction procedures and to explain how the rebound at the excavation level is taken into account at the FWSC. In the response to RAI 02.05.04-25 dated January 11, 2010 (ADAMS Accession No. ML100130382), the applicant provided the rebound values for the excavation of the FWSC at the top of the Bass Islands Group and stated that the settlement of the FWSC was not calculated from the rebound position with the excavation level at the top of the bedrock. In a finite element analysis, the applicant simulated the FWSC construction sequence to estimate the settlement and stress changes. The first stage of the sequence was to simulate the excavation, the second stage to simulate the backfill placement, third stage to introduce loads of structures at the foundation level, and the fourth stage to introduce the engineered granular backfill around the FWSC and other structures. The applicant indicated that the settlement associated with the backfill should not be accounted for in the total settlement of the FWSC foundation because, it occurs as the backfill is placed before the construction of the FWSC.

Table 2.5.4-6 Summary of Modulus of Elasticity of Bedrock Units based Test Results, and Hoek-Brown Criterion

(Reproduced from Fermi COL FSAR Table 2.5.4-228)

Rock Unit		Average Modulus of Elasticity based on Laboratory Test	Elastic Modulus of Elasticity based on Average V_s	Elastic Modulus based on Hoek-Brown Criterion			Average Modulus of Elasticity based on Pressuremeter Test
				Upper Bound	Mean	Lower Bound	
Bass Island Group		43,025 (898,600)	26,630 (556,200)	5,240 (109,500)	3,860 (80,700)	2,870 (59,900)	Not measured
Salina Group	Unit F	25,340 (529,200)	6,350 (132,600)	1,520 (31,700)	1,160 (24,200)	924 (19,300)	995 (20,800)
	Unit E	32,150 (671,500)	36,190 (755,800)	23,560 (492,100)	20,310 (424,200)	16,710 (349,000)	Not measured
	Unit C	36,540 (763,200)	48,240 (1,007,600)	29,830 (623,000)	26,780 (559,300)	23,080 (482,100)	
	Unit B	72,050 (1,504,800)	55,390 (1,156,900)	63,430 (1,324,700)	58,820 (1,228,400)	52,800 (1,102,700)	
*All units are in MPa (ksf) Ksf = kip per square-foot; MPa= megapascal							

The staff reviewed the response to RAI 02.05.04-25, including the impact on rebound and settlement calculations for the FWSC from the excavation and the construction sequence. The staff noted that the applicant had applied an appropriate excavation and construction sequence for the FWSC to calculate the rebound at the top of the Bass Islands Group bedrock during the excavation. The staff also noted that the applicant had clarified that the presented total foundation settlement for the FWSC is referenced to the top of concrete backfill and not to the rebound position. Therefore, the staff agreed with the applicant that the settlement of the FWSC foundation is triggered by the loadings of the FWSC structure and the backfill above the foundation level; and the rebound position at the top of the bedrock under the FWSC is not used to estimate the FWSC settlements. Because the applicant had clarified the excavation and construction sequence for the FWSC, the staff concluded that the total settlement analysis of the FWSC is not influenced by the rebound position at the excavation level. Consequently, RAI 02.05.04-25 is resolved and closed.

Lateral Earth Pressures

The staff's review of FSAR Subsection 2.5.4.10.3 focused on the lateral earth pressures calculation. The applicant used a surcharge pressure of 24 kPa (500 psf) to represent the compaction of the backfill behind the rigid retaining wall. In RAI 02.05.04-26, the staff asked the applicant to provide information regarding the basis for adopting a surcharge pressure of 24 kPa (500 psf). In the response to RAI 02.05.04-26 dated January 11, 2010 (ADAMS Accession No. ML100130382), the applicant presented a figure to illustrate the configuration of the increase in the lateral earth pressure associated with compaction and the formula used to evaluate the lateral pressure on the wall due to backfill compaction. The applicant's calculation showed that the lateral earth pressure was approximately 23 kPa (484 psf), assuming a small size vibratory soil compactor. Based on Black and Veatch (2007), the applicant stated that the 24 kPa (500 psf) compacted surcharge was appropriate for the additional compaction surcharges that are developed, thus indicating that the calculated lateral earth pressure of 23 kPa (484 psf) was less than those proposed. The applicant will apply at-rest lateral earth pressure at depths where the at-rest lateral earth pressures are greater than 24 kPa (500 psf).

The staff's review of the response to RAI 02.05.04-26 focused on the lateral earth pressure attributable to a surcharge pressure from compaction of backfill to ensure that the lateral earth pressure associated with compaction is adequately and appropriately taken into account. The staff reviewed the detailed calculation and found that the lateral earth pressure induced by small size compaction equipment was considered in the evaluation of the lateral earth pressure.

<u>NRC Staff's Conclusion Regarding Static Stability</u>

Based on the staff's review of the information in FSAR Subsection 2.5.4.10 and the applicant's responses to RAIs described in Subsection 2.5.4.4.10 of this SER, the staff concluded that the applicant has provided sufficient information in FSAR Subsection 2.5.4.10 which includes a static and dynamic bearing capacity evaluation; total and differential settlement evaluation; and a lateral earth pressure evaluation to meet the standard design values and to satisfy the applicable requirements of 10 CFR Part 50, Appendix S; 10 CFR Part 50, Appendix A, GDC 2; and 10 CFR 100.23.

2.5.4.4.11 Design Criteria

FSAR Subsection 2.5.4.11 refers to ESBWR DCD, Tier 2, Table 2.0-1 for a description of the standard site parameters, such as the allowable static and dynamic bearing capacity, liquefaction potential; angle of internal friction; and maximum settlement values and V_s. The ESBWR DCD latest revision changed significantly from the revision first used by the applicant. Therefore, the staff asked the applicant in RAI 02.05.04-27 to demonstrate that the Fermi 3 site meets the revised ESBWR DCD requirements in terms of the friction angle; bearing capacity analysis; and minimum V_s. In the response to RAI 02.05.04-27 dated February 15, 2010 (ADAMS Accession No. ML100540502), the applicant demonstrated that the in situ material and backfill meet the requirement of the angle of internal friction of more than 35 degrees. The applicant indicated that the residual friction angle along the discontinuities had a mean of 52 degrees, and the estimated friction angle for the Bass Islands Group dolomite bedrock had a mean of 48 degrees. The applicant stated that the well-graded granular backfill will be placed in controlled lifts with compaction, and it will result in a dense to very dense engineered backfill.

In order to meet the criteria stipulated in Note 7 of the ESBWR DCD, Tier 2, Table 2.0-1, the applicant performed the corresponding changes to the values of the dynamic loading conditions to provide the correct data for the comparison between the maximum dynamic bearing demand and the allowable bearing pressure.

To be in accordance with Note 8 of the ESBWR DCD, Tier 2, Table 2.0-1, the applicant demonstrated that the V_s at minus one sigma from the mean were enveloped by the site-related minimum V_s parameter. The applicant performed soil amplification analyses for the RB/FB, CB, and FWSC soil profiles and obtained the response motions at the foundation level. The applicant sorted the iterated V_s into rank order and obtained the 16th, 50th, and 84th percentiles V_s profile at the seismic strain. The applicant stated that the 16th percentiles represent the mean minus one standard deviation and meet the criteria for the minimum V_s parameter as referenced in the ESBWR DCD.

The staff's review of the response to RAI 02.05.04-27 focused on foundation materials to ensure their properties meet the updated requirements from the ESBWR DCD updates to the site parameters. The staff concluded that the applicant had addressed all changes needed according to the latest revision of the ESBWR DCD. Based on the applicant's information, the staff also concluded that the site foundation material properties meet the updated requirements of the ESBWR DCD. As a result of this RAI, the applicant updated the FSAR. The staff confirmed that these updates are reflected in the revised FSAR. Based on the fact that the updated requirements of the ESBWR DCD have been met, RAI 02.05.04-27 is resolved and closed.

The staff reviewed the sections of the FSAR containing the geotechnical design criteria and determined that they contained sufficient details to meet the requirements of 10 CFR Parts 50 and 100. Based on this review, the staff concluded that the applicant's design criteria for the Fermi 3 site are acceptable and meet the requirements of the applicable regulations.

2.5.4.4.12 Techniques to Improve Subsurface Conditions

In FSAR Subsection 2.5.4.12, the applicant stated that any area with open fractures in exposed foundation bedrock of the RB/FB and the CB will be filled with fill concrete. For the FWSC, the applicant stated that all soils will be removed below the foundation to the top of the bedrock and will be replaced with fill concrete to improve subsurface conditions. The staff reviewed this information and concluded that the plan for subsurface improvements will ensure the stability of the foundation and the structures to be built at this site. Therefore, the applicant's improvements satisfy the requirements of 10 CFR 100.23. The staff therefore concluded that the techniques presented to improve subsurface conditions of the Fermi 3 site are acceptable.

2.5.4.5 *Post Combined License Activities*

The applicant identifies the following commitment and ITAAC:

- Commitment (COM 2.5.4-001) – Develop a Contingency Plan for mitigation of any settlement before the start of the Fermi 3 construction.

- ITAAC Table 2.4.1-1 – Site-specific ITAAC for the fill concrete under Seismic Category I structures.

- ITAAC Table 2.4.2-1 – Site-specific ITAAC for the backfill surrounding Seismic Category I structures.

- License Condition 2.5.3-1- Geologic Mapping License Condition (see SER Subsection 2.5.3.5 for details)

2.5.4.6 *Conclusion*

NRC staff reviewed the application and confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the Fermi 3 COL FSAR related to this section.

In addition, the staff compared the additional information in the COL application to the relevant NRC regulations, the guidance in Section 2.5.4 of NUREG–0800, and applicable NRC regulatory guides. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff determined that the applicant has adequately addressed COL Item EF3 COL 2.0-29-A, as it relates to the stability of subsurface materials and foundations.

The staff's review concludes that the applicant has adequately determined the engineering properties of the soil and rock underlying the Fermi 3 site through field and laboratory investigations. The applicant used the latest field and laboratory methods in accordance with the guidance in RGs 1.132, 1.138, and 1.198 to determine the required site-specific engineering properties for the Fermi 3 site and to ensure that those properties meet the design criteria outlined in the ESBWR DCD. Accordingly, the staff concludes that the applicant has performed sufficient field investigations and laboratory testing to determine the overall subsurface profile and the properties of the soil and rock underlying the Fermi 3 site. Specifically, the staff concludes that the applicant has adequately determined (1) the soil and rock dynamic properties through field investigations and laboratory tests; (2) the response of the soils and rocks to dynamic loading; and (3) the liquefaction potential of the soils.

As set forth above, the applicant presented and substantiated the necessary information to establish the geotechnical engineering characteristics of the Fermi 3 site. The staff reviewed the information and concludes that the applicant has performed sufficient investigations at the site to justify the soil and rock characteristics used in the ESBWR design, and the design analyses contain adequate margins of safety for the construction and operation of the nuclear power plant and meet the requirements of 10 CFR Parts 50, 52, and 10 CFR 100.23.

2.5.5 Stability of Slopes

2.5.5.1 *Introduction*

This FSAR section addresses the stability of all earth and rock slopes, both natural and manmade (cuts, fill, embankments, dams, etc.) whose failure, under any of the conditions to which they could be exposed during the life of the plant, could adversely affect the safety of the plant. The topics that the staff evaluated based on the data provided by the applicant in the FSAR and information available from other sources are (1) slope characteristics; (2) design criteria and design analyses; (3) results of the investigations including borings, shafts, pits, trenches, and laboratory tests; (4) properties of borrow material, compaction, and excavation specifications; and (5) any additional information to meet requirements prescribed within the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.5.5.2 *Summary of Application*

Section 2.5.5 of the Fermi 3 COL FSAR addresses the stability of all earth and rock slopes, both natural and manmade. In addition, in FSAR Section 2.5.5, the applicant provides the following:

COL Item

- EF3 COL 2.0-30-A Stability of Slopes

In FSAR Section 2.5.5, as summarized below, the applicant discusses the resolution of COL Item EF3 COL 2.0-30-A by providing site-specific information in accordance with SRP Section 2.5.5.

2.5.5.2.1 Slope Characteristics

FSAR Subsection 2.5.5.1 provides a general discussion of the slope characteristics including the slope materials, properties, groundwater, and seepage. The applicant indicated that in the Fermi 3 site area, there is no evidence of past instability or potentially unstable conditions. The applicant will place backfill in the water channels located west of the Fermi 3 site, and as a consequence, the applicant indicated that no natural or man-made slopes will be in the proximity of the site. The applicant established the grade for the power block area at an elevation of 179.6 m (589.3 ft) NAVD 88. The applicant used a slope of 12.5 horizontal to 1 vertical (12.5:1) and an 8 percent (4.5 degrees) slope angle away from the structures. The applicant concluded that slope stability in the fill will not impact Seismic Category I structures, because the foundations for all Seismic Category I structures are founded on bedrock or fill concrete that extends to the bedrock. The applicant's assumed groundwater level is at an elevation of 178.4 m (585.4 ft) NAV 88, which is equal to the flood level associated with the design basis Probable Maximum Flood (PMF). The applicant's estimated hydraulic conductivity is 76.5 to 541 m/day (251 to 1,776 ft/day). FSAR Subsection 2.5.5.1.1 refers to FSAR Subsection 2.5.4.2 and Section 2.4.12 for a detailed discussion of the subsurface material properties and the groundwater, respectively.

2.5.5.2.2 Design Criteria and Analyses

FSAR Subsection 2.5.5.2 states that the slope angle is 6.5 times less than the minimum required effective angle of internal friction for the engineered backfill or existing fill. The applicant concluded that the finished site grade has no impact on the site safety-related SSCs.

2.5.5.2.3 Boring Logs

FSAR Subsection 2.5.5.3 refers to FSAR Subsection 2.5.4.2 for a discussion of the exploration program and the drilling and sampling procedures. FSAR Appendix 2.5DD includes the soil and rock boring logs in the vicinity of the excavation.

2.5.5.2.4 Compacted Fill

The applicant will follow the backfilling and quality control requirements in the placement and compaction of the fill. The applicant indicated that the source of the fill material will be from the construction excavation or imported from local quarries.

2.5.5.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the stability of slopes, and the associated acceptance criteria, are in Section 2.5.5 of NUREG–0800. The applicable regulatory requirements are as follows:

- 10 CFR Part 50, Appendix A, GDC 2 as it relates to the consideration of the most severe natural phenomena historically reported for the site and surrounding area, with a sufficient margin for the limited accuracy, quantity, and period of time that the historical data were accumulated.

- 10 CFR Part 50, Appendix S, as it applies to the design of nuclear power plant structures, systems, and components important to safety to withstand the effects of earthquakes.

- 10 CFR 100.23 provides the nature of the investigations required to obtain the geologic and seismic data necessary to determine site suitability and to identify geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants.

The related acceptance criteria from Section 2.5.5 of NUREG–0800 are as follows:

- Slope Characteristics: To meet the requirements of 10 CFR Parts 50 and 100, the discussion of slope characteristics is acceptable if the subsection includes (1) cross sections and profiles of the slope in sufficient quantity and detail to represent the slope and foundation conditions; (2) a summary and description of static and dynamic properties of the soils and rocks comprised of seismic Category I embankment dams and their foundations, natural and cut slopes, and all soil or rock slopes whose stability would directly or indirectly affect safety-related and Category I facilities; and (3) a summary and description of groundwater, seepage, and high and low groundwater conditions.

- Design Criteria and Analyses: To meet the requirements of 10 CFR Parts 50 100, the discussion of design criteria and analyses is acceptable if the criteria for the stability and design of all Seismic Category I slopes are described and valid static and dynamic analyses are presented to demonstrate that there is an adequate margin of safety.

- Boring Logs: To meet the requirements of 10 CFR Parts 50 and 100, the applicant should describe the borings and soil tests carried out for slope stability studies and dam and dike analyses.

- Compacted Fill: To meet the requirements of 10 CFR Part 50, the applicant should describe the excavation, backfill, and borrow material planned for any dams, dikes, and embankment slopes.

In addition, the geologic characteristics should be consistent with appropriate sections in RGs 1.27, 1.28, 1.132, 1.138, 1.198, and 1.206.

2.5.5.4 *Technical Evaluation*

NRC staff reviewed Section 2.5.5 of the Fermi 3 COL FSAR related to stability of slopes as follows:

COL Item

- EF3 COL 2.0-30-A Stability of Slopes

This COL item requires the applicant to provide site-specific information in accordance with SRP Section 2.5.5. The NRC staff's evaluation of COL Item EF3 COL 2.0-30-A is presented below.

2.5.5.4.1 Slope Characteristics

FSAR Subsection 2.5.5.1 provides the applicant's general discussion of the slope characteristics including the slope materials, properties, groundwater, and seepage. The applicant noted the existing water channels located west of the Fermi 3 site and plans to backfill them as part of the site development. The applicant therefore stated that there are no natural or manmade slopes, dams, embankments, or channels on or in the proximity of the Fermi 3 site. The applicant also stated that the finished grade for the Fermi 3 site will be relatively flat, with an 8 percent slope angle down from the periphery of the power block fill area without cut slopes. In addition, the applicant stated that slope stability in the fill will not impact Seismic Category I structures because the foundations for all Seismic Category I structures are founded on bedrock or concrete fill that extends to the bedrock. The applicant also discussed the groundwater and seepage conditions at the site.

The staff reviewed the site grade plan and foundation excavation sections as provided in FSAR Section 2.5.4. The staff also examined the site during the site audit (November 3–5, 2009, (ADAMS Accession No. ML14112A212). The staff also reviewed the site boring logs, the site subsurface soil profile, and the hydraulic conductivity properties of the soil to evaluate the seepage condition. The staff's analysis of these inputs is in Section 2.5.4 of this SER.

The staff's review determined that (1) all Seismic Category I structures will be founded on bedrock or fill concrete that extends to the bedrock, so a slope failure will not affect the safety of the structures; and (2) the existing water channels located west of the Fermi 3 site will be backfilled during construction; therefore, the water channels will not affect the safety of the structures. Based on these findings, the staff concluded that no slope failure at the site will adversely affect the safety of the nuclear power plant structures; and the applicant has provided sufficient information in FSAR Subsection 2.5.5.1 to satisfy the applicable criteria of 10 CFR Parts 50 and 100.

2.5.5.4.2 Design Criteria and Analyses

In FSAR Subsection 2.5.5.2, the applicant concluded that the finished site grade has no impact on the site safety-related system structures or components. In RAI 02.05.05.1, the staff asked the applicant to provide information on seismically induced lateral spreading and to discuss the monitoring plans during and after construction to detect occurrences that could affect the facility.

In the response to this RAI dated February 11, 2010 (ADAMS Accession No. ML100570311), the applicant stated that according to Youd et al. (2001), if the site is nonliquefiable, then a lateral spread will not occur. Also, the applicant stated that a liquefiable layer with all SPT $(N_1)_{60}$ values greater than 15 is too dense and dilative for a lateral spread to occur. Therefore, the applicant concluded that because the engineered granular backfill used in the site is not susceptible to liquefaction, lateral spreading will not occur at the Fermi 3 site. The applicant indicated that heave monitoring is not needed, because the expected rebound heave from the foundation excavation is less than 12.7 mm (0.5 in.). The applicant predicted that the settlement will be within the ESBWR DCD limits. To confirm the predictions, the applicant established benchmarks at the corners of selected Seismic Category I structures; at 1 m (3 ft) above the site grade; and connected to the sidewalls. The applicant indicated that the monitoring will continue until 90 percent of the expected settlement has occurred or until the rate of settlement has virtually stopped. The applicant stated that because there is no man-made earth or rock dams on the site and no anticipated seepage, no shallow sloping ground and no lateral spreading concern, the periodic examination of slopes, monitoring evidence for seepage and measurement of locals well and piezometer are not necessary after construction.

The staff's review of the response to RAI 02.05.05-1 focused on the potential for liquefaction-induced lateral spreading and its monitoring plans. The staff noted that all Seismic Category I structures are founded on either bedrock or fill concrete. The staff reviewed the applicant's response to RAI 02.05.04-20, which is documented in Subsection 2.5.4.4.6 of this SER. The staff concluded that the engineered granular backfill surrounding the Seismic Category I structures and used to develop the remainder of the site is not susceptible to liquefaction because of the $(N_1)_{60}$ values. Therefore, the staff concluded that seismically induced lateral spreading is not likely to occur. RAI 02.05.05-1 is therefore resolved and closed.

The staff considered the permanent slopes to be stable because the 8 percent (4.6 degrees) maximum permanent slope angle for the Fermi 3 site in the power block area or elsewhere is 7.6 times less than the minimum required effective angle of internal friction of 35 degrees for the engineered fill or existing fill. Based on this finding, the staff concluded that no slope failure at the site will adversely affect the safety of the nuclear power plant structures. Therefore, no slope stability analysis is necessary for the Fermi 3 site.

2.5.5.4.3 Boring Logs

The applicant provided boring logs in FSAR Appendix 2.5DD. The staff reviewed the applicant's exploration program, and the drilling and sampling procedures that are discussed in FSAR Subsection 2.5.4.2. The staff concluded that the applicant's information satisfies the requirements of 10 CFR Parts 50 and 100.

2.5.5.4.4 Compacted Fill

In FSAR Subsection 2.5.5.4, the applicant indicated that the source of the fill material will be from onsite the construction excavation or imported from local quarries. The staff reviewed FSAR Subsection 2.5.4.5, which describes the specific property requirements, site preparation, fill placement, compaction requirements, and the proper verification and installation of the engineered granular fill. The staff concluded that this information is an acceptable consideration of compacted fill properties and it satisfies the requirements of 10 CFR Part 50.

2.5.5.5 *Post Combined License Activities*

There are no post COL activities related to this section.

2.5.5.6 *Conclusion*

NRC staff reviewed the application and confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional information in the COL application to the relevant NRC regulations, the guidance in Section 2.5.5 of NUREG–0800, and applicable NRC regulatory guides. The staff's review concludes that the applicant has provided sufficient information to satisfy the requirements of NRC regulations. The staff determined that the applicant has adequately addressed COL Item EF3 COL 2.0-30-A, as it relates to the stability of slopes.

The staff's review concludes that the applicant has presented and substantiated information to assess the stability of all earth and rock slopes, both natural and man-made, at the Fermi 3 site. The staff reviewed the site investigations related to slope stability and concludes that (1) there are no natural or man-made slopes that could adversely affect the Fermi 3 Seismic Category I structures; (2) no safety-related retaining walls, bulkheads, or jetties are required for the site; and (3) no man-made earth or rock dams are on the site that could adversely affect the safety of the nuclear plant facilities. The staff further concludes that the applicant has provided sufficient information to meet the requirements of 10 CFR Part 50, Appendix A; GDC 2; 10 CFR Part 50, Appendix S; and 10 CFR 100.23.

3.0 DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS

3.1 Conformance with NRC General Design Criteria

Section 3.1 of the Fermi 3 Combined License (COL) Final Safety Analysis Report (FSAR), Revision 7, incorporates by reference, with no departures or supplements, Section 3.1, "Conformance with NRC General Design Criteria," of Revision 10 of the Economic Simplified Boiling-Water Reactor (ESBWR) Design Control Document (DCD), referenced in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "License, Certification, and Approval for Nuclear Power Plants," Appendix E, "Design Certification Rule for the ESBWR Design." The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section have been resolved.

3.2 Classification of Structures, Components, and Systems

3.2.1 Introduction

Nuclear power plant structures, systems, and components (SSCs) important to safety are designed to withstand the effects of earthquakes without loss of capabilities to perform their safety functions. SSCs important to safety are defined in 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix A, "General Design Criteria for Nuclear Power Plants," as those SSCs that "provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public." These SSCs include safety-related SSCs whose functions ensure: (1) the integrity of the reactor coolant pressure boundary (RCPB); (2) the capability to shut down the reactor and maintain it in a safe shutdown condition; and (3) the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures. These safety-related plant features are designed to sustain the safe shutdown earthquake (SSE). The SSE is based on an evaluation of the maximum earthquake potential for the site and is an earthquake that produces the maximum vibratory ground motion for which SSCs are designed to remain functional. The regulatory treatment of nonsafety systems (RTNSS) process is applied to define seismic requirements for SSCs that are nonsafety-related but perform risk significant functions.

Nuclear power plant SSCs important to safety are designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed. SSCs important to safety are those that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public. Risk-significant nonsafety-related fluid systems that are important to safety are evaluated under the RTNSS process.

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

3.2.2 Summary of Application

Section 3.2 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 3.2 of the ESBWR DCD, Revision 10. Section 3.2 of the DCD includes Subsections 3.2.1, "Seismic Classification," and 3.2.2, "Quality Group Classification."

The system seismic and quality group classifications, discussed in the ESBWR DCD, address the requirement to design nuclear power plant SSCs important to safety to withstand the effects of earthquakes without a loss of capability to perform their safety functions – that means designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed.

This requirement is applicable to both pressure-retaining and non-pressure-retaining SSCs that are part of the RCPB, and to other systems important to safety, when reliance is placed on these systems to (1) prevent or mitigate the consequences of accidents and malfunctions originating within the RCPB, (2) permit a shutdown of the reactor and maintain it in a safe-shutdown condition, and (3) retain radioactive material. Regulatory Guide (RG) 1.29, Revision 4, "Seismic Design Classification," describes an acceptable method of identifying and classifying those plant features that should be designed to withstand the effects of SSEs. RG 1.26, Revision 4, "Quality Group Classification and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," provides the regulatory guidance for designing safety-related SSCs to quality standards. Risk-significant nonsafety-related SSCs that are important to safety are evaluated under the RTNSS process described in FSAR Chapter 19 and reviewed by the staff in Chapter 22, "Regulatory Treatment of Nonsafety Systems," of NUREG-1966, "Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling-Water Reactor."

In addition, Fermi 3 COL FSAR, Section 1.9 includes the following information related to the applicable seismic classification and quality group:

- In FSAR Table 1.9-201, "Conformance with Standard Review Plan" (SRP), the applicant added a line stating that the Fermi 3 application conforms to Revision 2 of the SRP for Section 3.2.1. In this table, the applicant added another line stating that the Fermi 3 application conforms to Revision 2 of the SRP for Section 3.2.2.

- In FSAR Table 1.9-202, "Conformance with Regulatory Guides," the applicant added a line stating that the Fermi 3 application conforms to RG 1.29. This conformance is evaluated in Appendix 17AA, "Quality Assurance Program Description" (QAPD), Part IV. In this table, the applicant added another line stating that the Fermi 3 application conforms to RG 1.26. This conformance is evaluated in Appendix 17AA, QAPD, Part IV.

- In FSAR Table 1.9-203, "Conformance with the FSAR Content Guidance in RG 1.206," the applicant stated that the Fermi 3 application conforms to RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," Regulatory Position C.III.1 Subsection C.I.3.2.1, "Seismic Classification." The applicant also stated that there are no additional safety-related or RTNSS SSCs subject to seismic classification beyond those addressed in the DCD. There are no SSCs outside the referenced certified design that are required to be designed for an OBE. In this table, the applicant also stated that the Fermi 3 application conforms to RG 1.206, Position C.III.1, Subsection C.I.3.2.2, "System Quality Group Classification."

In addition, in Fermi 3 COL FSAR, Revision 7, Section 3.2, the applicant provides the following:

Conceptual Design Information

- STD CDI Classification Summary – RTNSS

  There are no site specific safety related or nonsafety-related RTNSS systems beyond the scope of the DCD.

- STD CDI Classification Summary – Hydrogen Water Chemistry System

  The site-specific plant design includes the HWCS.

- STD CDI Classification Summary – Zinc Injection System

  The site-specific plant design does not include the Zinc Injection System.

3.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1966, the Final Safety Evaluation Report (FSER) related to the certified ESBWR DCD.

In addition, the relevant requirements of Commission regulations for the seismic classification and quality group classification, and the associated acceptance criteria are in Section 3.2.1 and Section 3.2.2 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, (LWR Edition)," the SRP.

The applicable regulatory requirements for the seismic classification of SSCs are as follows:

10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2, "Design bases for protection against natural phenomena," which requires (in part) that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes.

The related acceptance criteria are as follows:

- RG 1.29 establishes an acceptable regulatory basis for meeting GDC 2 relative to seismic classification and classifies SSCs that are to be designed to withstand earthquakes.

- RG 1.206 states that the applicant should identify those SSCs important to safety that are outside the scope of the referenced certified design and that are designed to withstand the effects of earthquakes without loss of capabilities to perform their safety functions. The applicant should designate plant features that are outside the scope of the referenced certified design and that are designed to remain functional in the event of an SSE or a surface deformation as seismic Category I. The applicant should identify portions of SSCs outside the scope of the referenced certified design that are not required to continue to function, but whose failure could reduce the functioning of any seismic Category I plant feature to an unacceptable safety level or could result in a incapacitating injury to control room occupants. The design and construction of these SSCs should ensure that the SSE would not cause such failures. The applicant should also list or otherwise clearly identify all SSCs or portions thereof that are outside the scope of the referenced certified design and are intended to be designed for an Operating Basis Earthquake (OBE).

The applicable regulatory requirements for the quality group classification of SSCs are as follows:

- 10 CFR Part 50, Appendix A, GDC 1, "Quality standard and records," which requires (in part) that SSCs important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be supplemented or modified as necessary to assure a quality product consistent with the required safety function.

The related acceptance criteria are as follows:

- RG 1.26 establishes an acceptable regulatory basis for meeting GDC 1 relative to quality group classification. RG 1.26 also classifies fluid systems and their supports that are important to safety, which are to be designed to quality standards commensurate with their safety function.

- RG 1.206 states that the applicant should identify those fluid systems or portions thereof that are important to safety and outside of the certified design scope, as well as the applicable industry codes and standards for each pressure-retaining component.

3.2.4 Technical Evaluation

As documented in NUREG–1966, NRC staff reviewed and approved Section 3.2 of the ESBWR DCD. The staff reviewed Section 3.2 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the ESBWR DCD and the information in the Fermi 3 COL FSAR, Revision 7, appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the relevant information related to this section.

Section 1.2.3 of this safety evaluation report (SER) provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the design certification (DC) and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the North Anna Unit 3 application were equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna 3 COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes to the Fermi 3 COL FSAR (and other parts of the COL application, as applicable) resulting from

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

requests for additional information (RAIs) and open and confirmatory items identified in the North Anna SER with open items.

- The staff confirms that the applicant has endorsed all responses to the RAIs identified in the corresponding standard content (the North Anna SER) evaluation.

- The staff verified that the site-specific differences were not relevant to this section.

The staff has completed the review and found the evaluation performed for the North Anna Unit 3 standard content to be directly applicable to the Fermi 3 COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting.

The staff reviewed the information in the Fermi 3 COL FSAR, Revision 7, as follows:

<u>*Conceptual Design Information*</u>

- STD CDI Classification Summary

The staff reviewed the additional information related to the seismic classification of safety-related SSCs included under Section 3.2.1 of the Fermi 3 COL FSAR, which states the following:

- There are no site-specific safety-related systems or nonsafety-related RTNSS systems beyond the scope of the DCD.

- The site-specific plant design includes the HWCS.

- The site-specific plant design does not include the Zinc Injection System.

Seismic Classification

The following portion of this technical evaluation section is reproduced from Subsection 3.2.1.4, "Technical Evaluation," of the North Anna Unit 3 SER (Agency wide Documents Access and Management System (ADAMS) Accession No. ML092010530):

<u>Seismic Classification of Site Specific RTNSS SSCs</u>

> *GDC 2 identifies, in part, that SSCs important to safety shall be designed to withstand the effects of earthquakes. FSAR Section 3.2.1 identifies no departures or supplements relative to the seismic classification of SSCs, and the standardization matrix identifies no site specific information that applies to Section 3.2. However, certain potential RTNSS-important SSCs, such as the plant service water system (PSWS) and makeup water system, are identified as site specific and makeup sources for the ultimate heat sink. Also, it is not clear whether there are any nonsafety-related SSCs outside of the DCD scope that may be important to safety.*
>
> *The staff issued RAI 03.02.01-6, which requested the applicant to clarify whether there are any site specific, nonsafety-related SSCs outside of the DCD scope that are important to safety and, if so, to identify the appropriate seismic classification of those SSCs. For example, certain site specific defense in depth RTNSS SSCs, such as the PSWS and the intake structure, may be considered nonsafety-related but may*

be important to safety and should be categorized as designed to withstand the effects of earthquakes. This seismic concern for RTNSS SSCs was also identified during the concurrent ESBWR design certification review. If the applicant decides to resolve this issue in the DCD rather than in the COL for all plant SSCs, including those that are site specific, the staff has asked the applicant to so advise the NRC. The applicant's response to the RAI stated that there are no nonsafety-related SSCs important to safety (RTNSS SSCs) that are outside of the DCD scope. This response also clarified that the seismic classification of RTNSS SSCs is within the DCD scope, and Appendix 19A of the DCD has undergone substantial changes in DCD Revision 5. The staff concurred that the seismic classification of site specific RTNSS SSCs can be evaluated in the DCD. Therefore, this COL concern is closed.

<u>Seismic Classification of Other Site Specific SSCs</u>

Section 1 of the DCD identifies only limited site specific SSCs that are outside the scope of the DCD, and for which the COL applicant is expected to provide site specific information. COL application Table 1.9-203 indicates that there are no safety-related or RTNSS SSCs that are not included in the DCD. It is not clear, however, whether there are any other nonsafety-related SSCs that are considered important to safety but are not included in the DCD that will be addressed in the COL application.

The staff issued RAI 03.02.01-5 which requested the applicant to clarify whether there are any site specific SSCs outside of the DCD scope that are not included in DCD Table 3.2-1 and are to be seismically classified in the COL. For example, site specific structures such as the stack and miscellaneous items such as the reactor vessel insulation, which may or may not be site specific, are not included in the tables. If so, the RAI requested the applicant to identify the appropriate seismic classification of those SSCs or clarify when those SSCs will be classified. The applicant's response to the RAI stated that there are no nonsafety-related SSCs important to safety (RTNSS SSCs) outside of the DCD scope, and there are no site specific SSCs not in the DCD that are to be seismically classified. In regard to the stack (changed to three stacks in DCD Revision 5) and reactor vessel insulation, the applicant clarified that these SSCs are not site specific. Because no site specific SSCs will be classified in the COL, the staff concurred that this COL concern is closed.

<u>Quality Assurance for seismic Category II SSCs</u>

It is not clear in either the DCD or the FSAR how 10 CFR Part 50, Appendix B applies to seismic Category II SSCs, including those that may be site specific. FSAR Table 1.9-202 identifies conformance to RG 1.29. However, seismic Category II SSCs are not designated as QA Requirement B in either the DCD or the COL application. DCD Section 17.3 states that the COL applicant will address the QA Program, but it is not clear how the QA Program will include provisions for seismic Category II SSCs. The staff issued RAI 03.02.01-4, which requested the applicant to clarify the extent to which pertinent QA requirements of Appendix B to 10 CFR Part 50 in Regulatory Position C.4 of RG 1.29 apply to the activities affecting safety-related functions of those portions of SSCs covered under Regulatory Positions 2 and 3 of RG 1.29, including any site specific SSCs. This concern was also cited in an RAI for the ESBWR design certification review, and a special class was *designated for important nonsafety-related SSCs. But SSCs that are designated as a special class are not specified for review at this time. If the applicant decides to resolve this issue in the DCD rather than in the COL for all plant SSCs, including those that are site specific, the staff has asked the applicant to so advise the NRC. The applicant's response to the RAI stated that this issue will be resolved in the DCD, and General Electric-Hitachi (GEH) has included this information in DCD Section 3.2 and in DCD Appendix 19A for all SSCs, including those that are site specific. The staff concurred that this COL can be reviewed in the design certification, and therefore this RAI is closed.*

Consistency with Regulatory Guidance

FSAR Table 1.9-201 points out that the seismic classification conforms to SRP Section 3.2.1, Revision 2, and that SRP Section 3.2.1 references RG 1.29 (currently Revision 4) for seismic classification. SRP Section 3.2.1 identifies that the applicant should provide a list of SSCs that are necessary for continued safe operation that must remain functional without undue risk to the health and safety of the public and within applicable stress, strain, and deformation limits during and following an OBE, if the applicant has set the OBE ground motion to the value of one-third of the safe shutdown earthquake (SSE) ground motion. The list of SSCs may be addressed either in this section or in the operational programs for pre-earthquake planning in COL FSAR Section 3.7.4. Other than the three CDIs noted above, Section 3.2 of FSAR Revision 0 does not identify any departures or supplements relative to the seismic classification in the DCD and the conformance to RG 1.29 Revision 3 in the DCD.

The staff issued RAI 03.02.01-3, which requested the applicant to clarify the extent to which site specific seismic classifications of SSCs are consistent with RG 1.29, Revision 4. The applicant's response to the RAI clarified that the FSAR is incorrect. The classification of site specific SSCs is consistent with the DCD that references RG 1.29 Revision 3, and COL FSAR Table 1.9-202 will be revised accordingly. In addition, the staff has indicated to the applicant that there are no site specific SSCs requiring classification in the COL application or changes to the methodology. Therefore, the staff finds that use of RG 1.29, Revision 3 is acceptable.

However, in order to be consistent with SRP Section 3.2.1, Revision 2, the staff has indicated to the applicant that a list of SSCs necessary for continued operation when subjected to an OBE should be available for review if the applicant has set the OBE ground motion equal to one-third of the SSE ground motion. Since the COL applicant has not deviated from the DCD, which sets the OBE ground motion equal to one-third of the SSE ground motion, the applicant should submit a list of SSCs necessary for continued operation either in this section or in the operational programs for pre-earthquake planning in COL FSAR Section 3.7.4. Therefore, resolution of this issue is pending as Open Item 03.02.01-3.

List of SSCs Necessary for Continued Safe Operation During and Following an OBE

In RAI 03.02.01-7 for the previous R-COL applicant, the staff indicated to Dominion that, in order to be consistent with the requirements and guidance of 10 CFR Part 50, Appendix S, IV(a)(2)(I) and (3), RG 1.166, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Postearthquake Actions," and NUREG-0800, SRP Section 3.2.1, Revision 2, a list of

SSCs necessary for continued operation when subjected to an OBE should be available for review if the applicant has set the OBE ground motion equal to one-third of the SSE ground motion. Dominion's RAI response indicated that there is no deviation from the DCD, which sets the OBE ground motion equal to one-third of the SSE ground motion. The staff requested Dominion to provide the list of SSCs necessary for continued safe operation that must remain functional without undue risk to the health and safety of the public and within applicable stress, strain, and deformation, during and following an OBE.

In a letter dated December 9, 2009 (ADAMS Accession No. ML093490251), Dominion responded to RAI 03.02.01-7 stating that as noted in 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," Section IV(a)(2)(i)(A), if the OBE ground motion is set to one-third or less of the SSE, then the requirements associated with the OBE ground motion in 10 CFR Part 50, Appendix S, Section IV (a)(2)(i)(B)(I) can be satisfied without Dominion performing explicit response or design analyses. Since the ESBWR has set the OBE at one-third of the SSE (as discussed in ESBWR FSAR Tier 2, Section 3.7), no further explicit response is required in accordance with 10 CFR Part 50, Appendix S, Section IV(a)(2)(i)(A). Those SSCs that are designed to withstand an SSE are classified as seismic Category I and are given in ESBWR Tier 2, Table 3.2.2-1, "Classification Summary." This classification is in accordance with SRP Section 3.2.2-1. Based on Dominion's statement that the list is addressed through ESBWR DCD, Tier 2, Table 3.2.2-1 and the staff finding that the table is acceptable, the staff considers RAI 03.02.01-7 resolved.

Detroit Edison adopted Dominion's RAI response. After further examination, the staff finds that Open Item 03.02.01-3 is fully addressed within the scope of the ESBWR DCD as discussed above. Therefore, Open Item 03.02.01-3 is closed.

<u>Important to Safety SSCs</u>

DCD and COL FSAR Section 1 identify certain site-specific SSCs that are outside the scope of the DCD and the COL applicant is expected to provide site-specific information. FSAR Section 3.2 identifies only limited site-specific systems. FSAR Table 1.9-203 states that there are no safety-related or RTNSS SSCs not included in the DCD, but it was not clear if there are any unique plant-specific nonsafety-related SSCs that are considered important to safety and are not addressed in the DCD that are to be evaluated in the FSAR. Therefore, the staff issued RAI 03.02.01-2 requesting the applicant (Detroit Edison [DTE]) to provide additional information regarding site-specific SSCs, specifically, if there are any site specific SSCs that are nonsafety-related but are still considered to be important to safety that are not addressed in the DCD.

In a letter dated September 21, 2010 (ADAMS Accession No. ML102660141), the applicant states the following:

> FSAR Section 3.2 incorporates DCD Table 3.2-1 by reference with two changes. One change is the identification that the site-specific plant design includes the Hydrogen Water Chemistry System (HWCS). DCD Table 3.2-1 includes the classification information for the HWCS; thus, the only detail included in the FSAR is to identify that the HWCS is included in the site-specific plant design. As shown in DCD Table 3.2-1, the HWCS is nonsafety-related and non-seismic. The second change is the identification that the site-specific design does not include the Zinc Injection System.

DCD Appendix 19A demonstrates that the ESBWR design adequately addresses RTNSS issues. DCD Appendix 19A defines the criteria that are applied to the ESBWR design to determine the systems that are candidates for regulatory oversight. Based on the criteria, DCD Appendix 19A, Table 19A-2 identifies the RTNSS functions. DCD Appendix 19A Table 19A-3 identifies the structures housing the RTNSS functions identified in DCD Table 19A-2. There are no site-specific RTNSS functions or structures housing RTNSS functions outside the scope of the DCD. Additionally, there are no site-specific SSCs not in the DCD that are important to safety.

The staff finds that the applicant's response conforms to the guidance in RG 1.206 and the requirements in 10 CFR Part 50, Appendix A, GDC 1, and is therefore acceptable. Accordingly, Fermi 3 site-specific RAI 03.02.01-2 is closed.

The following portion of this technical evaluation section is reproduced from Subsection 3.2.1.4, "Technical Evaluation," of North Anna Unit 3 SER (ADAMS Accession No. ML092010530):

List of RTNSS SSCs

DCD Revision 5, Section 3.2.1 refers to Table 19A-1 for a list of RTNSS SSCs. However, Table 19A-1 in Revision 5 of the DCD has been deleted. It is not clear whether this list includes site specific SSCs. The staff issued RAI 03.02.01-2, which requested the applicant to identify the appropriate reference for the list of site specific RTNSS SSCs. The applicant's response to the RAI agrees that there is an inconsistency and has notified GEH accordingly. The correct reference for risk-significant RTNSS SSCs is in Table 3 of NEDO-33411, which documents the list of risk-significant RTNSS SSCs. NRC staff concurred that this list of RTNSS SSCs can be reviewed in the design certification for site specific SSCs, so this RAI is closed.

RTNSS SSCs Classified as Non-Seismic

DCD Revision 4 Table 3.2-1 identifies various nonsafety-related potential RTNSS SSCs as either Seismic II or non-seismic (NS). It is not clear whether any of these potential RTNSS SSCs are considered site specific. DCD Section 19A.8.3 classifies RTNSS Criterion B-SSCs, as a minimum, seismic Category II, and are qualified to the Institute of Electrical and Electronics Engineers (IEEE)-344-1987. These SSCs must be available following a seismic event. Relative to any site specific RTNSS-important SSCs that are required to withstand the effects of earthquakes and are qualified to the IEEE-344, NRC staff issued RAI 03.02.01-1, which requested the applicant to clarify the basis for the Seismic II or NS classification or identify an appropriate departure. The applicant's response to the RAI stated that there are no site specific, RTNSS-important SSCs beyond those identified in the DCD. Because there are no site specific, RTNSS-important SSCs included in the COL, the staff concurred that this concern can be reviewed in the design certification. Therefore, this RAI is closed.

Consistency with Regulatory Guides

The staff issued RAI 03.02.01-1 requesting the applicant to explain and justify why the seismic classification of site-specific SSCs in FSAR Table 1.9-202 uses Revision 3 of RG 1.29 rather than the current Revision 4. In a letter dated September 21, 2010 (ADAMS Accession No. ML102660141), the applicant states the following:

> ESBWR SSCs, including all site-specific SSCs, for Fermi 3 have been classified in the DCD in accordance with Revision 3 of Regulatory Guides [sic] 1.29 (refer to DCD Table 3.2-1). There are no additional site-specific SSCs beyond those listed in the DCD. Therefore, FSAR Revision 2, Table 1.9-202 takes exceptions to Revision 4 of RGs 1.29. The justification for these exceptions, as stated in FSAR Table 1.9-202, are that the requirements for the seismic classifications for systems and structures are defined by the DCD, which implements Revision 3 of RG 1.29.

In Detroit Edison's response to RAI 17.05-23, submitted in letter NRC3-10-0036, dated September 2, 2010 (ADAMS Accession No. ML102570700), the applicant provides a proposed markup for FSAR Table 1.9-202 to clarify that conformance with Revision 4 of RG 1.29 is limited to site-specific SSCs that are outside the scope of the DCD. The staff finds that the applicant's response conforms to the guidance in RG 1.29 and is therefore acceptable. Accordingly, Fermi 3 site-specific RAI 03.02.01-1 is closed.

Summary

Based on the above evaluation of the applicant's information related to seismic classification, the staff finds that the requirements of GDC 2 are met and the information is consistent with the guidance in RGs 1.29 and 1.206.

Quality Group Classification

The NRC staff's review of Subsection 1.1.1.7 of the Fermi 3 COL FSAR, Revision 7, finds that the applicant has incorporated by reference Subsection 3.2.2 of the ESBWR DCD, Revision 10. The review confirms that the information in the application and the information incorporated by reference address the required information relating to the quality group classification of SSCs.

NRC staff determined that the departures and supplements that include site-specific information related to the hydrogen water chemistry and zinc injection systems do not affect the quality group classifications.

There are no COL information items in Subsection 3.2.2 of the ESBWR DCD. DCD Section 1.10 states that the COL applicant is required to provide site-specific information.

The staff reviewed the COL applicant's information to determine whether the application contains sufficient information on the system quality group classification of site-specific SSCs that are outside of the DCD scope. Several RAIs were prepared to determine whether the scope of the SSCs that are considered site-specific is essentially complete, and whether sufficient information concerning the quality group classification of those SSCs is included in the application. The staff completed the review and found that the evaluation performed for the North Anna standard content is directly applicable to the Fermi COL application.

The following italicized portion of this technical evaluation section is reproduced from Subsection 3.2.2.4, "Technical Evaluation," of the North Anna Unit 3 SER (ADAMS Accession No. ML092010530):

Consistency with Regulatory Guidance

> *FSAR Table 1.9-201 shows that the seismic classification conforms to SRP Section 3.2.2, Revision 2 and that SRP Section 3.2.2 references RG 1.26 (currently Revision 4) for quality group classification. Section 3.2 of the FSAR Revision 0 does not identify any departures or supplements relative to the quality group classification identified in the DCD and compliance with RG 1.26 Revision 3 in the DCD. But FSAR Table 1.9-202 references conformance to Revision 4, dated March 2007. QA Program AR-NA-30 references Revision 4 to RG 1.26 with the DCD exception, but incorrectly references February 1976 rather than March 2007. NRC staff issued RAI 03.02.02-1, which requested the applicant to clarify whether classifications of site specific SSCs are consistent with RG 1.26 Revision 4.*
>
> *The applicant's response to the RAI clarified that the FSAR is incorrect. The classification of site specific SSCs is consistent with the DCD that references RG 1.26 Revision 3. COL FSAR Table 1.9-202 and Appendix 17BB will be revised accordingly. COL applicants should supplement generic DCD information on conformance to RGs to address those that were issued since the time the standard design was approved. There are no site specific SSCs classified in the COL application, so the effective RGs are appropriately referenced in the DCD. Therefore, this is Confirmatory Item 03.02.02-1.*

The staff tracked the verification that the next FSAR revision included this change. The staff verified that FSAR Revision 7 includes the proposed revisions. Therefore, Confirmatory Item 03.02.02-1 is resolved.

Fermi 3 FSAR, Revision 2, Subsection 3.2 did not identify any departures or supplements relative to the quality group classification in the ESBWR DCD, nor did it conform to RG 1.26, Revision 4. However, FSAR Table 1.9-202 identified an exception to Revision 4, dated March 2007, and cited conformance with RG 1.26, Revision 3 instead of Revision 4. In RG 1.206, Regulatory Position C.III.1, Subsection C.I.1.9.1 states that, for site-specific portions of the facility design that are not included in the referenced certified design, a COL applicant should address conformance with RGs in effect 6 months before the submittal date of the COL application. In RAI 03.02.02-1 the staff requested the applicant to explain and justify why the quality group classifications of any site-specific SSCs are based on RG 1.26, Revision 3 rather than the current Revision 4.

In the response to RAI 17.5-23 dated September 2, 2010 (ADAMS Accession No. ML102570700), the applicant states that ESBWR SSCs for Fermi 3, including all site-specific SSCs are classified in the DCD in accordance with Revision 3 of RG 1.26 (with a reference to DCD Table 3.2-1). There are no additional site-specific SSCs beyond those listed in the DCD. Therefore, FSAR Revision 2, Table 1.9-202 takes exceptions to Revision 4 of RG 1.26. The justification for these exceptions, as stated in FSAR Table 1.9-202, are that the requirements for the quality group classifications for systems and structures are defined by the DCD, which implements Revision 3 of RG 1.26. The response to RAI 17.05-23 also, provides a proposed markup for FSAR Table 1.9-202 to clarify that conformance with Revision 4 of RG 1.26 is limited to site specific SSCs that are outside the scope of the DCD. Confirmation that the FSAR has been updated is included in Chapter 17 of this SER.

The staff's review of the changes to the FSAR concludes that the application of the current version of RG 1.26 to any site-specific systems outside the scope of the DCD is consistent with the regulatory guidance and is therefore acceptable.

The following portion of this technical evaluation section is reproduced from Subsection 3.2.2.4, "Technical Evaluation," of the North Anna Unit 3 SER (ADAMS Accession No. ML092010530):

Codes and Standards

> *The NRC staff requirements memorandum (SRM) dated July 21,1993, concerning SECY-93-087, stated that the staff will review passive plant design applications using the newest codes and standards endorsed by the NRC, and unapproved revisions to the codes will be reviewed on a case-by-case basis. Editions of various codes and standards referenced in DCD Section 3.2.6 are not current, and newer codes and standards are not referenced in COL applicant Sections 3.2 or 1.8. The staff issued RAI 03.02.02-2, which requested the applicant to clarify the specific code editions the applicant has referenced that are currently endorsed by the NRC. The applicant was also asked to clarify whether current editions of codes and standards will be applied to the detailed design and procurement of ESBWR SSCs, so that these editions may be reviewed on a case-by-case basis. If the applicant decides to resolve this issue in the DCD rather than in the COL for all plant SSCs, including those that are site specific, the staff has asked the applicant to so advise the NRC.*
>
> *The applicant's response to the RAI stated that DCD Table 1.8-22 identifies industrial codes and standards and adjustments that have been made to these codes and standards. The applicant also indicated that questions regarding versions of codes and standards should be addressed to GEH. COL applicants should supplement generic DCD information on compliance with RGs to address those that have been issued since the time the standard design was approved.*
>
> *Although there are no site specific SSCs that are not classified in the DCD, effective regulatory guidance for site specific SSCs should be identified in the COL application rather than in the DCD, so that the effective RG revision is applied to site specific SSCs, including those added in the future. COL Table 1.9-204 identifies industrial codes and standards applicable to portions of the design that are beyond the scope of the DCD or SSAR, but the editions referenced in this list are different from the earlier editions referenced in Table 1.8-22 of the referenced DCD. In addition, the staff indicated that the applicant should more clearly identify which editions of industrial codes and standards are applicable to specific SSCs and whether those editions have been endorsed by the NRC. This is identified as Open Item 03.02.02-2.*

The Staff Requirements Memorandum (SRM) dated July 21, 1993, concerning SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," notes that the staff will review passive plant design applications using the newest codes and standards endorsed by the NRC and unapproved revisions to the codes will be reviewed on a case-by-case basis. RG 1.206, Regulatory Position CIII, states that COL applicants that referencing a certified design do not need to include additional information on codes and standards. However, if the applicant deviates from the DCD or there are site-specific SSCs, codes and standards would be expected to be identified. Editions of various codes and standards are referenced in FSAR Table 1.9-204, but it is not clear whether the list of codes and standards is a comprehensive list or applies only to site-specific SSCs. For example, the American Society of Mechanical Engineers (ASME) B31.1 Code, "Power Piping," and supplemental standards used for the plant-specific fiberglass pressure pipe; and the applicable editions are not referenced in FSAR Table 1.9-204. In RAI 03.02.02-2, the staff requested the applicant to clarify which editions of codes and standards apply to any site-specific SSCs - such as fiberglass piping - and whether those editions are endorsed by the NRC or need to be reviewed on a case-by-case basis.

The applicant's response to RAI 03.02.02-2 (ADAMS Accession No. ML102660141) states the following:

> The industrial codes and standards which are applicable to the design and procurement of ESBWR SSCs are provided in DCD Revision 7, Table 1.9-22. As described in FSAR Section 1.9.2, under Industrial Codes and Standards:
>
> > Table 1.9-204 identifies the Industrial Codes and Standards that are applicable to those portions of the Fermi 3 design that are beyond the scope of the DCD, and to the operational aspects of the facility.

Therefore, the codes and standards referenced in FSAR Table 1.9-204 apply to the portions of the Fermi 3 design beyond the scope of the DCD and to operational aspects of the facility, and are not a comprehensive list of all codes and standards applicable to Fermi 3.

As described in the supplemental response to RAI 09.02.01-3 submitted in Detroit Edison letter NRC3-10-0029, dated July 9, 2010 (ADAMS Accession No. ML101930518), Detroit Edison has elected not to pursue the use of fiberglass reinforced polyester piping for the Plant Service Water System (PSWS). Alternatively, Detroit Edison has selected carbon steel that meets ASTM standards for underground piping in the PSWS. As described in the response to RAI 09.02.01-3 quality and seismic requirements for the underground piping for the PSWS are dictated by DCD Table 3.2-1. The codes and standards for the underground carbon steel piping are included in DCD Table 1.9-22.

The staff finds that because no nonmetallic piping is used for the PSWS piping, there are no applicable augmented code requirements, and the industrial codes and standards identified in the FSAR are applicable to any site-specific SSCs not included in the DCD. Therefore, all issues related to codes and standards for site-specific systems are resolved and Open Item 03.02.02-2 associated with RAI 03.02.02-2 is closed.

Special Treatment for Risk-Significant SSCs

GDC 1 identifies (in part) that SSCs important to safety shall be designed, fabricated, erected and tested to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function. In RG 1.206, Regulatory Position C.III.1, Subsection C.I.3.2.2 states that the COL applicant will "identify those fluid systems or portions thereof that are important to safety and outside the scope of the certified design, as well as the applicable industry codes and standards for each pressure-retaining component." SRP Section 3.2.2 also specifically states that the staff reviews quality standards including the application of the Quality Assurance (QA) Program and the applicability of codes and standards. Supplemental quality standards and the QA Program applicable to passive SSCs used in nonsafety-related RTNSS that may be important to safety are not clearly defined in Subsection 3.2 of the COL application for site-specific SSCs. In RAI 03.02.02-3, the staff also requested the applicant to clarify in FSAR Section 3.2 or to include a reference to another FSAR chapter that defines which supplemental quality standards are applied to nonsafety-related site-specific SSCs that are important to safety to ensure that all SSCs important to safety are designed, fabricated, erected, and tested to quality standards commensurate with the safety function to be performed. For example, FSAR Subsection 9.2.1.5 states that fiberglass pressure pipe meeting ASME B31.1 and other supplemental standards will be applied, but it is not obvious which supplemental quality standards apply to site-specific SSCs, such as fiberglass piping, in either the DCD Tier 2, Section 3.2 tables or FSAR Section 3.2.

The applicant's response (ADAMS Accession No. ML102660141) states that FSAR Section 3.2 incorporates DCD Tier 2, Table 3.2-1 by reference with two changes. The first change includes the HWCS in the site-specific plant design. DCD Tier 2, Table 3.2-1 includes the classification information for the HWCS; thus, the only detail included in the FSAR is to identify that the HWCS is included in the site-specific plant design. As shown in DCD Table 3.2-1, the HWCS is nonsafety-related and non-seismic. The second change is not including the zinc injection system in the site-specific design. ESBWR DCD Tier 2, Table 3.2-1 specifies the extent to which the quality assurance requirements apply to nonsafety-related SSCs. General Electric-Hitachi (GEH) has included this information in DCD Tier 2, Section 3.2 and in Appendix 19A. These requirements are applied to all SSCs, including those that are site-specific. In addition, FSAR Table 1.9-203 states:

> There are no additional safety-related or RTNSS SSCs subject to seismic classification beyond those addressed in the DCD. There are no SSCs outside the referenced certified design that are required to be designed for an OBE.

There are no site-specific safety-related systems or nonsafety-related RTNSS systems beyond the scope of the DCD. Therefore, there is no need to define supplemental quality standards for site-specific SSCs.

As indicated above, in the supplemental response to RAI 09.02.01-3 (ADAMS Accession No. ML1019305180), Detroit Edison has elected not to pursue the use of fiberglass-reinforced polyester piping for the PSWS. Detroit Edison has selected carbon steel that meets ASTM standards for underground piping in the PSWS. Quality assurance and seismic requirements for the PSWS underground piping are dictated by DCD Tier 2, Table 3.2-1. The codes and standards for the underground carbon steel piping are included in DCD Tier 2, Table 1.9-22.

Because the applicant has revised FSAR Section 3.2 to state that there are no site-specific SSCs important to safety beyond the scope of the DCD and has elected not to use nonmetallic materials in the PSWS (a RTNSS Criterion C function) all issues associated with the special treatment for risk-significant site-specific systems are resolved. Therefore, RAI 03.02.02-3 is closed.

Summary

Based on the above evaluation of the applicant's information related to quality group classification, the staff finds that the requirements of GDC 1 are met and the information is consistent with the guidance in RG 1.26 and RG 1.206.

3.2.5 Post Combined License Activities

There are no post COL activities related to this section.

3.2.6 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

In addition, the staff compared the additional COL information in the application to the relevant NRC regulations, the guidance in Sections 3.2.1 and 3.2.2 of NUREG–0800, and the applicable RGs. The staff's review concludes that the applicant has adequately addressed the seismic and quality group classifications. The staff notes that these classifications meet the requirements of GDC 1 and GDC 2 and the guidance of RG 1.26, RG 1.29, and RG 1.206. Therefore the staff also finds that Fermi 3 COL FSAR, Revision 7, Subsections 3.2.1 and 3.2.2 are acceptable because they meet NRC regulatory requirements and acceptance criteria in Sections 3.2.1 and 3.2.2 of NUREG-0800.

3.3 Wind and Tornado Loadings

Section 3.3 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference, with no departures or supplements, Section 3.3, "Wind and Tornado Loadings," of Revision 10 of the ESBWR DCD. NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the wind and tornado loadings have been resolved.

[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

3.4 Water Level (Flood) Design

Section 3.4 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference, with no departures or supplements, Section 3.4, "Water Level (Flood) Design," of Revision 10 of the ESBWR DCD. NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the water level from floods have been resolved.

3.5 Missile Protection

3.5.1 Introduction

SSCs important to safety are analyzed for and designed to be protected from a wide spectrum of missiles, such as internally generated missiles from rotating equipment, high energy fluid systems, and gravitational missiles; externally generated missiles from tornado winds and extreme winds; and missiles from proximate site sources and aircraft hazards.

Methods of protection must be provided for all SSCs that are necessary to perform functions required to attain and maintain a safe shutdown or to otherwise mitigate the consequences of an accident. These methods may consist of (1) locating the system or component in a missile-proof structure, (2) isolating redundant systems or components in the missile's path or range, (3) providing local shields and barriers for SSCs, or (4) designing the equipment to withstand the impact of the most damaging missile.

The specific reactor site location determines the potential for missile hazards from nearby industrial sources and the hazards from aircraft operating in the region.

3.5.2 Summary of Application

Section 3.5 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 3.5 of the ESBWR DCD, Revision 10. In addition, in FSAR Sections 3.5, the applicant provides the following:

Supplemental Information

- STD SUP 3.5-1 Site-Specific Missile Sources

In FSAR Subsection 3.5.1.5, the applicant states the following:

> Site-specific missile sources are addressed in Section 2.2..

- STD SUP 3.5-2 Site-Specific Aircraft Analysis and the Site-Specific Critical Areas

In FSAR Subsection 3.5.1.6, the applicant states the following:

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Site-specific aircraft hazard analysis and the site-specific critical areas are addressed in Section 2.2.

3.5.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1966. In addition, the relevant guidance for compliance with the Commission regulations for missile protection, and the associated acceptance criteria, are in NUREG–0800, Subsection 3.5.1.3 for the turbine missile; Subsection 3.5.1.5 for the nearby site-generated missiles; and Subsection 3.5.1.6 for the aircraft hazards.

The applicable regulatory requirements for all missile protections are in:

10 CFR Part 50, Appendix A, GDC 4, "Environmental and dynamic effects design bases."

3.5.4 Technical Evaluation

As documented in NUREG–1966, NRC staff reviewed and approved Section 3.5 of the ESBWR DCD. The staff reviewed Section 3.5 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the ESBWR DCD and the information in the Fermi 3 COL FSAR, Revision 7, appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the relevant information related to this section.

The staff reviewed the information in the Fermi 3 COL FSAR, Revision 7, as follows:

Supplemental Information

- STD SUP 3.5-1 Site Specific Missile Sources (Site Proximity Missiles)

NRC staff reviewed STD SUP 3.5-1, which states that the site-specific missile sources are in Section 2.2 of the Fermi 3 FSAR.

The staff's technical evaluation of this portion of the application is limited to reviewing the supplemental information pertaining to STD SUP 3.5-1.

The staff reviewed the conformance of Section 3.5 of the Fermi 3 COL FSAR to the guidance in RG 1.206, Regulatory Position C.III.1, Subsection C.I.3.5.1.3, "Turbine Missiles". The staff finds that the FSAR appropriately incorporates by reference Subsection 3.5.1.1.1.2 of the ESBWR DCD, Tier 2, Revision 10.

The staff requested in RAI 03.05.01.05-1 that the applicant provide an assessment of the potential for the turbine missile generation from the existing Fermi 2 that may affect the safe operation of the proposed Fermi 3. The applicant's response to this RAI in a letter dated on January 27, 2010 (ADAMS Accession No. ML100290010) stated that based on strike angles

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

from the Fermi 2 site layout and beginning at the southeast corner of the Fermi 2 turbine building, there are no Fermi 3 essential systems within the strike zone. Therefore, the applicant concluded that because of the turbine orientation and offsets between the Fermi 2 turbine building to Fermi 3 targets, turbine missiles from Fermi 2 would not affect the safe operation of Fermi 3. The staff accepted the applicant's explanation as reasonable and concluded that the information in the FSAR and in the RAI response meets the requirements of GDC 4 and the guidance in Subsection 3.5.1.5 of NUREG-0800.

Based on the above, the staff concludes that the relevant information in the COL FSAR is acceptable and meets the requirements of GDC 4 of Appendix A to 10 CFR Part 50. The staff based this conclusion on the following:

STD SUP 3.5-1, "Site Proximity Missiles," is acceptable because the applicant has identified potential accidents related to the generation of site proximity missiles (except aircraft) in the site vicinity that could affect a nuclear power plant or plants of the specified type that might be constructed on the proposed site. The applicant has appropriately determined those potential accidents that should be considered as design-basis events and has demonstrated that the plant is adequately protected and can be operated with an acceptable degree of safety with regard to the design-basis accidents. The staff reviewed the information in the FSAR. For the reasons stated above, the staff concluded that the applicant has established that the construction and operation of Fermi 3 of the specified type on the proposed site location is acceptable and meets the requirements of 10 CFR 52.79(a)(1)(iv) and 10 CFR 52.79(a)(1)(vi) for compliance with respect to determining the acceptability of the site.

- STD SUP 3.5-2 Site-Specific Aircraft Analysis (Aircraft Hazards)

NRC staff reviewed STD SUP 3.5-2 which states that the site-specific aircraft analysis and site-specific critical areas are addressed in Section 2.2 of the Fermi 3 FSAR.

The staff's technical evaluation of this portion of the application is limited to reviewing the supplemental information pertaining to STD SUP 3.5-2.

The applicant performed the aircraft hazards evaluation in Fermi 3 FSAR, Subsection 2.2.3.1.3.1. The applicant addressed and evaluated potential aircraft hazards following the approach and methodology outlined in NUREG-0800, Subsection 3.5.1.6. The applicant simulated an aircraft crash into the effective plant areas of the safety-related structures on the site. The applicant determined the probability of aircraft accidents resulting in radiological consequences greater than the 10 CFR Part 100 exposure guidelines to be 2.3×10^{-7} per year from Mills Field Airport or Detroit Metropolitan Wayne County Airport.

The applicant addressed the evaluated airways in Fermi 3 FSAR, Subsection 2.2.3.1.3.2, and calculated the aircraft hazards probability for Airways V383 and V10-176-188. However, the applicant did not provide enough information with regard to the effective area used in the probability calculation. Therefore, the staff requested in RAI 03.05.01.06-1 that the applicant provide data, assumptions, annual flight operations and the effective area used in the calculation of the aircraft hazards probabilities. The applicant responded to this RAI in a letter dated January 27, 2010 (ADAMS Accession No. ML100290010) and provided information and revisions to the FSAR sections. The staff reviewed the applicant's information and performed confirmative probability calculations using annual average flight operations data from 2004 - 2009 within 8 kilometers (km) (5 miles) of the Fermi site obtained from the Federal Aviation Administration. Based on the review of the applicant's response and the confirmatory calculations, the staff concludes that the applicant's approach is reasonable and the conclusion is acceptable because the aircraft hazards probability is within the acceptable criterion of the magnitude on the order of 1 x 10^{-7} per year.

STD SUP 3.5-2, "Aircraft Hazards," is acceptable because the applicant has identified potential accidents related to the aircraft hazards in the site vicinity that could affect a nuclear power plant or plants of the specified type that might be constructed on the proposed site. The applicant has appropriately determined those potential accidents that should be considered as design-basis events and has demonstrated that the plant is adequately protected and can be operated with an acceptable degree of safety with regard to the design-basis accidents. The staff reviewed the information in the FSAR.

For the reasons stated above, the staff concludes that the applicant has established that the construction and operation of Fermi 3 on the proposed site location is acceptable and meets the requirements of 10 CFR 52.79(a)(1)(iv) and 10 CFR 52.79(a)(1)(vi) for compliance with respect to determining the acceptability of the site. Accordingly, RAI 03.05.01.05-1 and 03.05.01.06-1 are closed.

3.5.5 Post Combined License Activities

There are no post COL activities related to this section.

3.5.6 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

In addition, the staff compared the COL information in the application to the relevant NRC regulations, the guidance in Section 3.5 of NUREG–0800, and other NRC RGs. The staff's review concludes that the applicant has provided adequate information to satisfy the NRC requirements of GDC 4. Therefore, the staff finds that the relevant information in Section 3.5 of the Fermi 3 COL FSAR, Revision 7, is acceptable and meets the regulatory guidance in Sections 3.5 of NUREG-0800.

3.6 Protection against Dynamic Effects Associated with the Postulated Rupture of Piping

Section 3.6 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference, with no departures or supplements, Section 3.6, "Protection against Dynamic Effects Associated with the Postulated Rupture of Piping," of Revision 10 of the ESBWR DCD. The staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. In Appendix 14.3A, "Design Acceptance

[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Criteria (DAC) ITAAC Closure Process," the applicant proposes two commitments, COM 3.10-003 and COM 14.3-001 regarding schedule for piping (including the pipe break analysis report) DAC ITAAC closure. In Section 14.3.4 and 14.3.5 of this safety evaluation, the staff reviewed these two commitments and finds them to be acceptable. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the protection against dynamic effects associated with the postulated rupture of piping have been resolved.

3.7 Seismic Design

Safety-related systems, structures, and components (SSCs) are designed to withstand safe-shutdown earthquake (SSE) loads and other dynamic loads, including those due to reactor building vibration (RBV) caused by suppression pool dynamics. This section addresses seismic aspects of the design and analysis in accordance with RG 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)."

3.7.1 Seismic Design Parameters

Seismic Category I SSCs are designed to withstand the effects of the SSE event and to maintain the specified design functions. Seismic Category II and nonseismic (NS) structures are designed or physically arranged (or both) so that the SSE could not cause unacceptable structural interactions with or the failure of seismic Category I SSCs. The ESBWR standard plant SSE design ground motion is addressed in Section 3.7 of ESBWR DCD, Tier 2, Revision 10. The horizontal and vertical SSE design ground response spectra (for 5 percent damping), also termed certified seismic design response spectra (CSDRS) for the ESBWR design were developed based on enveloping RG 1.60, Revision 1, "Design Response Spectra for Seismic Design of Nuclear Power Plants," response spectra anchored to 0.3 g peak ground acceleration (PGA) and the high-frequency hard rock spectra anchored to 0.5g PGA. These spectra are shown in ESBWR DCD, Tier 2, Revision 10, Chapter 2.0, Figures 2.0-1 and 2.0-2 for horizontal and vertical directions, respectively. The CSDRS have been applied as the input ground motion at the building foundation level for the seismic design of the Category I structures included in the design document. For the reactor and fuel building (RB/FB) and the control building (CB), the input motion is the same as that shown in Figures 2.0-1 and 2.0-2. The input motion for the firewater service complex (FWSC) is 1.35 times the values shown in DCD Tier 2, Figures 2.0-1 and 2.0-2. The applicant has provided the seismic design parameters for the Fermi 3 site in this FSAR section, as documented below.

3.7.1.1 *Introduction*

This FSAR section addresses the design earthquake ground motion used for the seismic analysis and design of the Category I structures. The design earthquake ground motion is based on the seismic and geologic characteristics at the site and is established in terms of a set of idealized and smooth curves called the design response spectra. At the Fermi 3 site, the specific seismic design parameters include the design ground motion in terms of the foundation input response spectra (FIRS), design ground motion time histories, percentage of critical damping values, and the characteristics of the supporting media for Category I structures.

3.7.1.2 *Summary of Application*

Section 3.7.1 of the Fermi 3 COL FSAR, Revision 7 incorporates by reference Section 3.7.1 of the ESBWR DCD, Revision 10. In addition, in FSAR Section 3.7.1, the applicant provides the following:

<u>*Supplemental Information*</u>

- EF3 SUP 3.7-1 Site-Specific Design Ground Motion Response Spectra

In FSAR Section 3.7.1, the applicant provides the following:

1) The development of a comprehensive set of site-specific seismic inputs for the Fermi 3 site-specific soil-structure interaction (SSI) analyses of the RB/FB and the CB structures. Site-specific seismic inputs consist of performance-based surface response spectra (PBSRS), FIRS, site-specific ground motion time histories, and subsurface material profiles with corresponding dynamic properties used in the site-specific SSI analyses. The analyses also include the development of the FIRS for the FWSC structure.

2) The development of the damping ratios for the subsurface material profiles used in the site-specific SSI analyses of the RB/FB and the CB in FSAR Subsection 3.7.1.1.4.

3) The development of the dynamic properties of the subsurface material profiles used in the site-specific SSI analyses of the RB/FB and the CB in FSAR Subsection 3.7.1.1.4.

3.7.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1966. In addition, the relevant requirements of the Commission regulations for the seismic design, and the associated acceptance criteria, are in Section 3.7.1 of NUREG–0800. The specific requirements include the following:

- 10 CFR Part 50, Appendix A, GDC 2, as it relates to the seismic design basis to reflect the appropriate consideration of the most severe earthquakes historically reported for the site and surrounding area with a sufficient margin for the limited accuracy, quantity, and period of time in which historical data have been accumulated; and SSCs important to safety be designed to withstand the effects of earthquakes without a loss of capability to perform their intended safety functions.

- 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," as it relates to the SSE ground motion in the free-field at the foundation level of the structures to be an appropriate response spectrum with a peak ground acceleration of at least 0.1g; and if the OBE is chosen to be less than or equal to one-third of the SSE ground motion, it will not be necessary to conduct explicit response or design analyses in accordance with Section IV.(2)(i)(A) of 10 CFR Part 50, Appendix S.

In addition, the acceptance criteria and regulatory guidance associated with the review of FSAR Section 3.7.1 include the following:

- SRP Section 3.7.1 for reviewing seismic design parameters to ensure that they are appropriate and contain a sufficient margin so that seismic analyses (reviewed under other SRP sections) accurately and/or conservatively represent the behavior of SSCs during postulated seismic events.

- RG 1.60, Revision 1, "Design Response Spectra for Seismic Design of Nuclear Power Plants," to determine the acceptability of design response spectra for input into the seismic analysis of nuclear power plants.

- RG 1.61, Revision 1, "Damping Values for Seismic Design of Nuclear Power Plants," to determine the acceptability of damping values used in the dynamic seismic analyses of seismic Category I SSCs.

- Design certification/COL–Interim Staff Guidance (DC/COL-ISG)-017, "Interim Staff Guidance on Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analysis."

- NUREG/CR–6728, "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard- and Risk-Consistent Ground Motion Spectra Guidelines," to determine the acceptability of the site-specific FIRS used in the site-specific seismic analysis.

3.7.1.4 *Technical Evaluation*

As documented in NUREG–1966, NRC staff reviewed and approved Section 3.7.1 of the ESBWR DCD. The staff reviewed Section 3.7.1 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the required information relating to this section.

The staff reviewed the following information in the Fermi 3 COL FSAR, Revision 7:

Supplemental Information

- EF3 SUP 3.7-1 Site-Specific Design Ground Motion Response Spectra

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Design Ground Motion

FSAR Figures 3.7.1-228, 3.7.1-229, and 3.7.1-238 show that the FIRS developed in FSAR Subsection 3.7.1.1.4 are enveloped by the ESBWR CSDRS in both horizontal and vertical directions for the RB/FB, CB, and FWSC. In addition, the Fermi 3 site-specific SSI analyses for the RB/FB and the CB were performed to address the following two Fermi 3 site-specific conditions:

- To confirm that the DCD standard plant design is applicable to the Fermi 3 site-specific conditions, where the RB/FB and the CB structures are partially embedded in the Bass Islands Group rock, with the engineered granular backfill surrounding the structures from the top of the rock to the grade level of the plant.

- To demonstrate that the standard plant design is applicable to the Fermi 3 site-specific conditions, even though the DCD requirements for the engineered granular backfill that surrounds the seismic Category I structures are not being met for the RB/FB and the CB structures. Specifically, the requirements in DCD Tier 2, Table 2.0-1 state that the minimum shear wave velocity of the material surrounding the embedded walls of these structures should be greater than 300 meters per second (m/s) (1000 feet [ft]/s).

FSAR Subsection 3.7.1.1 indicates that the FWSC is a surface-founded structure according to DCD Tier 2, Subsection 3.7.1.1, and there are no embedded walls for the FWSC. Therefore, the DCD requirements for the backfill surrounding seismic Category I structures are not applicable to the FWSC. As discussed in FSAR Section 2.5.4, the FWSC is founded on fill concrete that meets the DCD Tier 2, Table 2.0-1 requirements underneath seismic Category I structures. Therefore, no site-specific SSI analysis is performed for the FWSC. The staff's review of this issue is in Subsection 3.7.2.4 of this SER, where the staff concludes that no site-specific SSI analysis is needed for the FWSC.

The applicant developed seismic inputs for the site-specific SSI analysis to be consistent with the procedure described in DC/COL-ISG-017. The RB/FB and the CB design ground motions for the site-specific SSI analyses were based on the outcrop FIRS developed in FSAR Subsection 3.7.1.1.4 as the soil column outcrop response (SCOR). The SCOR was further enhanced to ensure that the PBSRS is enveloped at the ground surface. The SSE for Fermi 3 was then designated as the lower of the two enhanced SCOR FIRS for the RB/FB and the CB. The SSE is defined at the foundation level to be consistent with the definition used in the DCD. The applicant also stated that the OBE is one-third of the SSE

The staff found the applicant's specification of the SSE acceptable because it is defined as the lower of the two enhanced SCOR FIRS at the foundation level, which is consistent with the definition in the DCD. The staff's evaluation of the SCOR FIRS and the enhanced SCOR FIRS for the RB/FB and the CB, as well as the FIRS for the FWSC, is provided below under "Fermi 3 Site-Specific Ground Motions." The staff's evaluation of the site-specific RB/FB and CB SSI analysis is in Subsection 3.7.2.4 of this SER.

Fermi 3 Site-Specific Ground Motions

Development of Horizontal RB/FB SCOR FIRS, CB SCOR FIRS, and PBSRS

In the Fermi 3 site-specific SSI analyses in FSAR Section 3.7.2, the RB/FB and the CB are modeled as partially embedded structures within the Bass Islands Group rock. The site-specific SSI analyses did not consider the effect of the engineered granular backfill on the RB/FB and the CB. To confirm that the engineered granular backfill does not adversely impact seismic Category I structures, the applicant performed additional site-specific SSI analyses that included the engineered granular backfill above the top of the Bass Islands Group bedrock.

The applicant used the Nuclear Energy Institute (NEI) method described in Section 5.2.1 of DC/COL-ISG-017 to develop SCOR FIRS at the RB/FB and the CB foundation levels, as well as the PBSRS at the finished grade level. The SCOR FIRS were enhanced using the procedure described in Section 5.2.1 of DC/COL-ISG-017 to ensure hazard-consistent seismic inputs for the site-specific SSI analyses when compared to the PBSRS at the finished grade level. The staff found the applicant's process of developing the SCOR FIRS and enhanced SCOR FIRS acceptable, because the method and procedure used are consistent with the guidance in DC/COL-ISG-017.

The applicant developed three base case site response profiles to reflect the range in granular backfill material properties that may be used. These base case profiles are referred to as the lower-range (LR), intermediate range (IR), and upper-range (UR) profiles, and their properties are defined in FSAR Tables 3.7.1-201, 3.7.1-202, and 3.7.1-203, respectively (the staff notes that the LR, IR, and UR profiles are identical below the backfill in the rock portion, which is assumed to be linear). In addition, the applicant randomized the dynamic properties of the three base case profiles (i.e., shear-wave velocity and shear modulus reduction and damping) using the method described in FSAR Subsection 2.5.2.5.1.3. To develop the SCOR FIRS and PBSRS, the applicant used the same process that was used to develop its ground motion response spectrum (GMRS) in FSAR Subsections 2.5.2.5.3 and 2.5.2.6. According to the logic tree shown in FSAR Figure 3.7.1-210, the applicant assigned relative weights of 0.35, 0.50, and 0.15 to the respective UR, IR, and LR base case profiles in the development of the final amplification functions.

In RAI 02.05.02-20 and RAI 02.05.02-21, the staff requested the applicant to provide information related to the properties of the proposed engineered granular backfill—including a justification for the weighting factors developed for the LR, IR, and UR base case profiles. Based on the information in the response to both RAIs (ADAMS Accession Nos. ML13043A012 and ML13226A030, respectively), the staff performed a confirmatory site response analysis for the three individual base case profiles (LR, IR, and UR) without assigning any weighting factors.

The staff's analysis indicates that the envelope of the FIRS developed with the staff's confirmatory analysis and obtained from the three base cases without consideration of any weighting factors, is bounded by the enhanced SCOR FIRS used by the applicant in the site-specific SSI analysis. Furthermore, a comparison with the DCD CSDRS shows that significant margin exists between the CSDRS and the site-specific enhanced SCOR FIRS for both the RB/FB and the CB, as shown in the FSAR Figures 3.7.1-228 and 3.7.1-229. In addition, the envelope of the PBSRS obtained from the staff's site response analysis using the three backfill base cases, without consideration of any weighting factors, is bounded by the surface envelope of the response spectra computed from the SSI deterministic input and based on the three deterministic profiles used in the site-specific SSI analysis.

Based on the confirmatory analysis, the staff concludes that the PBSRS and the enhanced SCOR FIRS used by the applicant to develop the seismic input for the site-specific SSI analysis of the RB/FB and the CB are adequate for the Fermi 3 site.

Basis of the Assumption of One-Dimensional Versus Two-Dimensional Backfill Material Surrounding the Power Block

FSAR Figure 2.5.4-201 shows that the backfill material surrounding the power block structures extends to a perimeter diaphragm wall that is used to support the excavation of in situ material. Beyond the diaphragm wall, it appears that in situ soils will remain in place. Because the use of backfill material is limited in the lateral extent, the staff requested the applicant in RAI 03.07.01-5 to explain why it is appropriate to establish the PBSRS and FIRS for the RB/FB and the CB on the basis of a one-dimensional (1-D) site response analysis using a column of backfill/rock material.

In the response to RAI 03.07.01-5 (ADAMS Accession No. ML12086A091), the applicant demonstrated the appropriateness of defining the PBSRS and FIRS for the RB/FB and the CB on the basis of the 1-D column of backfill/rock material, by comparing the amplification functions obtained from the soil profiles inside and outside of the diaphragm wall support. Figures 5 through 7 of the response to RAI 03.07.01-5 provide the comparisons of the amplification functions for inside and outside of the diaphragm wall. The staff's review of these comparisons concludes that a 1-D representation of the backfill material is acceptable for establishing the PBSRS and FIRS for the RB/FB and the CB, because the shear wave velocity profiles for the conditions inside and outside of the perimeter diaphragm wall produce comparable SCOR amplification functions at the RB/FB and the CB foundation levels.

Meeting the Minimum Requirement of 10 CFR Part 50 Appendix S

10 CFR Part 50, Appendix S, requires that the horizontal component of the SSE ground motion in the free-field at the foundation levels of structures must be an appropriate response spectrum with a PGA of at least 0.1g. Therefore, in RAI 03.07.01-8, the staff requested the applicant to provide in the FSAR comparison plots of the RB/FB and the CB horizontal FIRS with the RG 1.60 horizontal spectrum anchored at 0.1g, which demonstrate that the RB/FB and the CB horizontal FIRS envelop the RG 1.60 spectrum anchored at 0.1g at all frequencies of interest.

FSAR Figures 3.7.1-226 and 3.7.1-227 provide the requested comparison plots of the RB/FB and the CB horizontal SCOR FIRS with the RG 1.60 horizontal spectrum anchored at 0.1g, respectively. The plots show that, the SCOR FIRS obtained from the site-response analysis for the RB/FB and the CB do not envelop the RG 1.60 shape scaled to a PGA of 0.1g in the frequency range of about 0.2 to 3 Hertz (Hz). To meet the requirements of the minimum horizontal ground motions specified in 10 CFR Part 50, Appendix S, the applicant modified the SCOR FIRS to ensure that these envelop the RG 1.60 spectrum scaled to a PGA of 0.1g. In addition, the applicant used the guidance specified in DC/COL-ISG-017 for ensuring performance-based seismic inputs for the site-specific SSI analysis. The staff notes that the initially enhanced FIRS as discussed above were further enhanced using the procedure described in Section 5.2.1 of DC/COL-ISG-017, thus ensuring performance-based seismic inputs for the site-specific SSI analyses when compared to the PBSRS at the finished grade level, as discussed above under "*Development of Horizontal RB/FB SCOR FIRS, CB SCOR FIRS, and PBSRS*."

The staff verified that the modified SCOR FIRS designated as “initially enhanced” FIRS in the FSAR enveloped the RG 1.60 spectrum scaled to a PGA of 0.1g as shown in FSAR Figures 3.7.1-226 and 3.7.1-227. The staff also verified that the final enhancements to the SCOR FIRS designated as the “enhanced SCOR FIRS” in the FSAR as shown in FSAR Figures 3.7.1-228 and 3.7.1-229 are developed using the guidance in DC/COL-ISG-017 and are bounded by the ESBWR CSDRS. On the above basis, the staff concludes that the site-specific enhanced SCOR FIRS meet the minimum requirement of 10 CFR Part 50, Appendix S and represent a performance-based seismic input acceptable for the site-specific SSI analysis

Development of Horizontal FWSC FIRS

According to FSAR Subsection 3.7.1.1.4.1, the FWSC is founded on 9.15 m (30 ft) of fill concrete, which overlies the Bass Islands Group rock. The FSAR states that because the FWSC is essentially a surface-founded structure, the FIRS for the FWSC was developed as a truncated soil column response (TSCR) in accordance with the NEI method described in DC/COL-ISG-017. FSAR Table 3.7.1-204 provides the site response analysis profile for both the fill concrete and the rock beneath the fill concrete used in the development of the FWSC FIRS. In addition, the applicant randomized the dynamic properties of the FWSC profile (i.e., shear-wave velocity and shear modulus reduction and damping) using the method described in FSAR Subsection 2.5.2.5.1.3. The applicant used a process similar to the process for developing the GMRS in FSAR Subsections 2.5.2.5.3 and 2.5.2.6 to compute the FWSC amplification functions and the FIRS.

The staff found the applicant’s method for developing the FWSC FIRS acceptable, because the method is in accordance with the NEI method described in DC/COL-ISG017. In addition, the staff also performed a confirmatory analysis using the static and dynamic material properties in FSAR Subsection 3.7.1.1.4.1.1. To represent the input rock motions, the staff used the high- and low-frequency rock spectra associated with 10^{-4} exceedance probability, as well as the high- and low-frequency rock spectra associated with 10^{-5} exceedance probability. The staff’s analysis confirms acceptability of the FIRS computed by the applicant because the results of the staff’s analysis are comparable with that of the applicant’s analysis used to establish the FIRS.

The FWSC FIRS is shown in FSAR Figure 3.7.1-238 and tabulated in FSAR Table 3.7.1-216. FSAR Figure 3.7.1-238 also shows the curve for FWSC CSDRS which is 1.35 times the ESBWR CSDRS as described in DCD Tier 2, Subsection 3.7.1.1. As shown in this Figure, the FWSC FIRS is enveloped by 1.35 times the ESBWR CSDRS by a significant margin. As such, the staff concludes that FWSC site-specific FIRS are bounded by the FWSC CSDRS and a site-specific SSI analysis for the FWSC is not needed.

Basis of the Assumption of One-Dimensional Versus Two-Dimensional Concrete Fill Material Underneath the FWSC

FSAR Figure 2.5.4-202 indicates that the lateral extent of the concrete fill material beneath the FWSC is limited to the footprint of the basemat. Because the concrete fill is limited in a lateral extent, the staff in RAI 03.07.01-3 requested the applicant to explain why it is appropriate to establish the FIRS for the FWSC on the basis of a 1-D site response analysis using a column of concrete fill/rock material, which presumes the concrete fill has infinite lateral extent.

In the response to RAI 03.07.01-3, dated March 13, 2012 (ADAMS Accession No. ML120730531), the applicant presented a methodology for developing the FIRS for the FWSC that takes into account 2-D site response analyses performed using the QUAD4MU program. In the 2-D analyses, the finite lateral extent of the concrete fill is explicitly taken into account; as well as the properties of the backfill from the LR, IR, and UR profiles. Following this methodology, the applicant established the 2-D versus the 1-D response spectral ratio envelopes at the FWSC foundation level. The 2-D versus the 1-D envelopes are shown in FSAR Figure 3.7.1-215 for the 10^{-4} and 10^{-5} exceedance probability levels of input ground motions. The plots indicate that the 2-D effect produces an increase in the mean site amplification functions above 5 Hz compared to the 1-D site response. The increase is generally greater for the 10^{-5} exceedance probability level than for the 10^{-4} exceedance level. FSAR Figure 3.7.1-216 shows the smoothed mean site amplification functions for the 10^{-4} and 10^{-5} exceedance probability levels at the FWSC foundation level for the 1-D site response compared with those incorporating the 2-D effects.

The FWSC FIRS shown in FSAR Figure 3.7.1-238 and tabulated in FSAR Table 3.7.1-216 are based on the mean site amplification functions that were modified by the 2-D versus the 1-D response spectral ratio envelopes shown in FSAR Figure 3.7.1-215 and illustrated in FSAR Figure 3.7.1-216.

Based on the above review, the staff concludes that the applicant's methodology for developing the FWSC FIRS adequately captures the 2-D effects resulting from the limited extent of the concrete fill beneath the FWSC basemat. The applicant's methodology is therefore acceptable.

Development of Vertical RB/FB SCOR FIRS, CB SCOR FIRS, FWSC FIRS, and PBSRS

The discussions above refer to the horizontal components of the SCOR FIRS for the RB/FB and CB, and the horizontal components of the FWSC FIRS and the PBSRS. To obtain the vertical component of the SCOR FIRS for the RB/FB and CB and the FWSC FIRS, FSAR Subsections 3.7.1.1.4.4 and 3.7.1.1.4.5 indicate that the applicant utilized the frequency-dependent vertical-to-horizontal (V/H) response spectral ratios for hard rock recommended by NUREG/CR–6728 for central and eastern United States (CEUS) bedrock sites (for 0.2 g ≤ PGA ≤ 0.5 g), which the staff finds acceptable because the RB/FB and the CB foundation levels are located within the bedrock. The staff noted that, unlike the RB/FB and the CB, the FWSC foundation level is located on concrete fill instead of the rock. The staff, however, finds the use of V/H response spectral ratios for hard rock recommended by NUREG/CR–6728 to be acceptable for the FWSC since the shear wave velocity for the concrete fill is comparable to that of the bedrock.

To obtain the vertical component of the PBSRS, the above approach is not entirely applicable because the full soil column for the PBSRS consists of a layer of backfill above the bedrock. Based on recent findings in the technical literature (FSAR References 3.7.1-213 and 3.7.1-215), FSAR Subsection 3.7.1.1.4.3.2 indicates that the applicant has modified the V/H ratios for hard rock by shifting the peak V/H ratio toward lower frequencies and slightly reducing the V/H ratios for frequencies below 9 Hz (a maximum reduction of approximately 15 percent).

The staff finds the above approach acceptable for the following reasons. First, the data in the references support the trend that (a) the peak V/H ratio is shifted to the lower frequencies, and (b) there is a slight reduction in the V/H ratios for low frequencies and for cases that compare soft rock relative to firm rock responses. Second, the full soil column for the PBSRS (which is closer to a shallow stiff soil site) is softer than the rock columns considered in the derivation of the V/H ratios recommended in NUREG/CR–6728 for CEUS bedrock sites; the staff thus expects a similar trend to apply. Third, a review of FSAR Figure 3.7.1-234 indicates that there is a sufficient margin between the vertical component of the PBSRS and the surface envelope of the vertical response spectra computed from the SSI deterministic inputs, based on the three deterministic profiles used in the site-specific SSI analysis. As a result of the above discussion, the staff concludes that the applicant has adequately addressed the effects of the variability in the modified V/H ratios on the SSI analysis.

FSAR Figure 3.7.1-220 shows the frequency-dependent V/H ratios for hard rock recommended by NUREG/CR–6728 for CEUS bedrock sites (for 0.2 g ≤ PGA ≤ 0.5 g) and the V/H ratios used to obtain the vertical component of the PBSRS.

The staff notes that the vertical components of the SCOR FIRS for the RB/FB and the CB were then enhanced following the procedure described in Section 5.2.1 of DC/COL-ISG-017. This procedure ensures hazard-consistent seismic inputs for the site-specific SSI analyses when compared to the PBSRS at the finished grade level, in the same manner as the horizontal components of the SCOR FIRS for the RB/FB and CB that the staff reviewed and accepted (see the discussion above under "*Development of Horizontal RB/FB SCOR FIRS, CB SCOR FIRS, and PBSRS*"). On the basis of this review, the staff concludes that the vertical components of the enhanced SCOR FIRS are acceptable for the RB/FB, the CB, the FWSC FIRS, and the PBSRS.

Deterministic Profiles for Site-Specific SSI Analyses

FSAR Subsection 3.7.1.1.4.3.3 describes the methodology used by the applicant to develop the following three deterministic profiles of subsurface material properties for site-specific SSI analyses: Best Estimate (BE), Lower Bound (LB), and Upper Bound (UB). The methodology follows the guidance in SRP Acceptance Criterion 3.7.2.II.4 and DC/COL-ISG-17. The methodology is based on the statistics of the strain-iterated soil properties obtained from the probabilistic site response analyses using the randomized full soil column profiles described in FSAR Subsection 3.7.1.1.4.1.1.3, which include the engineered granular backfill above the top of the Bass Islands Group bedrock. In the implementation of this methodology, the applicant addressed the following:

- The probabilistic site-response analyses took into consideration (a) the three base case profiles (LR, IR, and UR) to reflect the range of granular backfill material properties that may be used; (b) three alternate damping ratios for the bedrock (which was assumed to remain linear); and (c) 10^{-4} and 10^{-5} exceedance probability levels of high-frequency (HF) and low-frequency (LF) deaggregated earthquake (DE) of low, medium, and high seismic events. The logic tree is shown in FSAR Figure 3.7.1-210. As discussed in FSAR Subsection 3.7.1.1.4.1.1.3, randomized full soil column profiles and randomized modulus reduction and damping curves were utilized in the process.

- The BE profile was determined from the 50th percentile results of the strain-iterated soil properties. The LB and UB profiles were determined from the 16th and 84th percentile results, respectively.

- The UB and LB shear wave velocity profiles were adjusted where necessary to satisfy SRP Acceptance Criterion 3.7.2.II.4, which indicates that G_{UB} should be greater than or equal to G_{BE} x (1 + COV) and G_{LB} should be less than or equal to G_{BE} / (1 + COV), where G_{UB}, GL_B, and G_{BE} are the shear moduli for the UB, LB, and BE profiles; and COV represents the coefficient of variation. Since the in situ subsurface materials have been well investigated at the Fermi 3 site, a COV of 0.5 was used for the bedrock. However, for the backfill, a COV of 1.0 was used to be consistent with SRP

Acceptance Criterion 3.7.2.II.4 and to correspond with sites that are not well investigated.

- Damping ratios for the BE profile were determined from the 50th percentile results of the strain-iterated results. Damping ratios for the LB and UB profiles were determined from the 84th and 16th percentile results, respectively. Maximum damping ratios were below 15 percent in all cases and are thus consistent with SRP Acceptance Criterion 3.7.2.II.4.

- The compression wave velocity profiles were based on the corresponding shear wave velocity profiles and the site-specific Poisson's ratios identified in FSAR Table 2.5.4-202. In the layers of saturated backfill, the compression wave velocities were increased to the lower value of either 1,460 m/s (4,790 ft/s) or the compression wave velocity that resulted in a maximum Poisson's ratio of 0.48 for the corresponding LB, BE, and UB shear wave velocity. In the layers of bedrock below the groundwater table, the compression wave velocities exceeded 1,460 m/s (4,790 ft/s) in all cases and no adjustment was necessary.

FSAR Tables 3.7.1-206 through 3.7.1-211 and FSAR Figures 3.7.1-222 and 3.7.1-223 document the deterministic profiles of subsurface material properties used for site-specific SSI analyses, with and without engineered granular backfill above the top of the Bass Islands Group bedrock. The deterministic profiles without the backfill are the same as the deterministic profiles for the full soil column below the top of the Bass Islands Group bedrock.

The staff finds the above information acceptable because it was developed to adhere to the guidance in SRP Acceptance Criterion 3.7.2.II.4 and DC/COL-ISG-17.

Site-Specific Design Ground Motion Time Histories

FSAR Subsection 3.7.1.1.5 indicates that two sets of three orthogonal time histories (two horizontal and one vertical component) were generated to match the horizontal and vertical enhanced SCOR FIRS for the RB/FB and the CB, respectively, in accordance with SRP Acceptance Criterion 3.7.1.II.1.B, Option 1, Approach 2. The seed time histories used are those of the 1999 Chi-Chi Taiwan Earthquake, TAP078 recording, which was chosen from the CEUS record library in NUREG/CR–6728. Details of this record are in FSAR Table 3.7.1-217. Spectral matching was performed using the time-domain spectral matching technique described in FSAR References 3.7.1-219 and 3.7.1-220.

The staff verified the following aspects of the spectrally matched time histories:

- The correlation coefficients between the three components are less than 0.16, as listed in FSAR Table 3.7.1-218, which indicates statistical independence.

- The strong motion durations as defined in SRP Acceptance Criterion 3.7.1.II.1.B are listed in FSAR Table 3.7.1-219 and are in the order of 25 to 31 seconds, thus exceeding the minimum requirement of 6 seconds.

- The 5-percent damped response spectra of the time histories were compared with the enhanced SCOR FIRS at 301 spectral frequency points (or 100 frequencies per spectral frequency decade) in FSAR Figures 3.7.1-239 through 3.7.1-244. The comparison indicates that the response spectra are within 90 percent to 130 percent of the enhanced SCOR FIRS for the frequency range between 0.1 and 50 Hz.

- The time step and duration of the time histories are 0.005 seconds and 80 seconds, respectively, which correspond to an acceptable Nyquist frequency of 100 Hz.

On the basis of the above verifications, the staff finds the spectrally matched time histories to be acceptable per SRP Acceptance Criterion 3.7.1.II.1.B, Option 1, Approach 2. FSAR Figures 3.7.1-245 through 3.7.1-250 show that the spectrally matched time histories are compatible with the enhanced SCOR FIRS for the RB/FB and CB at the foundation levels.

The values of the parameter peak ground velocity (PGV)/PGA shown in FSAR Table 3.7.1-219 are consistent with the characteristic values reported in NUREG/CR–6728; however, the values of PGA x peak ground displacement (PGD)/PGV^2 are larger. This difference is acceptable because the time histories are spectrally matched to the enhanced SCOR FIRS, which represent a combination of hazards from both large, distant earthquakes and smaller, closer earthquakes. In this situation, a parameter such as PGA x PGD/PGV^2 may not necessarily match the characteristic values reported in NUREG/CR–6728 because the latter correspond to individual events and not combinations of events.

The applicant performed an additional verification to demonstrate that there are no significant gaps in power for the spectrally matched time histories. To do this, power spectral densities (PSDs) were calculated for the frequency range of 0.3 to 50 Hz per the guidance in Appendices A and B of SRP Section 3.7.1.

The staff notes that the spectrally matched time histories have a very long total duration (approximately 80 seconds) and clearly show non-stationary characteristics, with the high-frequency content decreasing significantly after about 45 to 50 seconds. These characteristics were inherited from the seed records corresponding to the 1999 Chi-Chi Taiwan event that were used to generate the time histories. As a consequence of the non-stationary characteristics, the PSD computations are sensitive to the definition and duration of the strong motion window used to define the PSD per the SRP guidance. To account for this sensitivity, several strong motion windows were addressed as shown in FSAR Figure 3.7.1-251.

The PSD plots are shown in FSAR Figures 3.7.1-252 through 3.7.1-255. The only appreciable dips in energy content are observed to occur below 1 Hz and above 25 Hz, for the shorter strong motion windows (the staff notes that the dips become attenuated as the durations of the windows increase). The reason for the dips is the energy content at these frequencies that occurs outside of the corresponding window used to define the PSD and thus cannot be represented in the plots. This is a limitation of the methodology for computing the PSD, which presumes stationary characteristics and does not necessarily reflect a deficiency in the energy content of the time histories. The staff concludes that the spectrally matched time histories are acceptable because the calculated PSD does not show significant gaps in power for the frequency range of 0.3 to 50 Hz, which is the frequency range of interest for the SSI analysis and is consistent with SRP Acceptance Criterion 3.7.1.II.1.B.ii.

Based on the NEI method described in DC/COL-ISG-017, the applicant developed in-column motions at the foundation levels of the RB/FB and the CB using the spectrally matched time histories defined as outcrop motions at the foundation levels and the deterministic subsurface profiles (BE, LB, and UB with and without backfill). These in-column motions are used as inputs into the Fermi 3 site-specific SSI analyses described in FSAR Section 3.7.2. This approach is acceptable to the staff because it is consistent with the NEI method described in DC/COL-ISG-17.

Percentage of Critical Damping Values

In FSAR Subsection 3.7.1.2, the applicant summarizes the damping ratios for the subsurface material profiles used in the site-specific SSI analyses of the RB/FB and CB, which were described in detail in FSAR Subsection 3.7.1.1.4. The staff's review of this information is discussed above in this SER under "*Deterministic Profiles for Site-Specific SSI Analyses.*" Maximum damping ratios were below 15 percent in all cases and are therefore acceptable per the guidance in SRP Acceptance Criterion 3.7.2.II.4.

Supporting Media for Category I Structures

In FSAR Subsection 3.7.1.3, the applicant summarizes the dynamic properties of the subsurface material profiles used in the site-specific SSI analyses of the RB/FB and CB, which were described in FSAR Subsection 3.7.1.1.4. The staff's review of this information is discussed above in this SER under "*Deterministic Profiles for Site-Specific SSI Analyses.*"

The applicant provides the site plans and profiles of the supporting media for the Category I and Category II structures in FSAR Figures 2.5.4-201 through 2.5.4-204. The staff determined that this information together with the standard plant structural data in the ESBWR DCD, Revision 10, is sufficient per SRP Acceptance Criterion 3.7.1.II.3. The staff's evaluation of the site-specific seismic analysis of the RB/FB using the site characteristics described in FSAR Subsection 3.7.1.3 is discussed in Section 3.7.2 of this SER.

3.7.1.5 *Post Combined License Activities*

There are no post COL activities related to this section.

3.7.1.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the Fermi 3 FSAR related to this section. All nuclear safety issues relating to the seismic design parameters that were incorporated by reference have been resolved.

The staff compared the supplemental information in the COL application to the relevant NRC regulations, the guidance in Section 3.7.1 of NUREG–0800, other NRC RGs, and the Interim Staff Guidance. The staff finds that the applicant has addressed seismic design parameters in accordance with the acceptance criteria delineated in these guidance documents. On this basis, the staff concludes that the applicant has satisfied the relevant requirements of the regulations delineated in Subsection 3.7.1.3 of this SER.

3.7.2 Seismic System Analysis

3.7.2.1 *Introduction*

This FSAR section addresses the seismic analysis methods and acceptance criteria used for the ESBWR seismic Category I structures. Seismic Category I structures are designed to withstand the effects of the SSE event and to maintain the specified design functions. This section applies to building structures that constitute primary structural systems. The reactor pressure vessel (RPV) is not a primary structural component; but it is considered as another part of the primary system of the RB for the purpose of dynamic analysis because of its dynamic interaction with the supporting structure. Seismic Category II and NS structures are designed or physically arranged (or both) to prevent the SSE from causing unacceptable structural interactions with or the failure of seismic Category I SSCs. The ESBWR method for a standard plant seismic analysis of the Category I structures is in Section 3.7.2 of ESBWR DCD, Tier 2, Revision 10.

3.7.2.2 *Summary of Application*

Section 3.7.2 and Appendices 3A and 3C of the Fermi 3 COL FSAR, Revision 7, incorporate by reference Section 3.7.2 and Appendices 3A and 3C of ESBWR DCD, Revision 10. In addition, in FSAR Section 3.7.2 and Appendices 3A and 3C, the applicant provides the following:

Supplemental Information

- EF3 SUP 3.7-4 Soil-Structure Interaction

In FSAR Subsection 3.7.2.4, the applicant presents the site-specific SSI analyses for the RB/FB and the CB performed for the Fermi 3 site conditions. The SSI analyses considered site conditions with and without the engineered granular backfill placed above the top of the Bass Islands Group rock. The FSAR includes a comprehensive set of the SSI analysis results (e.g., enveloping structural loads, maximum vertical accelerations, and floor response spectra) and their comparisons against corresponding DCD values.

- EF3 SUP 3.7-5 Interaction of Non-Category I Structures with Seismic Category I Structures

In FSAR Subsection 3.7.2.8, the applicant addresses the requirements for site-specific analyses of Non-Category I structures both within and outside the scope of the DCD and including the turbine building (TB), service building (SB), ancillary diesel building (ADB), and radwaste building (RWB).

In FSAR Subsection 3.7.2.14, the applicant indicates that the "site-specific stability evaluation against overturning" is in FSAR Section 3.8.5.

- EF3 SUP 3A.5-1 Soil Structure Interaction Analysis Method

In FSAR Appendix 3A Section 3A.5.3, the applicant indicates that the SASSI2010 computer program was used for all site-specific SSI and structure-soil-structure interaction (SSSI) analyses using the direct method (DM) or the modified subtraction method (MSM) of analysis described in FSAR Subsection 3.7.2.4.1.3. The staff reviewed the computer programs used in the site-specific analysis along with the review of the FSAR Section 3.7.2.

- EF3 SUP 3C-1 Site Specific Soil-Structure Interaction

In FSAR Appendix 3C, the applicant describes the computer codes used in the Fermi 3 site-specific SSI analysis—including the computer code SASSI2010. The staff reviewed the computer programs used in the site-specific analysis along with a review of FSAR Section 3.7.2.

Conceptual Design Information

- EF3 CDI ESBWR Standard Plant Site Plan

The applicant indicates in FSAR Section 3A.1 that FSAR Chapter 2 describes site-specific geotechnical data, which are compatible with the site enveloping parameters considered in the standard design. The staff reviewed this information as it relates to the site-specific SSI analysis along with the review of the FSAR Section 3.7.2.

The applicant indicates in FSAR Section 3A.2 that FSAR Figure 2.1-204 depicts the site plan. The staff used this information in reviewing the FSAR Section 3.7.2.

3.7.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1966. In addition, the relevant requirements of the Commission regulations for the seismic system analysis, and the associated acceptance criteria, are in Section 3.7.2 of NUREG–0800. The specific requirements include the following:

- 10 CFR Part 50, Appendix A, GDC 2, as it relates to the seismic design basis to reflect appropriate consideration of the most severe earthquakes historically reported for the site and surrounding area with a sufficient margin for the limited accuracy, quantity, and period of time in which historical data have been accumulated. In addition, SSCs important to safety should be designed to withstand the effects of earthquakes without losing the capability to perform their intended safety functions.

- 10 CFR Part 50, Appendix S, as it relates to the SSE ground motion in the free-field at the foundation level of the structures to be an appropriate response spectrum with a peak ground acceleration of at least 0.1g; and if the OBE is chosen to be less than or equal to one-third of the SSE ground motion, it is not necessary to conduct explicit response or design analyses in accordance with Section IV.(2)(i)(A) of 10 CFR Part 50, Appendix S, and the requirement of taking into account SSI effects.

In addition, the acceptance criteria and regulatory guidance associated with the review of FSAR Section 3.7.2 include the following:

- SRP Section 3.7.2 guidance to review methods for site-specific seismic analysis and modeling of structures to ensure that they accurately and/or conservatively represent the behavior of SSCs during postulated seismic events.

- DC/COL-ISG-1, "Interim Staff Guidance on Seismic Issues of High Frequency Ground Motion," and DC/COL-ISG-017 in reviewing the seismic input and the SSI dynamic model acceptability for the Fermi 3 site.

- RG 1.61 to determine the acceptability of the damping values used in the structural model.

3.7.2.4 *Technical Evaluation*

As documented in NUREG–1966, NRC staff reviewed and approved Section 3.7.2 and Appendices 3A and 3C of the ESBWR DCD. The staff reviewed Section 3.7.2 and Appendices 3A and 3C of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the required information relating to this section.

The staff reviewed the following information in the Fermi 3 COL FSAR:

Supplemental Information

- EF3 SUP 3.7-4 Soil-Structure Interaction
- EF3 SUP 3A.5-1 Soil-Structure Interaction Analysis Method
- EF3 SUP 3C-1 Site Specific Soil-Structure Interaction

Conceptual Design Information

- EF3 CDI ESBWR Standard Plant Site Plan

Soil-Structure Interaction

Site-Specific SSI Analysis

SRP Section 3.7.2 provides the guidance on the review of the seismic analysis of seismic Category I structures. Specifically, the NRC staff's review includes an assessment of the methods used in the seismic analysis to account for SSI effects, including the validation of the computer programs used in the analysis.

As indicated in FSAR Section 2.5.4 and Figures 2.5.4-201 through 2.5.4-204, the RB/FB and the CB structures at the Fermi 3 site are partially embedded in the Bass Islands Group rock. Therefore, the underlying soil media are in fact rock media. In the case of the FWSC, the structure is supported on a block of concrete fill that bears on the Bass Islands Group rock. A block of concrete fill is also located in the gap between the RB/FB and the CB.

Engineered granular backfill is used to fill the site excavation surrounding the power block structures. This backfill is placed above the top of the Bass Islands Group rock up to the plant grade level and is depicted in FSAR Figures 2.5.4-201, 2.5.4-202, and 2.5.4-203. FSAR

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Subsection 2.5.4.5.4.2 describes the material properties and specifications of the engineered granular backfill.

Site-specific SSI analyses for the RB/FB and the CB were performed for the site conditions with and without the presence of the engineered granular backfill. These analyses are documented in FSAR Subsection 3.7.2.4 and in Sargent & Lundy Reports SL-011864 Revision 1, “Licensing Basis SSI Analyses of Reactor Building/Fuel Building and Control Building Summary Report,” (ADAMS Accession No. ML13210A144); and SL-011956, Revision 1, “SSI Analyses of Reactor Building/Fuel Building and Control Building with Engineered Backfill Summary Report,” (ADAMS Accession No. ML13360A176).

Site-specific SSI analyses were also performed to account for the SSSI effect of the RB/FB and FWSC on the CB, considering the presence of the engineered granular backfill. These analyses are documented in Sargent & Lundy Report SL-011960,Revision 0, “SSSI Sensitivity Studies of CB and FWSC with Engineered Backfill Summary Report,” (ADAMS Accession No. ML13232A006).

The staff reviewed calculations pertinent to the site-specific SSI and SSSI analyses during the onsite audit on November 18 through 22, 2013 (ADAMS Accession No. ML14028A245). The staff also reviewed calculations pertaining to the validation and verification of the computer program used in the site-specific SSI and SSSI analyses during the onsite audit on March 19 through 21, 2013, (ADAMS Accession No. ML13149A515). This program is further discussed later in this section under “Computer Programs Verification and Validation Issues.”

The site-specific SSI and SSSI analyses for the RB/FB and the CB structures were performed by the applicant to address the following site-specific issues:

- To confirm that the ESBWR DCD standard plant design is applicable to the Fermi 3 site-specific conditions where the RB/FB and the CB structures are partially embedded in the Bass Islands Group rock, with engineered granular backfill surrounding the structures from the top of the rock to the plant grade level. These site-specific conditions deviate from the soil cases considered in the SSI analyses described in ESBWR DCD, Tier 2, Appendix 3A.

- To demonstrate that the standard plant design is applicable to the Fermi 3 site-specific conditions, even though the ESBWR DCD requirements for the engineered granular backfill that surrounds the seismic Category I structures are not being met for the RB/FB and the CB structures. Specifically, ESBWR DCD, Tier 2, Table 2.0-1 states that the minimum shear wave velocity of the material surrounding the embedded walls of these structures should be greater than 300 m/s (1000 ft/s). In accordance with Footnote (16) to ESBWR DCD, Tier 2, Table 2.0-1; ESBWR DCD, Tier 1, Section 5.0, “Site Parameters”; and Footnote (6) to ESBWR DCD, Tier 1, Table 5.1-1; site-specific SSI analyses are required to demonstrate the adequacy of the standard plant design for sites not meeting the ESBWR DCD soil parameter requirements.

Site-specific SSI analyses for the FWSC structure were not performed by the applicant. The staff finds this acceptable because the two issues identified above are not applicable to the FWSC. First, because the FWSC at the Fermi site is supported on a block of concrete fill that bears on the Bass Islands Group rock, the FWSC is therefore not partially embedded in the Bass Islands Group rock. Second, as described in ESBWR DCD, Tier 2, Subsection 3.7.1.1, the FWSC is essentially a surface-founded structure (embedded 2.35 m [7.7 ft]) with no embedded walls. Therefore, the requirement in ESBWR DCD, Tier 2, Table 2.0-1 for material surrounding the embedded walls is not applicable to the FWSC. Because the site-specific FIRS for the FWSC is bounded by the ESBWR CSDRS, and all other requirements in ESBWR DCD, Tier 2, Table 2.0-1 are met, the staff concludes that the standard plant design for the FWSC is applicable to the Fermi 3 site without further site-specific SSI analyses.

The various SSI and SSSI case analyses performed by the applicant are summarized in Table 3.7.2-1 and Table 3.7.2-2 of this SER. In these tables, DM and MSM refer to the "Direct Method" and "Modified Subtraction Method" of the SASSI2010 program, respectively. (See the discussion below under "*SSI Analysis Method.*") BE, LB and UB refer to the "Best Estimate"; "Lower Bound" and "Upper Bound" subsurface material profiles, respectively. (See the discussion below under "*Strain Compatible Dynamic Subsurface Material Properties.*")

Strain Compatible Dynamic Subsurface Material Properties

The site-specific SSI analyses considered the three site-specific subsurface material profiles that are documented in FSAR Tables 3.7.1-206 through 3.7.1-211. The staff finds these profiles acceptable because they account for the effects of the potential variability in the properties of the soils and rocks at the site and are consistent with SRP Acceptance Criterion 3.7.2.II.4. The three profiles are designated as BE, LB, and UB. For the LB and UB profiles, the SSI analyses considered separate cases with and without the engineered granular backfill surrounding the structures. For the BE profile, the SSI analyses considered only the case without the backfill.

The staff's review of the above information is in Subsection 3.7.1.4 of this SER. The staff notes that the subsurface material profiles documented in FSAR Tables 3.7.1-206 through 3.7.1-211 were slightly adjusted in the SSI analyses to ensure that layer thicknesses and mesh dimensions would match the characteristics of the embedded portions of the structures, as well as to address finite element aspect ratios and model passing frequencies (see the discussion below under "*SSI Analyses of Structural Models*"). During the onsite audit on November 18 through 22, 2013, (ADAMS Accession No. ML14028A245) the staff confirms that the effect of these adjustments on the SSI analyses was negligible, and the SSI analyses are therefore acceptable.

The subsurface material profiles used in the SSI analyses—with the adjustments described above—are documented in Sargent & Lundy Reports SL-011864, Revision 1 (ADAMS Accession No. ML13210A144) and SL-011956, Revision 1 (ADAMS Accession No. ML13360A176).

FIRS Compatible Ground Motion Time History

The site-specific SSI analyses considered three orthogonal components (two horizontal and one vertical) of ground motion time histories described in FSAR Subsection 3.7.1.1.5. These time histories were developed to be in-column motions at the bottom of the RB/FB and the CB basemat elevations and are compatible with the site-specific FIRS of the RB/FB and the CB (designated as "enhanced SCOR FIRS") described in FSAR Section 3.7.1. The staff finds that these ground motion time histories are acceptable control motions for the site-specific SSI analyses performed by the applicant.

The staff's review of the above information is in Subsection 3.7.1.4 of this SER.

SSI Analysis Method

The applicant performed site-specific SSI analyses following the methodology in ESBWR DCD, Tier 2, Appendices 3A.5 and 3A.5.2, which is based on the frequency domain complex response approach using the SASSI 2000 program. Structural responses were computed in terms of maximum absolute accelerations, maximum forces and moments, and floor response spectra (FRS) at the key locations in the structures identified in ESBWR DCD, Tier 2, Appendix 3A, as well as seismic lateral soil pressures acting on below-grade exterior walls (seismic soil pressures are reviewed in Subsection 3.8.4.4 of this SER). The above methodology is acceptable to the staff because it is the same methodology applied in the ESBWR DCD and is consistent with SRP Acceptance Criterion 3.7.2.II.4.

However, the applicant used the SASSI2010 program instead of the SASSI2000 program in the site-specific SSI analyses. To ensure the acceptability of the SASSI2010 program for use in the site-specific SSI analyses at Fermi 3, the applicant performed validation and verification analyses. The staff's review of this validation and verification effort is described below under "Computer Programs Verification and Validation Issues," where the staff concludes that the SASSI2010 program is acceptable for the site-specific SSI analyses at the Fermi 3 site.

To perform the SSI analysis of embedded structures such as the RB/FB and the CB, the SASSI2010 program may use the DM (also known as the "Flexible Volume Method"), the MSM, or the SM ("Subtraction Method"). The DM is the most accurate but also the most computationally intensive method. If not implemented properly, the SM could potentially result in erroneous and non-conservative SSI responses when compared to the DM.

FSAR Subsection 3.7.2.4.1.3 indicates that the site-specific SSI analyses were performed using either the DM or the MSM, but not the SM. Current staff guidance regarding the use of the DM versus the MSM is in SRP Section 3.7.2, Revision 4, SRP Acceptance Criterion 3.7.2.II.4. Although the guidance states that the DM should be used to the extent practical, the MSM is also identified as an alternative for very large computer models where it is not feasible to use the DM. The guidance recommends the use of reduced-size computer models (e.g., quarter models) to perform direct comparisons between the MSM and the DM solutions and to draw conclusions that can be extrapolated to the full-size models.

In accordance with the above guidance, the applicant performed additional benchmark studies for those SSI case analyses that required the use of the MSM in SASSI2010 because of the computational limitations with the size of the computer models (SSI analyses of cases RBFB2UB-MSM and RBFB2LB-MSM for the RB/FB and CB4-FWSC1UB-MSM and CB4-FWSC1LB-MSM for the CB).

The benchmark studies discussed below used reduced-size models and the same site-specific subsurface material profiles (UB with backfill considered) and input motions as the full-size models. The benchmark studies performed were as follows:

- Direct DM versus the MSM comparison of a quarter-size model of the RB/FB determined that two layers of interaction nodes were necessary in the implementation of the MSM to obtain essentially identical results as the DM for the frequency range of interest. The two layers of interaction nodes were located at the plant grade elevation of +4.65 m (15.26 ft) and at the elevation of -2.025 m (-6.644 ft), in the portion of the SSI model known as the "excavated volume."

- Direct DM versus the MSM comparison of a full-size model of the CB determined that two layers of interaction nodes were necessary in the implementation of the MSM to obtain essentially identical results as the DM for the frequency range of interest. The two layers of interaction nodes were located at the plant grade elevation of +4.50 m (14.76 ft) and at the elevation of -2.00 m (6.56 ft).

- Direct DM versus the MSM comparison of a half-size model of the FWSC determined that a single layer of interaction nodes was required in the implementation of the MSM to obtain essentially identical results as the DM for the frequency range of interest. The layer of interaction nodes was located at the plant grade elevation of +4.50 m (14.76 ft).

The results of these benchmark studies are documented in Sargent & Lundy Reports SL-011814, Revision 0, "Modified Subtraction Method (MSM) Reactor Building/Fuel Building Benchmark Summary Report," (ADAMS Accession No. ML13127A034); SL-011874 Revision 0, "Modified Subtraction Method (MSM) Control Building Benchmark Summary Report," (ADAMS Accession No. ML13175A263); and SL-011863 Revision 0, "Modified Subtraction Method (MSM) Firewater Service Complex Benchmark Summary Report," (ADAMS Accession No. ML13175A264). The benchmark studies were reviewed by the staff during the onsite audit on November 18 through 22, 2013, (ADAMS Accession No. ML14028A245). The staff notes that the benchmark studies of the CB and the FWSC were necessary for the SSSI analyses discussed below under "*SSSI Analysis*."

The staff reviewed the reduced-size models used in the benchmark studies to ensure that they were representative of the full-size models in terms of dynamic characteristics, foundation width-to-depth ratio, embedment depth, subsurface material profiles, and input motions. The staff also reviewed the DM versus the MSM comparisons of structural responses in terms of transfer functions, maximum absolute accelerations, maximum forces and moments, FRS at the key locations in the structures identified in ESBWR DCD, Tier 2, Appendix 3A, and the seismic lateral soil pressures acting on below-grade exterior walls. The staff confirmed that the results are essentially identical for the frequency range of interest to the Fermi 3 site conditions.

On the basis of the benchmark studies performed using reduced-size computer models and the staff guidance discussed above, the staff concludes that the applicant's implementation of the MSM in SASSI2010 is acceptable because the full-size models used the same number of layers of interaction nodes identified in the benchmark studies. The staff's review of the SSI and SSSI analyses is documented in Sargent & Lundy Reports SL-011956, Revision 1 (SSI analyses with engineered granular backfill) and SL-011960 Revision 0 (SSSI analyses with engineered granular backfill), respectively. The review confirms the acceptability of the applicant's implementation of the MSM and thus resolved the issue.

SSI Analyses of Structural Models

The site-specific SSI models of the RB/FB and the CB consist of (a) lumped-mass stick models that consider shear, bending, torsion, and axial deformations of the buildings; (b) single-degree-of-freedom (SDOF) oscillators connected to the stick models and used to represent the out-of-plane seismic response of flexible slabs in the buildings; (c) plate finite elements arranged in a uniform mesh that was used to represent the exterior walls below grade and the basemats; (d) brick finite elements arranged in a uniform mesh that was used to model the portion of the subsurface backfill/rock medium where the structures are embedded (known as the "excavated volume"); and (e) horizontal layers of infinite extension used to represent the subsurface profile of the backfill/rock medium. It should be noted that the exterior walls below grade and the basemats match the lateral perimeter and bottom boundary of the excavated volume.

FSAR Subsection 3.7.2.4.1.4 indicates that the site-specific SSI model configurations are the same as those in ESBWR DCD, Tier 2, Figures 3A.7-8 through 3A.7-10 for the RB/FB and DCD Figures 3A.7-11 through 3A.7-13 for the CB, except that the vertical and horizontal spacing of the excavated soil volume nodes and boundary—items (c) and (d) above—are adjusted to closely match the site-specific subsurface profile layers and to address model passing frequencies. The staff finds this model configuration acceptable, as discussed below.

The site-specific SSI model configurations are depicted in FSAR Figures 3.7.2-201 through 3.7.2-203 (the RB/FB model without backfill and designated as model RBFB1 in SER Table 3.7.2-1 below); FSAR Figures 3.7.2-203a through 3.7.2-203c (the RB/FB model with backfill and designated as model RBFB2 in SER Table 3.7.2-1 below); FSAR Figures 3.7.2-204 through 3.7.2-206 (the CB model without backfill and designated as model CB1 in SER Table 3.7.2-2 below); and FSAR Figures 3.7.2-206a through 3.7.2-206c (the CB model with backfill and designated as model CB2 in SER Table 3.7.2-2 below).

FSAR Subsection 3.7.2.4.1.4 indicates that the stick models and the SDOF oscillators for the RB/FB and the CB—items (a) and (b) above—are the same as those described in ESBWR DCD, Tier 2, Section 3A.7, “Analysis Models,” and depicted in DCD Figure 3A.7-4 (RB/FB) and Figure 3A.7-6 (CB). The stick models and the SDOF oscillators used in the site-specific SSI models are therefore acceptable because they are the same as those used in the ESBWR DCD for the same purpose, and they are consistent with SRP Acceptance Criterion 3.7.2.II.3.C.

To ensure that the dynamic response of the site-specific SSI models is adequate for the frequency range of interest, the uniform finite element meshes used to represent the excavated soil volumes and their boundaries—items (c) and (d) above—should be sufficiently refined to address criteria (1) the horizontal dimensions (both East-West and North-South directions) should not exceed 20 percent of the shear wavelength of the corresponding layer at the passing frequency of the model; (2) the vertical dimension should not exceed 20 percent of the shear wavelength of the corresponding layer at the passing frequency of the model; and (3) the aspect ratio of the plate and brick finite elements used in the mesh should not exceed 1:3, as identified by the applicant in the validation and verification study for the SASSI2010 program, which is discussed later in this section under “Computer Programs Verification and Validation Issues.” Per the Interim Staff Guidance DC/COL-ISG-1, the passing frequency of the SSI models should be at least 50 Hz.

The staff reviewed the finite element meshes of the corresponding excavated volumes depicted in FSAR Figures 3.7.2-201 through 3.7.2-203, FSAR Figures 3.7.2-203a through 3.7.2-203c, FSAR Figures 3.7.2-204 through 3.7.2-206, and FSAR Figures 3.7.2-206a through 3.7.2-206c. The staff concluded that the mesh sizes meet the criteria identified above except for the SSI analyses of cases RBFB2LB-MSM and CB2LB-DM (the LB subsurface profile with backfill considered). For these cases, the staff concluded that the passing frequency of the SSI models is approximately 19 Hz and thus deviates from the guidance in DC/COL-ISG-1.

The staff reviewed the horizontal layers of the infinite extension used to represent the subsurface profiles of the backfill/rock medium—item (e) above—as documented in Sargent & Lundy Reports SL-011956, Revision 1 (SSI analyses with engineered granular backfill) and SL-011960, Revision 0 (SSSI analyses with engineered granular backfill). The staff concluded that the thickness of the rock layers in the models satisfies the limiting criterion of 20 percent of the shear wavelength at the passing frequency of the model. However, the SSI analyses of cases RBFB2LB-MSM and CB2LB-DM (the LB subsurface profile with backfill considered), the thickness of the backfill layers did not satisfy the criterion and resulted in a passing frequency of approximately 19 Hz, which is consistent with the staff's finding for the finite element meshes of the excavated volumes.

The staff's assessment concluded that the deviation from the guidance identified above is not a technical concern for the following reasons. First, the site-specific seismic responses computed for the UB subsurface profile with and without considering the backfill are more sensitive to the frequency content of input motions above 19 Hz. These are accurately captured in the analyses because they are based on SSI models that have the required 50 Hz passing frequency. Second, the reduced passing frequency for the SSI analyses of cases RBFB2LB-MSM and CB2LB-DM reflects an insufficient mesh/layer refinement in the backfill portions of the models only—the mesh/layer dimensions in the rock portions are adequate. Third, a review of site-specific seismic responses in the structures computed for SSI analyses of cases RBFB2LB-MSM and CB2LB-DM indicates that these cases are generally almost always bounded by the other case analyses that have the required 50 Hz passing frequency. This is because SSI effects at the Fermi 3 site are dominated by the interaction between the structures and the rock in which they are embedded. Fourth, the reduced passing frequency for the SSI analyses of cases RBFB2LB-MSM and CB2LB-DM does not affect the seismic lateral soil pressures computed for these cases because these are mainly due to low frequency responses (i.e., below 19 Hz).

On the basis of these considerations for items (a) through (e) identified above, the staff finds that the site-specific SSI models documented in FSAR Subsection 3.7.2.4.1.4 meet SRP Acceptance Criteria 3.7.2.II.3 and 3.7.2.II.4 and are therefore acceptable. ESBWR DCD, Tier 2, Table 3A.6-1 identifies several modifications to the basic stick models of the RB/FB and the CB for purposes of evaluating the effects of parameter variations on the seismic responses. FSAR Subsection 3.7.2.4.1 indicates that in the site-specific SSI analyses, the basic stick models designated as "base" were used. These base models considered the concrete to be "uncracked," which is represented by assuming the full value of the concrete modulus of elasticity.

In the supplemental response to RAI 03.07.02-9 Item 4 (Attachment 15 to DTE Letter NRC3-13-0036, ADAMS Accession No. ML13354B536), the applicant further clarified that OBE damping ratios were used for the structural elements in all SSI and SSSI analyses. In the RB/FB models, OBE damping values of 4 percent and 3 percent were used for reinforced concrete elements and welded steel elements, respectively. In the CB models, OBE damping values of 4 percent were used for the reinforced concrete elements.

The staff finds the above modeling assumptions acceptable given the overall moderate magnitude of the site-specific stress levels induced throughout the RB/FB and the CB structures. As discussed below under "*SSI Analysis Results—Enveloping Maximum Structural Loads*," and "*SSI Analysis Results—Enveloping Single-Degree-of-Freedom Oscillator Response,*" the site-specific seismic loads are bounded by the seismic loads considered in the standard design—in some cases by a significant margin. Therefore, per SRP Acceptance Criterion 3.7.1.II.2 and RG 1.61 guidance, the use of uncracked section properties and OBE damping is conservative and are thus acceptable.

SSI Case Analyses

The various SSI case analyses performed by the applicant are summarized in SER Tables 3.7.2-1 and 3.7.2-2. Site-specific SSSI analyses of cases are also included in these tables for completeness. SSSI analyses are discussed below under "*SSSI Analysis*."

The three site-specific subsurface material profiles BE, LB, and UB account for the variability in the subsurface material properties at the Fermi 3 site, as discussed earlier in Subsection 3.7.1.4 of this SER. For the LB and UB profiles, the SSI analyses considered separate cases with and without the backfill surrounding the structures. For the BE profile, the SSI analyses considered only the case without the backfill. The staff finds this acceptable because the dynamic properties of the LB and UB profiles with backfill effectively bound the corresponding properties of the BE profile with the backfill. The staff concludes that the SSI and SSSI cases summarized in SER Tables 3.7.2-1 and 3.7.2-2 provide sufficient information for the staff to determine the acceptability of the ESBWR standard plant design at the Fermi 3 site.

SSI Analysis Results—Transfer Functions

Sargent & Lundy Reports SL-011864, Revision 1 (SSI analyses without engineered granular backfill) and SL-011956, Revision 1 (SSI analyses with engineered granular backfill) document the transfer functions computed for the site-specific SSI case analyses. These reports present results for the following key locations identified in DCD Appendix 3A:

- RB/FB: top of basemat, refueling floor, reinforced concrete containment vessel (RCCV) top slab, top of vent wall, top of reactor shield wall (RSW), top of RPV.
- CB: top of basemat and top of roof slab.

The staff reviewed the transfer function plots and found them to be generally smooth, with a sufficient density of calculated frequency points in the frequency range of interest. Although some isolated sharp spikes were noted in a few of the plots because of the interpolation scheme used by the SASSI2010 program, these spikes had no observable impact on the seismic response or the FRS.

Therefore, the staff concludes that the site-specific SSI analyses performed by the applicant with the SASSI2010 program were implemented in a manner consistent with the frequency domain complex response method described in ESBWR DCD, Tier 2, Appendix 3A.

SSI Analysis Results—Enveloping Maximum Structural Loads

FSAR Tables 3.7.2-203a through 3.7.2-203e document the envelope of the maximum seismic forces and moments in the different stick models of the RB/FB complex obtained from the site-specific SSI case analyses and compare these to the corresponding values in ESBWR DCD, Tier 2, Tables 3A.9-1a through 3.A.9-1e. The comparisons are as follows:

- RB/FB stick (FSAR Table 3.7.2-203a and DCD Table 3A.9-1a): maximum ratio of site-specific seismic loads to corresponding DCD values is approximately 67 percent.
- RCCV stick (FSAR Table 3.7.2-203b and DCD Table 3A.9-1b): maximum ratio of site-specific seismic loads to corresponding DCD values is approximately 68 percent.

- Vent Wall/Pedestal stick (FSAR Table 3.7.2-203c and DCD Table 3A.9-1c): maximum ratio of site-specific seismic loads to corresponding DCD values is approximately 51percent.

- RSW stick (FSAR Table 3.7.2-203d and DCD Table 3A.9-1d): maximum ratio of site-specific seismic loads to corresponding DCD values is approximately 60 percent.

- RPV stick (FSAR Table 3.7.2-203e and DCD Table 3A.9-1e): maximum ratio of site-specific seismic loads to corresponding DCD values is approximately 86 percent.

FSAR Table 3.7.2-204 documents the envelope of the maximum seismic forces and moments in the CB obtained from the site-specific SSI case analyses and compares these to the corresponding values in ESBWR DCD, Tier 2, Table 3A.9-1f. The comparison is as follows:

- CB stick (FSAR Table 3.7.2-204 and DCD Table 3A.9-1f): maximum ratio of site-specific seismic loads to corresponding DCD values is approximately 72 percent.

FSAR Tables 3.7.2-205a through 3.7.2-205d document the envelope of the maximum absolute vertical accelerations in the different stick models of the RB/FB complex obtained from the site-specific SSI case analyses and compare these to the corresponding values in ESBWR DCD, Tier 2, Tables 3A.9-3a through 3.A.9-3d. The comparisons are as follows:

- RB/FB stick (FSAR Table 3.7.2-205a and DCD Table 3A.9-3a): maximum ratio of site-specific vertical accelerations to corresponding DCD values is approximately 46 percent.

- RCCV stick (FSAR Table 3.7.2-205b and DCD Table 3A.9-3b): maximum ratio of site-specific vertical accelerations to corresponding DCD values is approximately 41 percent.

- Vent Wall/Pedestal stick (FSAR Table 3.7.2-205c and DCD Table 3A.9-3c): maximum ratio of site-specific vertical accelerations to corresponding DCD values is approximately 44 percent.

- RSW stick (FSAR Table 3.7.2-205d and DCD Table 3A.9-3d): maximum ratio of site-specific vertical accelerations to corresponding DCD values is approximately 45 percent.

FSAR Table 3.7.2-206 documents the envelope of the maximum absolute vertical accelerations in the CB obtained from the site-specific SSI case analyses and compares these to the corresponding values in ESBWR DCD, Tier 2, Table 3A.9-3g. The comparison is as follows:

- CB stick (FSAR Table 3.7.2-206 and DCD Table 3A.9-3g): maximum ratio of site-specific vertical accelerations to corresponding DCD values is approximately 41 percent.

Based on the above comparisons, the staff concludes that the site-specific envelope of maximum seismic forces and moments and maximum absolute vertical accelerations in the different stick models of the RB/FB and the CB are bounded by the corresponding values in ESBWR DCD, Tier 2, Section 3A.9.1. This finding is acceptable and indicates that the standard plant design is applicable to the RB/FB and the CB at the Fermi 3 site.

SSI Analysis Results—Enveloping Single-Degree-of-Freedom Oscillator Response

FSAR Table 3.7.2-205e documents the envelope of the maximum absolute vertical accelerations for the SDOF flexible slab oscillators in the RB/FB obtained from the site-specific SSI case analyses and compares these to the corresponding values in ESBWR DCD, Tier 2, Table 3.A.9-3e. The comparison is as follows:

- RB/FB (FSAR Table 3.7.2-205e and DCD Table 3A.9-3e): maximum ratio of site-specific vertical accelerations to corresponding DCD values is approximately 75 percent.

FSAR Table 3.7.2-206 documents the envelope of the maximum absolute vertical accelerations for the SDOF flexible slab oscillators in the CB obtained from the site-specific SSI case analyses and compares these to the corresponding values in ESBWR DCD Table 3A.9-3g. The comparisons are as follows:

- CB (FSAR Table 3.7.2-206 and DCD Table 3A.9-3g): maximum ratio of site-specific vertical accelerations to corresponding DCD values is approximately 75 percent.

Based on the above comparisons, the staff concludes that the site-specific envelope of maximum absolute vertical accelerations for the SDOF flexible slab oscillators in the RB/FB and the CB are bounded by the corresponding values in ESBWR DCD, Tier 2, Section 3A.9.1. This is acceptable and indicates that the standard plant design is applicable to the RB/FB and the CB at the Fermi 3 site.

SSI Analysis Results—Enveloping Floor Response Spectra

FSAR Figures 3.7.2-207a through 3.7.2-209f present the envelopes of the 5-percent damped FRS at the key locations in the RB/FB (top of basemat, refueling floor, RCCV top slab, top of vent wall, top of RSW, top of RPV) obtained from the site-specific SSI case analyses and compare these to the corresponding enveloping FRS in ESBWR DCD, Tier 2, Section 3A.9.2.

FSAR Figures 3.7.2-210a through 3.7.2-212b present the envelopes of the 5-percent damped FRS at the key locations in the CB (top of basemat and top of roof slab) obtained from the site-specific SSI case analyses and compare these to the corresponding enveloping FRS in ESBWR DCD, Tier 2, Section, 3A.9.2.

Based on the above comparisons, the staff concludes that the site-specific FRS at the key locations in the RB/FB and the CB are bounded by the corresponding enveloping FRS in ESBWR DCD, Tier 2, Section 3A.9.2, by a substantial margin. This finding is acceptable and indicates that the standard plant design is applicable to the RB/FB and the CB at the Fermi 3 site.

SSSI Analysis

To evaluate the SSSI effect of the RB/FB and the FWSC on the CB, the applicant performed site-specific SSSI analyses that adhered to the same methodologies described in ESBWR DCD, Tier 2, Section 3A.8.11. These analyses are documented in the Sargent & Lundy Report SL-011960, Revision 0 (SSSI analyses with engineered granular backfill).

The staff notes that the RB/FB is considerably more massive than the CB is, so the SSSI effect of the RB/FB on the CB is thus more significant than the effect of the CB on the RB/FB. On this basis, the applicant did not evaluate the SSSI effect of the CB on the RB/FB. The staff reviewed the ESBWR DCD and determined that the basis provided by the applicant for neglecting the SSSI effect of the CB on the RB/FB is consistent with the seismic analysis methodology described in ESBWR DCD, Tier 2, Section 3A.8.11 and is therefore acceptable.

To evaluate the SSSI effect of the RB/FB on the CB, the applicant performed the SSSI analyses denoted as CB3UB-DM and CB3LB-DM in SER Table 3.7.2-2 below. These analyses considered the presence of the backfill above the rock and were performed in two steps. In the first step, the ground motion responses at the center of the CB basemat location in the free-field were obtained from the SSI analyses of the RB/FB with backfill considered (SSI analyses of cases RBFB2UB-MSM and RBFB2LB-MSM). In the second step, the ground motion responses computed in the first step were used as input motions to SSI analyses of the CB, thus capturing the SSSI effect of the RB/FB on the CB. This method is the same as the one described in ESBWR DCD, Tier 2, Section 3A.8.11.

To evaluate the SSSI effect of the FWSC on the CB, the applicant performed the SSSI analyses denoted as CB4-FWSC1UB-MSM and CB4-FWSC1LB-MSM in SER Table 3.7.2-2, below. These analyses considered the presence of the backfill above the rock and used fully coupled models in which both the CB and the FWSC were represented together with the subsurface material. The input motions applied to the coupled CB4-FWSC1 models were the in-column motions corresponding to the SSI FIRS for the CB applied at the bottom of the CB basemat. This method is the same as the one described in ESBWR DCD, Tier 2, Section 3A.8.11.

The site-specific SSSI analyses described above used the same model representation of the RB/FB and the CB structures and the UB and LB subsurface profiles used in the other SSI case analyses, which the staff reviewed and accepted as discussed above under *"SSI Analyses of Structural Models."* The passing frequency of the models used for SSSI analyses of cases CB3LB-DM and CB4-FWSC1LB-MSM is approximately 19 Hz, which deviates from the guidance in DCD/COL-ISG-1. The staff concluded that this deviation is not a safety concern for several reasons discussed above under *"SSI Analyses of Structural Models*," which are also applicable to the SSSI analyses of the models.

For the site-specific SSSI analyses, the model representation of the FWSC structure consisted of a lumped-mass stick model, with plate finite elements used to represent the basemat described in ESBWR DCD, Tier 2, Section 3A.7. The excavated volume for the FWSC extended from the bottom of the concrete fill under the basemat up to plant grade elevation. The concrete fill under the basemat was modeled with brick finite elements and was considered part of the structure. The staff finds the model representation of the FWSC acceptable because it uses the same stick model as the one used in the EBSWR DCD for the same purpose; and the finite element mesh used to represent the concrete fill satisfies the acceptance criteria for the aspect ratio and the passing frequency discussed above under *"SSI Analyses of Structural Models,"* which are consistent with SRP Acceptance Criterion 3.7.2.II.3.C.

The staff reviewed the structural responses computed from the site-specific SSSI analyses in terms of transfer functions, maximum absolute accelerations, maximum forces and moments, and the 5-percent damped FRS at the key locations in the CB identified in ESBWR DCD, Tier 2, Appendix 3A. These results are documented in the Sargent & Lundy Report SL-011960, Revision 0 (ADAMS Accession No. ML13232A006). In reviewing the results, the staff observed the following:

The maximum ratio of site-specific seismic loads to corresponding ESBWR DCD values in the CB stick is approximately 65 percent (envelope of SSSI analyses of cases CB3UB-DM and CB3LB-DM) and 60 percent (envelope of SSSI analyses of cases CB4-FWSC1UB-MSM and CB4-FWSC1LB-MSM) compared to 72 percent obtained for the other SSI case analyses.

The maximum ratio of site-specific vertical accelerations to corresponding ESBWR DCD values in the CB stick is approximately 40 percent (envelope of SSSI analyses of cases CB3UB-DM and CB3LB-DM) and 39 percent (envelope of SSSI analyses of cases CB4-FWSC1UB-MSM and CB4-FWSC1LB-MSM) compared to 41 percent obtained for the other SSI case analyses.

The maximum ratio of site-specific vertical accelerations to corresponding ESBWR DCD values for the SDOF flexible slab oscillators in the CB is approximately 62 percent (envelope of SSSI analyses of cases CB3UB-DM and CB3LB-DM) and 61 percent (envelope of SSSI analyses of cases CB4-FWSC1UB-MSM and CB4-FWSC1LB-MSM), compared to 75 percent obtained for the other SSI case analyses.

A comparison of 5-percent damped FRS at the key locations in the CB (top of basemat and top of roof slab) obtained from the various site-specific SSSI case analyses to the corresponding enveloping FRS in ESBWR DCD, Tier 2, Section 3A.9.2 indicates that the latter bound the former by a significant margin.

Based on the above observation, the staff concludes that (a) at the Fermi 3 site, the SSSI effects on the CB are relatively minor; and (b) the structural responses computed from the site-specific SSSI analyses in terms of maximum absolute accelerations, maximum forces and moments, and the 5-percent damped FRS at the key locations in the CB identified in ESBWR DCD, Tier 2, Appendix 3A are bounded by the corresponding values considered in the EBSWR DCD. Therefore, the standard plant design for the Fermi 3 site is acceptable.

The seismic lateral soil pressures acting on below-grade exterior walls of the CB and computed from the site-specific SSSI analyses discussed above were incorporated into the applicant's evaluations of the design of below-grade exterior walls of the CB. This issue was reviewed by the staff under Subsection 3.8.4.4 of this SER.

Supplemental Information

- EF3 SUP 3.7-5 Interaction of Non-Category I Structures with Seismic Category I Structures

Interaction of Non-Category I Structures with Seismic Category I Structures

FSAR Subsection 3.7.2.8 indicates that site-specific Non-Category I structures (outside the scope of the ESBWR DCD) are separated from seismic Category I structures by at least a distance equal to their height above grade. Therefore, the collapse of any site-specific Non-Category I structure will not cause the Non-Category I structure to strike a seismic Category I structure. The locations of structures are depicted in FSAR Figure 2.1-204. The staff concludes that this is consistent with SRP Acceptance Criterion 3.7.2.II.8.A and is therefore acceptable.

FSAR Subsection 3.7.2.8 indicates that the design and analysis of the seismic Category II structures (TB; SB; and ADB) and the seismic Category NS RWB identified in ESBWR DCD, Tier 2, Subsection 3.7.2.8 will be completed as part of the detailed design phase for the ESBWR standard plant design, per DCD Tier 2, Subsection 3.7.2.8.1 for the TB, Subsection 3.7.2.8.2 for the RWB, Subsection 3.7.2.8.3 for the SB, and Subsection 3.7.2.8.4 for the ADB; and DCD Tier 1, ITAAC Tables 2.16.8-1 for the TB, 2.16.9-1 for the RWB, 2.16.10-1 for the SB, and 2.16.11-1 for the ADB.

In addition, for the TB, RWB, SB, and ADB structures, FSAR Subsection 3.7.2.8 and Fermi 3 COL application Part 10 identify site-specific ITAAC and corresponding acceptance criteria that indicate the following:

- If the Fermi 3 soil properties do not meet the site parameters specified in the ESBWR DCD, Tier 1, Table 5.1-1 and ESBWR DCD, Tier 2, Table 2.0-1 (e.g., for the engineered granular backfill surrounding the embedded walls of these structures), then Fermi 3 site-specific SSI and SSSI analyses using the Fermi 3 site properties will be performed for the TB, RWB, SB, and ADB structures adhering to the same methodology specified in ESBWR DCD, Tier 2, Appendix 3A; ESBWR DCD, Tier 2, Subsections 3.7.2.8.1 for the TB, 3.7.2.8.2 for the RWB, 3.7.2.8.3 for the SB, and 3.7.2.8.4 for the ADB; and ESBWR DCD, Tier 1 ITAAC Tables 2.16.8-1 for the TB, 2.16.9-1 for the RWB, 2.16.10-1 for the SB, and 2.16.11-1 for the ADB.

- The acceptance criteria consist of comparing the results of the site-specific SSI and SSSI analyses for the TB, RWB, SB, and ADB structures to the corresponding SSI and SSSI analyses performed for the standard plant design under the DCD and confirming that the standard plant design is adequate for the site-specific conditions at Fermi 3.

The site-specific ITAAC are in Fermi 3 COL application Part 10 Tables 2.4.15-1 (TB), 2.4.16-1 (RWB), 2.4.17-1 (SB), and 2.4.18-1 (ADB).

The staff believes that the applicant’s intent was to provide a site-specific ITAAC that will ensure that site-specific SSI and SSSI analyses are performed if necessary to demonstrate that the standard plant design for the TB, SB, ADB, and RWB is adequate for the site-specific conditions at the Fermi 3 site. However, the language in FSAR Subsection 3.7.2.8 and in Part 10 of the COL application was not clear. Therefore, the staff proposed modifications to the ITAAC for better clarity with respect to the expectations of these analyses. The proposed modifications were discussed with the applicant during an open items call held on May 8, 2014 (ADAMS Accession No. ML14140A531). On the same day the applicant submitted a revised FSAR markup (ADAMS Accession No. ML14129A360) that documented the revisions to the ITAAC. The staff is tracking these revisions to FSAR Subsection 3.7.2.8 and Fermi 3 COL application Part 10, Tables 2.4.15-1 (TB), 2.4.16-1 (RWB), 2.4.17-1 (SB), and 2.4.18-1 (ADB) as Confirmatory Item 3.7.2-1. The staff tracked the verification that the next FSAR revision included this change. Therefore, Confirmatory Item 3.7.2-1 is resolved.

<u>Determination of Seismic Overturning Moments and Sliding Forces for Seismic Category I Structures</u>

In FSAR Subsection 3.7.2.14, the applicant indicates that the site-specific stability evaluation against overturning is in FSAR Section 3.8.5. The staff’s evaluation of FSAR Section 3.8.5 is in Subsection 3.8.5.4 of this SER.

Computer Programs Verification and Validation Issues

The applicant performed a verification and validation study of the SASSI2010 program to ensure the numerical accuracy, stability, and consistency of the results obtained using SASSI2010. In this study, the applicant implemented a set of 47 SSI test problems for which the solutions obtained using SASSI2010 were verified and validated against (a) analytical or numerical solutions available in the technical literature; (b) solutions obtained using SASSI2000 and accepted by the staff for the SSI analyses documented in the ESBWR DCD; and (c) solutions obtained using other computer codes. Although most of the test problems were generic, the applicant did consider several test problems that incorporated subsurface profiles and input motions that were representative of the Fermi 3 site; as well as the frequency range of interest to the Fermi 3 site-specific SSI and SSSI analyses.

The staff reviewed selected portions of the applicant's validation and verification calculations during the onsite audits on March 19 through 21, 2013 (ADAMS Accession No. ML13149A515) and November 18 through 22, 2013 (ADAMS Accession No. ML14028A245). Two test problems that incorporated subsurface profiles representative of the Fermi 3 site conditions and frequency range of interest are documented in the supplemental response to RAI 03.07.02-11, (Attachment 1 to DTE Letter NRC3-13-0023, ADAMS Accession No. ML13192A302).

The staff reviewed test problems performed using the DM of analysis in SASSI2010, which were considered relevant to the Fermi 3 site conditions. Additional benchmarking study of the MSM relative to the DM of analysis in SASSI2010 is separately discussed in this report under "*SSI Analysis Method*."

The staff's review yielded the following conclusions:

- For test problems with subsurface profiles representative of the Fermi 3 site conditions and passing frequencies up to 50 Hz, comparisons of impedance functions computed with SASSI2010 and those computed using an alternative program or published solutions were found to be acceptable for approximately 50 Hz for the LB rock profile.

- Test problems with subsurface profiles representative of the Fermi 3 site conditions and passing frequencies up to 50 Hz confirmed the numerical stability of the SASSI2010 solutions to the upper limit of Poisson's ratio of 0.48, which is of interest at the Fermi 3 site.

- Several test problems indicated that the aspect ratio of both plate and brick finite elements used to model the excavated volume of partially embedded structures needs to be limited to 1:3 in the horizontal and vertical directions.

Based on the above discussion and staff's on-site audits mentioned above, the staff concludes that the SASSI2010 program is acceptable for the specific conditions at the Fermi 3 site because the applicant has demonstrated the applicability of SASSI2010 at the Fermi 3 site up to a frequency of 50 Hz. The staff also confirms that the aspect ratio limitation for plate and brick finite elements was implemented in the SSI and SSI analyses as discussed earlier in this SER.

Table 3.7.2-1 Summary of the Applicant's SSI Analyses for the RB/FB

Building	Case ID	DCD Model	Analysis Case	SASSI2010 Method of Analysis	Control Motion	Soil/Rock Profile		
						LB	BE	UB
RB/FB	RBFB1UB-DM	"Base" (*)	SSI without engineered backfill	DM	FIRS			X
	RBFB1BE-DM		SSI without engineered backfill	DM			X	
	RBFB1LB-DM		SSI without engineered backfill	DM		X		
	RBFB2UB-MSM		SSI with engineered backfill	MSM				X
	RBFB2LB-MSM		SSI with engineered backfill	MSM		X		

SSI = soil-structure interaction; RB/FB = reactor building/fuel building; LB = lower bound; BE= best estimate; UB = upper bound; DM = direct method; FIRS = foundation input response spectra; MSM = modified subtraction method.

Note: (*) DCD "Base" model refers to the structural model described in DCD Table 3A.6-1.

Table 3.7.2-2 Summary of the Applicant's SSI Analyses for the CB

Building	Case ID	DCD Model	Analysis Case	SASSI2010 Method of Analysis	Control Motion	Subsurface Profile		
						LB	BE	UB
CB	CB1UB-DM	"Base" (*)	SSI without engineered backfill	DM	FIRS			X
	CB1BE-DM		SSI without engineered backfill	DM			X	
	CB1LB-DM		SSI without engineered backfill	DM		X		
	CB2UB-DM		SSI with engineered backfill	DM				X
	CB2LB-DM		SSI with engineered backfill	DM		X		
	CB3UB-DM		SSSI with engineered backfill	DM	Modified FIRS (**)			X
	CB3LB-DM		SSSI with engineered backfill	DM		X		
	CB4-FWSC1UB-MSM		SSSI with engineered backfill	MSM	FIRS			X
	CB4-FWSC1LB-MSM		SSSI with engineered backfill	MSM		X		

SSI = soil-structure interaction; CB = control building; LB = lower bound; BE= best estimate; UB = upper bound; DM = direct method; FIRS = foundation input response spectra; SSSI = structure-soil-structure interaction; MSM = modified subtraction method.

Notes:

(*) DCD "Base" model refers to the structural model described in DCD Table 3A.6-1.

(**) Modified FIRS refers to control motion based on FIRS, but modified to account for SSSI between the RB/FB and the CB.

3.7.2.5 *Post Combined License Activities*

Site-specific ITAAC and corresponding acceptance criteria for Non-Category I structures within the scope of the DCD are described in Fermi 3 COL application Part 10 ,Tables 2.4.15-1, 2.4.16-1, 2.4.17-1, and 2.4.18-1. The review of these site-specific ITAAC is in Subsection 3.7.2.4 of this SER under "Interaction of Non-Category I Structures with seismic Category I Structures."

3.7.2.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the Fermi 3 FSAR related to this section. All nuclear safety issues relating to the seismic system analysis that were incorporated by reference have been resolved.

The staff compared the supplemental information in the COL application to the relevant NRC regulations, the guidance in Section 3.7.2 of NUREG–0800, other NRC RGs, and the Interim Staff Guidance. The staff finds that the applicant has adequately addressed the seismic system analysis, in accordance with the acceptance criteria delineated in these guidance documents. On this basis, the staff concludes that the applicant has satisfied the relevant requirements of the regulations delineated in Subsection 3.7.2.3 of this SER.

3.7.3 Seismic Subsystem Analysis

Section 3.7.3 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference, with no departures or supplements, Sections 3.7.3, "Seismic Subsystem Analysis," of the ESBWR DCD, Revision 10. NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. All nuclear safety issues relating to the seismic subsystem analysis have been resolved.

3.7.4 Seismic Instrumentation

3.7.4.1 *Introduction*

This FSAR section describes the seismic instrumentation systems as they relate to the capabilities and performance of the instruments to adequately measure the effects of earthquakes. The seismic instrumentation and associated equipment used to measure the plant responses to earthquake motion includes:

- One triaxial time-history accelerograph (THA) installed in the free-field; three THAs in the RB and two THAs in the CB.
- Recording and playback equipment

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

- Annunciators in the main control room.

3.7.4.2 *Summary of Application*

Section 3.7.4 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 3.7.4 of the ESBWR DCD, Revision 10. In addition, in Section 3.7.4, the applicant provides the following:

<u>*Supplemental Information*</u>

- EF3 SUP 3.7-6 Seismic Instrumentation

In FSAR Section 3.7.4, the applicant adds the following commitment (COM 3.7-001):

> The seismic monitoring program described in this subsection, including the necessary test and operating procedures, will be implemented prior to receipt of fuel on site.

3.7.4.3 *Regulatory Requirements*

The regulatory basis of the information incorporated by reference is in NUREG–1966. In addition, the relevant requirements of the Commission regulations for the seismic instrumentation, and the associated acceptance criteria, are in Section 3.7.4 of NUREG–0800. The specific requirements include the following:

- 10 CFR Part 50, Appendix S, requires instrumentation to be provided so that the seismic response of safety-related nuclear plant features can be evaluated promptly after an earthquake.

- 10 CFR Part 50.55a, "Codes and standards."

In addition, the acceptance criteria and regulatory guidance associated with the review of FSAR Section 3.7.4 is documented below:

- RG 1.12, Revision 2, "Nuclear Power Plant Instrumentation for Earthquakes"

- EPRI Report NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake"

- EPRI Report NP-5930, "A Criterion for Determining Exceedance of the Operating Basis Earthquake"

- EPRI Technical Report TR-100082, "Standardization of the Cumulative Absolute Velocity," as permitted by RG 1.166

- RG 1.166, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Postearthquake Actions"

- RG 1.167, "Restart of a Nuclear Power Plant Shut Down by a Seismic Event"

3.7.4.4 *Technical Evaluation*

As documented in NUREG–1966, NRC staff reviewed and approved Section 3.7.4 of the ESBWR DCD. The staff reviewed Section 3.7.4 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the required information relating to this section.

The staff reviewed the following information in the Fermi 3 COL FSAR:

Supplemental Information

- EF3 SUP 3.7-6 Seismic Instrumentation

The applicant adds the following commitment (COM 3.7-001) in FSAR Section 3.7.4:

> The seismic monitoring program described in this subsection, including the necessary test and operating procedures, will be implemented prior to receipt of fuel on site.

Based on the compliance of the proposed resolution with the general operability guidance for seismic equipment in RG 1.12, RG 1.166, and RG 1.167, the staff finds that the timing of the Commitment (COM 3.7-001) is appropriately scheduled before the initial fuel loading.

3.7.4.5 *Post Combined License Activities*

The applicant identifies the following commitment:

- Commitment (COM 3.7-001) – Implement the seismic monitoring program described in this subsection [ESBWR DCD Subsection 3.7.4.5], including the necessary test and operating procedures, before the receipt of fuel onsite.

3.7.4.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the Fermi 3 FSAR related to this section. There are no unresolved nuclear safety issues relating to the seismic instrumentation that were incorporated by reference.

The staff compared the supplemental information in the COL application to the relevant NRC regulations, the guidance in Section 3.7.4 of NUREG–0800, and other NRC RGs. The staff finds that the applicant has addressed seismic instrumentation in accordance with the acceptance criteria delineated in these guidance documents. On this basis, the staff concludes

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

that the applicant has satisfied the relevant requirements of the regulations delineated in Subsection 3.7.4.3 of this SER.

3.8 Seismic Category I Structures

3.8.1 Concrete Containment

Section 3.8.1 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference, with no departures or supplements, Section 3.8.1, "Concrete Containment," of the ESBWR DCD, Revision 10. NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. All nuclear safety issues relating to the concrete containment have been resolved.

3.8.2 Steel Components of the Reinforced Concrete Containment

Section 3.8.2 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference, with no departures or supplements, Section 3.8.2, "Steel Components of the Reinforced Concrete Containment," of the ESBWR DCD, Revision 10. NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. All nuclear safety issues relating to the steel components of the reinforced concrete containment have been resolved.

3.8.3 Concrete and Steel Internal Structures of the Concrete Containment

Section 3.8.3 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference, with no departures or supplements, Section 3.8.3, "Concrete and Steel Internal Structures of the Concrete Containment," of the ESBWR DCD, Revision 10. NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. All nuclear safety issues relating to the concrete and steel internal structures of the concrete containment have been resolved.

3.8.4 Other Seismic Category I Structures

3.8.4.1 *Introduction*

This FSAR section describes the RB, CB, FB, and FWSC as other seismic Category I structures that are not inside the containment and that constitute the ESBWR standard plant design. In addition, this section describes the Non-Category I structures that could interact with these structures and with other structures important to safety.

3.8.4.2 *Summary of Application*

Section 3.8.4 and Appendix 3G of the Fermi 3 COL FSAR, Revision 7, incorporate by reference Section 3.8.4 and Appendix 3G of the ESBWR DCD, Revision 10. In addition, in FSAR Section 3.8.4, the applicant provides the following:

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Supplemental Information

- EF3 SUP 3.8-1 Foundation Stability

In FSAR Subsection 3.8.4.5.6, the applicant provides supplemental information addressing the site-specific evaluation of the seismic lateral soil pressures acting on exterior walls of the RB/FB complex and the CB that are below grade and embedded in the soil media. This subsection also evaluates the design of these exterior walls for the seismic lateral soil pressures.

3.8.4.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1966, and NUREG-1966, Supplement 1 (ADAMS Accession No. ML14265A084). In addition, the relevant requirements of the Commission regulations for other seismic Category I structures, and the associated acceptance criteria, are in Section 3.8.4 of NUREG–0800. The specific requirements include the following:

- 10 CFR 50.55a and 10 CFR Part 50, Appendix A, GDC 1 as they relate to safety-related structures being designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

- 10 CFR Part 50, Appendix A, GDC 2, as it relates to the design of the safety-related structures that are capable of withstanding the most severe natural phenomena such as wind, tornadoes, hurricanes, floods, and earthquakes and the appropriate combination of all loads.

- 10 CFR Part 50, Appendix A, GDC 4, "Environmental and dynamic effects design bases," as it relates to appropriately protecting safety-related structures against dynamic effects—including the effects of missiles, pipe whipping, and discharging fluids—that may result from equipment failures and from events and conditions outside the nuclear power unit.

- 10 CFR Part 50, Appendix A, GDC 5, "Sharing of structures, systems, and components," as it relates to not sharing safety-related structures among nuclear power units, unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions.

- 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," as it relates to the quality assurance criteria for nuclear power plants.

- 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the COL, the provisions of the Atomic Energy Act, and the Commission's rules and regulations.

In addition, the acceptance criteria and regulatory guidance associated with the review of FSAR Section 3.8.4 include the following:

- SRP Section 3.8.4, to evaluate the combination of the incorporated information together with the supplementary information in this section to meet the relevant requirements of 10 CFR 50.55a; GDC 1, 2, 4, and 5 of Appendix A to 10 CFR Part 50; and Appendix B to 10 CFR Part 50.

- RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants."

3.8.4.4 *Technical Evaluation*

As documented in NUREG–1966, and NUREG-1966, Supplement 1, the supplemental FSER (ADAMS Accession No. ML14265A084) related to the certified ESBWR DCD, NRC staff reviewed and approved Section 3.8.4 of the ESBWR DCD. The staff reviewed Section 3.8.4 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the required information relating to this section.

The staff reviewed the following information in the COL FSAR:

<u>*Supplemental Information*</u>

- EF3 SUP 3.8-1 Foundation Stability

<u>Structural Acceptance Criteria</u>

Exterior Wall Design

SRP Section 3.8.4 provides guidelines for the staff's review. Specifically, the staff's review includes an assessment of the wall design for the site-specific seismic lateral soil pressures acting on seismic Category I exterior walls that are below grade and embedded in the soil media.

The review of seismic Category I exterior walls that are above grade, which are thus not subjected to seismic lateral soil pressures, is in Subsection 3.7.2.4 of this SER as part of the review of the overall site-specific seismic response of seismic Category I structures. As indicated in FSAR Section 2.5.4, Figures 2.5.4-201 through 2.5.4-204 depict that the RB/FB and CB are partially embedded in the Bass Islands Group rock. Therefore, the underlying soil media are in fact rock media. In the case of the FWSC, the structure is supported on a block of concrete fill, which bears on the Bass Islands Group rock. A block of concrete fill is also located in the gap between the RB/FB and CB.

Engineered granular backfill is used to fill the site excavation surrounding the power block structures. This backfill is placed above the top of the Bass Islands Group rock up to the plant grade level, as shown in FSAR Figures 2.5.4-201, 2.5.4-202, and 2.5.4-203. FSAR Subsection 2.5.4.5.4.2 describes the material properties and specifications of the engineered granular backfill.

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Therefore, below-grade exterior walls of the RB/FB and the CB bear against rock or concrete fill below the top of rock elevation and against the engineered granular backfill above this elevation. The FWSC has no below-grade walls, so seismic lateral soil pressures are not considered for the FWSC.

As shown in ESBWR DCD, Tier 2, Figures 3G.1-6 and 3G.1-7, the RB/FB has three stories below grade. The walls of the RB/FB that are subjected to lateral soil pressures vertically span between elevations of +3.65 m (11.98 ft) and -1.00 m (-3.28 ft) (top span), -2.00 m (6.56 ft) and -6.40 m (-21 ft) (middle span), and -7.40 m (-24.28 ft) and -11.50 m (-37.73 ft) (bottom span). Stiff floor slabs and the basemat provide lateral support for these walls typically between elevations of +4.65 m (15.26 ft) and +3.65 m (11.98 ft) (floor slab), -1.00 m (-3.28 ft) and -2.00 m (-6.56 ft) (floor slab), -6.40 m (-21 ft) and -7.40 m (-24.28 ft) (floor slab), and -11.50 m (-37.73 ft) and -15.50 m (-50.85 ft) (basemat).

As shown in ESBWR DCD, Tier 2, Figure 3G.2-3, the CB has two stories below grade. The walls of the CB that are subjected to lateral soil pressures vertically span between elevations of +4.15 m (13.61 ft) and -2.00 m (6.56 ft) (top span) and -2.50 m (-8.20 ft) and -7.40 m (-24.28 ft) (bottom span). Stiff floor slabs and the basemat provide lateral support for these walls, typically between elevations of +4.65 m (15.26 ft) and +4.15 m (13.61 ft) (floor slab), -2.00 m (6.56 ft) and -2.50 m (-8.20 ft) (floor slab), and -7.40 m (-24.28 ft) and -10.40 m (-34.12 ft) (basemat).

As indicated above, below-grade exterior walls of the RB/FB and the CB bear against rock or concrete fill below the top of rock elevation (approximately 11.40 m [37.40 ft] below the plant grade) and against the engineered granular backfill above this elevation. Because of the large discontinuity in stiffness between the rock/concrete and the granular backfill media in which the walls are embedded, standard methods for evaluating seismic lateral soil pressures—such as the method described in Subsection 3.5.3.2 of ASCE 4-98, “Seismic Analysis of Safety-Related Nuclear Structures and Commentary”—are not directly applicable to the Fermi 3 site because such methods are based on the assumption that the walls are embedded in a homogeneous soil medium. Therefore, the staff conducted a case-by-case review of the applicant's site-specific evaluations as discussed below.

The applicant's site-specific evaluations of seismic lateral soil pressures acting on below-grade exterior walls of the RB/FB and the CB are documented in FSAR Subsection 3.8.4.5.6 and with more details in the Sargent & Lundy Report SL-012018 Revision 1, “Evaluation of Reactor Building/Fuel Building and Control Building Dynamic Bearing Capacity, Foundation Stability, and Wall Seismic Soil Pressures Summary Report,” (ADMAS Accession No. ML13360A177). In these site-specific evaluations, the applicant used the results of the SSI and SSSI analyses described in FSAR Section 3.7.2, which are also documented in the Sargent & Lundy Reports SL-011864, Revision 1 (ADAMS Accession No. ML13210A144), SL-011956, Revision 1 (ADAMS Accession No. ML13360A176), and SL-011960, Revision 0 (ADAMS Accession No. ML13232A006).

The seismic lateral soil pressures were obtained from the resulting forces in the spring elements connected to the appropriate below-grade nodes of the various SSI and SSSI analysis models, which were specifically added to capture the lateral soil pressures from the SSI and SSSI analyses. The staff considers this to be an acceptable methodology for the Fermi 3 site conditions because it takes into account (a) the site-specific SSI and SSSI effects, and (b) the differences in stiffness between the rock and the granular backfill media in which the structures are embedded. The staff also notes that this SSI analysis-based methodology is consistent with the way the seismic design pressures were developed in the standard design, as described in DCD Tier 2, Sections 3G.1.5.2.1.13 and 3G.2.5.2.1.7.

The seismic lateral soil pressures obtained from the site-specific SSI and SSSI analyses are documented in FSAR Figures 3.8.4-201a through 3.8.4-201h for the RB/FB, FSAR Figures 3.8.4-202a through 3.8.4-202d for the CB (without SSSI effects), and FSAR Figures 3.8.4-203a and 3.8.4-203b for the CB (with SSSI effects). In these figures, the pressures exhibit a sharp peak at the elevation of the top of the rock, which reflects the stiffness discontinuity between the rock and the granular backfill media in which the walls are embedded. In the figures that correspond to SSI analyses without the granular backfill (FSAR Figures 3.8.4-201a, 3.8.4-201e, 3.8.4-202a, and 3.8.4-202c), there are no pressures above the elevation of the top of the rock because the granular backfill was not considered in the analysis of the models. However, these cases exhibit the largest pressure peaks at the elevation of the top of the rock.

In the figures for the RB/FB, the site-specific seismic lateral soil pressures are compared to the two pressure profiles considered in the standard design, which are: (a) seismic design pressures (DCD Tier 2, Subsection 3G.1.5.2.1.13), and (b) wall capacity passive pressures (DCD Tier 2, Subsection 3G.1.5.5). The staff notes that in the standard design, the wall capacity passive pressures are added to the at-rest soil pressures for the wall design so that the above comparison is appropriate. In the figures for the CB, the site-specific pressures are only compared to the seismic design pressures considered in the standard design (DCD Tier 2, Subsection 3G.2.5.2.1.7). The results of these comparisons indicate that the site-specific pressures for the RB/FB and the CB exceed the corresponding pressures considered in the standard design at some locations at elevations near the top of the rock.

To address this issue, the applicant performed additional evaluations to determine the impact of these exceedances on the design of below-grade exterior walls. These additional evaluations are documented in the Sargent & Lundy Report SL-012018, Revision 1 (ADAMS Accession No. ML13360A177). The applicant computed the maximum induced, out-of-plane bending moments and shear forces in the walls due to the site-specific seismic lateral soil pressures and compared them to the corresponding induced moments and shears in the walls due to the pressure profiles considered in the standard design. In all cases, the applicant determined that the Fermi 3 analyses were bounded by the analyses in the ESBWR DCD. The critical cases for the RB/FB were identified as (a) walls RA and RG (see DCD Tier 2, Figures 3G.1-1 and 3G.1-2 for the location of these walls); and (b) the bottom span (between elevations -7.40 m [-24.28 ft] and -11.50 m [-37.73 ft]), where the site-specific induced moments and shears range between 79 percent and 99 percent of the corresponding values resulting from the wall capacity passive pressure profiles considered in the standard design. The critical cases for the CB were identified as walls C1, C5, CA, and CD (see DCD Tier 2, Figures 3G.2-1 and 3G.2-2 for the location of these walls); and the bottom span (between elevations -2.50 m [-8.20 ft] and -7.40 m [-24.28 ft]), where the site-specific induced moments and shears range between 32 percent and 51 percent of the corresponding values resulting from the seismic design pressure profiles considered in the standard design.

The staff reviewed these evaluations and noted that at some locations, the site-specific seismic lateral soil pressures acting on below-grade exterior walls exceed the corresponding pressures considered in the standard design. However, the staff finds the standard design to be acceptable at the Fermi 3 site, because the site-specific member forces (moments and shears) induced in the walls by these pressures are bounded by the corresponding member forces considered in the standard design. The applicant's site-specific evaluation of the below-grade exterior walls design is therefore acceptable per SRP Acceptance Criterion 3.8.4.II.4.H.

Other Review Topics

Design for Hurricane Missiles for RTNSS Related Structures

Based on RG 1.221, the staff requested in RAI 02.03.01-20 that the applicant update the site characteristic values in the Fermi 3 FSAR. As a related matter, the staff also requested the applicant to explain whether the loads from site-specific hurricane winds and hurricane-generated missiles per RG 1.221 were bounded by the loads generally considered in the ESBWR DCD and in particular, the loads for the site-specific hurricane missiles considered in the design for the RTNSS and RTNSS-related structures identified in ESBWR DCD, Tier 2, Appendix 19A.

The staff noted that in ESBWR DCD, Tier 2, Tables 19A-3 and 19A-4 and ESBWR DCD, Tier 2, Table 2.0-1, Footnote (3) indicates that the tornado missile design criterion is not applicable to seismic Category NS and seismic Category II buildings. However, for seismic Category NS and seismic Category II buildings that house RTNSS equipment, a hurricane missile criterion is specified so that barriers are designed for the impact from missiles generated by Category 5 hurricanes (a 3-second gust wind speed of 313.76 kilometers per hour (kph) [195 miles per hour (mph)]). The missile spectrum and missile velocities are in accordance with SRP Subsection 3.5.1.4, Revision 2, where the tornado wind speed replaced the hurricane wind speed.

During the onsite audit on April 23 through 27, 2012 (ADAMS Accession No. ML12207A471), the applicant explained that a response to RAI 02.03.01-20 was submitted on April 3, 2012 (ADAMS Accession No. ML12095A283). The staff reviewed the response and found that it did not address the issue of site-specific hurricane missiles considered in the design of RTNSS and RTNSS-related structures.

The applicant explained that for the hurricane missile design, consistent with the guidance in SRP Subsection 3.5.1.4, Revision 2, the missile velocities associated with the three missile types (1,800-kilogram [kg] [3,968-pound] automobile, 125-kg [275.57-pound] pipe, and the 2.54–centimeter (cm) [1-inch] diameter solid sphere) are taken as 35 percent of the assumed 313.76-kph (195-mph) hurricane wind, which is 109.4 kph (68 mph) (i.e., 0.35 x 195 mph = 68 mph). This information is specified in a GEH internal document that the staff reviewed and identified in the staff’s audit report (ADAMS Accession No. ML12207A471).

The applicant also explained that by assuming the most conservative estimate of the RG 1.221 design-basis hurricane wind speed at the Fermi site of 209.2 kph (130 mph), missile velocities associated with the three missile types in RG 1.221 are 106.2 kph (66 mph) for the 1,800-kg [3,968-pound] automobile; 78.84 kph (49 mph) for the 125-kg (275.57-pound) pipe; and 67.58 kph (42 mph) for the 2.54-cm (1-inch) diameter solid sphere.

Because conservative estimates of site-specific missile velocities computed in accordance with RG 1.221 are bounded by the corresponding DCD hurricane missile criterion (i.e., 109.4 kph [68 mph]), the staff concludes that the DCD hurricane missile criterion bounds the Fermi 3 site for the seismic Category NS and seismic Category II buildings that house RTNSS equipment.

3.8.4.5 *Post Combined License Activities*

There are no post COL activities related to this section.

3.8.4.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966, and NUREG-1966, Supplement 1. NRC staff reviewed the application and checked the referenced ESBWR DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. All nuclear safety issues relating to the other seismic Category I structures have been resolved.

The staff compared the supplemental information in the COL application to the relevant NRC regulations, the guidance in Section 3.8.4 of NUREG–0800, and other NRC RGs. The staff finds that the applicant has adequately addressed the site-specific issues related to the design of other seismic Category I structures consistent with the acceptance criteria delineated in these guidance documents. On this basis, the staff concludes that the applicant has satisfied the relevant requirements of the regulations delineated in Subsection 3.8.4.3 of this SER.

3.8.5 Foundations

3.8.5.1 *Introduction*

This FSAR section addresses the foundations for all seismic Category I Structures. The ESBWR design employs separate reinforced-concrete mat foundations for major seismic Category I Structures. The RB including the containment and the FB are built on a common foundation mat. The foundations of the CB and the FWSC are separate from each other and from the RB and FB foundations.

3.8.5.2 *Summary of Application*

Section 3.8.5 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 3.8.5 of the ESBWR DCD, Revision 10. In addition, in FSAR Section 3.8.5, the applicant provides the following:

Supplemental Information

- EF3 SUP 3.8-1 Foundation Stability

In FSAR Subsection 3.8.5.5.1, the applicant provides the following:

- Site-specific evaluations of foundation stability for the RB/FB and the CB.
- Site-specific evaluations of sliding stability for the block of concrete fill under the FWSC.
- Site-specific dynamic bearing pressure demands for the RB/FB and the CB against the corresponding DCD values and site-specific dynamic bearing pressure capacities reported in FSAR Section 2.5.4.

3.8.5.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1966 and NUREG-1966, Supplement 1. In addition, the relevant requirements of the Commission regulations for the review of the foundation, and the associated acceptance criteria, are in Section 3.8.5 of NUREG–0800. The specific requirements include the following:

- 10 CFR 50.55a and 10 CFR Part 50, Appendix A, GDC 1, as they relate to safety-related foundations being designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

- 10 CFR Part 50, GDC 2, as it relates to the design of the safety-related foundations that are capable of withstanding the most severe natural phenomena such as wind, tornadoes, hurricanes, floods, and earthquakes and the appropriate combination of all loads.

- 10 CFR Part 50, GDC 4, as it relates to appropriately protecting safety-related foundations against dynamic effects; including the effects of missiles, pipe whipping, and discharging fluids that may result from equipment failures and from events and conditions outside the nuclear power unit.

- 10 CFR Part 50, GDC 5, as it relates to not sharing safety-related foundations among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions.

- 10 CFR Part 50, Appendix B, as it relates to quality assurance criteria for nuclear power plants.

- 10 CFR 52.80(a), which requires a COL application to contain the proposed inspections, tests, and analyses—including those applicable to emergency planning—that the licensee shall perform; and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that if the inspections, tests, and analyses are performed and the acceptance criteria are met, the facility has been constructed and will operate in conformity with the COL; the provisions of the Atomic Energy Act; and Commission rules and regulations.

3.8.5.4 *Technical Evaluation*

As documented in NUREG–1966 and NUREG-1966, Supplement 1, the supplemental FSER related to the certified ESBWR DCD, NRC staff reviewed and approved Section 3.8.5 of the ESBWR DCD. The staff reviewed Section 3.8.5 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the required information relating to this section.

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

The staff reviewed the following information in the COL FSAR:

Supplemental Information

- EF3 SUP 3.8-1 Foundation Stability

Structural Acceptance Criteria

Foundation Stability

SRP Section 3.8.5 provides guidelines to the staff for reviewing foundations of seismic Category I structures. Specifically, the staff's review includes an evaluation of the stability of the foundation against overturning, sliding, and flotation to ensure adequate safety margins.

The RB/FB complex foundation consists of a reinforced concrete basemat 4.0-m (13.12-ft) thick with plan dimensions of 70 m by 49 m (229.7 by 160.8 ft) (ESBWR DCD, Tier 2, Figures 3G.1-1, 3G.1-6, and 3G.1-7). The CB foundation consists of a 3.0-m (9.84-ft) thick reinforced concrete basemat with plan dimensions of 30.3 m by 23.8 m (99.41 by 72.54 ft) (ESBWR DCD, Tier 2, Figure 3G.2-1). The FWSC foundation consists of a 2.5-m (8.20-ft) thick reinforced concrete basemat with plan dimensions of 52 m by 20 m (170.6 by 65.62 ft) (ESBWR DCD, Tier 2, Figure 3G.4-1). Other key dimensions of the foundations are in ESBWR DCD, Tier 2, Table 3.8-13.

As indicated in FSAR Section 2.5.4, Figures 2.5.4-201 through 2.5.4-204, the RB/FB and the CB structures at the Fermi 3 site are partially embedded in the Bass Islands Group rock. Therefore, the underlying soil media are in fact rock media. In the case of the FWSC, the structure is supported on a block of concrete fill that bears on the Bass Islands Group rock. A block of concrete fill is also located in the gap between the RB/FB and the CB.

Engineered granular backfill is used to fill the site excavation surrounding the power block structures. This backfill is placed above the top of the Bass Islands Group rock up to the plant grade level, as shown in FSAR Figures 2.5.4-201, 2.5.4-202, and 2.5.4-203. FSAR Subsection 2.5.4.5.4.2 describes the material properties and specifications of the engineered granular backfill.

The applicant's site-specific evaluations of foundation stability for the RB/FB and the CB are in FSAR Subsection 3.8.5.5.1, FSAR Tables 3.8.5-201 and 3.8.5-202, and with more details in the Sargent & Lundy Report SL-012018, Revision 1 (ADAMS Accession No. ML13360A177). In these site-specific evaluations, the applicant used the results of the SSI analyses described in FSAR Section 3.7.2, which are documented in the Sargent & Lundy Reports SL-011864, Revision 1 (ADAMS Accession No. ML13210A144) and SL-011956, Revision 1 (ADAMS Accession No. ML13360A176).

The staff reviewed selected portions of the applicant's foundation stability calculations for the RB/FB and the CB during the onsite audit on November 18 through 22, 2013 (ADAMS Accession No. ML14028A245).

Sliding Stability of the RB/FB and CB

To calculate the minimum factor of safety (FS) against sliding due to site-specific seismic loads, the applicant followed the method described in ESBWR DCD, Tier 2, Subsection 3.8.5.5, which was accepted by the staff during the review of the ESBWR DCD and is therefore acceptable for the site-specific evaluation.

In this method, the FS is evaluated as the ratio of the total horizontal frictional resistance force to the horizontal seismic load. The FS was evaluated as a function of time, and the values reported in the FSAR correspond to a time instant that yields the lowest FS. The evaluation was performed separately in the two orthogonal horizontal directions.

The applicant considered a static friction coefficient of 0.7 to evaluate the frictional resistance along the sliding plane located at the bottom of the basemat shear keys, which is consistent with ESBWR DCD, Tier 2, Subsection 3.8.5.5 and is the major contributor to the total horizontal frictional resistance force. The staff finds this value of 0.7 acceptable because it corresponds to an equivalent angle of internal friction of 35 degrees, which is lower (i.e., more conservative) than the site-specific equivalent Mohr-Coulomb angle of internal friction parameters reported for the Bass Islands Group rock in FSAR Table 2.5.4-208. These site-specific parameters are 53 degrees (upper bound), 48 degrees (mean), and 42 degrees (lower bound)—all greater than 35 degrees. In addition, FSAR Subsection 2.5.4.10.1 indicates that the angle of internal friction representative of the Bass Islands Group rock is 52 degrees, which is also greater than 35 degrees.

The applicant conservatively ignored the following three forces that would contribute to the total horizontal resisting force: (a) skin friction resistance provided by the basemat sides parallel to the direction of motion; (b) skin friction resistance provided by the outside vertical surface of shear keys parallel to the direction of motion; and (c) lateral bearing resistance acting against the shear keys opposite to the direction of motion. The applicant conservatively ignored any contribution from the engineered granular backfill placed above the rock.

In the case of the RB/FB, the applicant also conservatively ignored the lateral bearing resistance acting against the basemat opposite from the direction of motion. In other words, the only horizontal resistance force considered in the evaluation of the RB/FB results from friction along the sliding plane located at the bottom of the basemat shear keys.

In the case of the CB, for the SSI analyses without the engineered granular backfill (the SSI analyses denoted as CB1LB-DM, RBFB1BE-DM, and RBFB1UB-DM and listed in Tables 3.7.2-1 and 3.7.2-2 of this SER), a certain amount of lateral bearing resistance against the basemat opposite from the direction of motion was necessary to obtain an acceptable FS of 1.1. The staff reviewed the applicant's calculations, which are summarized in the Sargent & Lundy Report SL-012018, Revision 1. The staff determined that the allowable lateral bearing strength of the rock and concrete fill that surrounds the CB basemat substantially exceeds the lateral bearing force necessary for an FS of 1.1. The staff's conclusion is based on comparisons of (1) the necessary bearing force to the site-specific allowable bearing capacity of the rock reported in FSAR Table 2.5.4-227 (for dynamic loading conditions), and (2) the compressive strength of the concrete fill specified in FSAR Subsection 2.5.4.5.4.2. The applicant also determined that in this condition, the block of concrete fill between the RB/FB and the CB will not slide relative to the underlying rock (the staff estimated an FS in excess of 3.0 for the block against sliding). Therefore, the staff concludes that there is no transfer of horizontal seismic load from the CB to the RB/FB through the block of concrete.

The applicant determined that the minimum FS against sliding for the RB/FB is 1.22 (for the SSI analysis of case RBFB1BE-DM in the North-South direction without the engineered granular backfill; other SSI case analyses yield a higher FS). Similarly, the applicant determined that the minimum FS against sliding for the CB is 1.1 (for SSI analyses of cases CB1LB-DM, CB1BE-DM, and CB11UB-DM in East-West and North-South directions without the engineered granular backfill; other SSI case analyses yield a higher FS). All SSI analyses without the engineered granular backfill yield a lower FS than the corresponding SSI analyses with the engineered granular backfill.

The staff concludes that the reported FS were conservatively estimated using acceptable methodologies, and all are greater than or equal to the required minimum FS of 1.1 specified in SRP Acceptance Criterion 3.8.5.II.5. The reported FS are therefore acceptable.

Overturning Stability of the RB/FB and CB

To calculate the minimum FS against overturning due to site-specific seismic loads, the applicant followed the energy method described in DCD Tier 2, Subsection 3.7.2.14. This method was accepted by the staff during the review of the DCD and is therefore acceptable for the site-specific evaluation.

This method evaluates the FS as the ratio of the potential energy required to overturn the structure to the maximum kinetic energy imparted to the structure by the site-specific seismic motions. To compute the maximum kinetic energy, the applicant used the maximum absolute velocities obtained from the site-specific SSI analyses. The applicant conservatively assumed that the maximum absolute velocities at all mass degrees-of-freedom in both the horizontal and vertical directions occur at the same time instant. To compute the potential energy required to overturn the structure, the applicant conservatively ignored the potential energy caused by the effect of embedment.

The applicant determined that the minimum FS against overturning for the RB/FB is 2,262 (for SSI analysis of case RBFB1UB-DM in East-West direction, without the engineered granular backfill; other SSI analysis cases yield higher FS). Similarly, the applicant determined that the minimum FS against overturning for the CB is 1,733 (SSI analysis of case CB1BE-DM in East-West direction, without the engineered granular backfill; other SSI case analyses yield higher FS). All SSI analyses without the engineered granular backfill yield a lower FS than the corresponding SSI analyses with the engineered granular backfill.

The staff concludes that the reported FS were conservatively estimated using methodologies accepted by the staff during the review of the DCD, and all are greater than or equal to the required minimum FS of 1.1 specified in SRP Acceptance Criterion 3.8.5.II.5. Therefore, the reported FS are acceptable.

Flotation Stability of the RB/FB and CB

To calculate the minimum FS against flotation due to site-specific flooding, the applicant followed the method described in DCD Tier 2, Subsection 3.8.5.5 that was accepted by the staff during the review of the DCD. This method is therefore acceptable for the site-specific evaluation. This method evaluates the FS as the ratio of the sustained downward forces (i.e., dead load) to the sustained upward forces (i.e., buoyancy).

The site-specific evaluation considered the design-basis flood level to be 0.30 m (1 ft) below plant grade, which is higher than the maximum site-specific flood level of 1.20 m (4 ft) below grade reported in FSAR Table 2.0-201 and is therefore conservative.

The applicant determined that the minimum FS against flotation are 3.50 and 1.86 for the RB/FB and the CB, respectively. The staff concludes that the reported FS were conservatively estimated using methodologies accepted by the staff during the review of the DCD, and all are greater than or equal to the required minimum FS of 1.1 specified in SRP Acceptance Criterion 3.8.5.II.5. The reported FS are therefore acceptable.

Sliding Stability of the Block of Concrete Fill Below the FWSC

Although site-specific seismic SSI analyses of the FWSC were not required (see Subsection 3.7.2.4 of this SER), the applicant performed an evaluation of the sliding stability of the block of concrete fill under the FWSC basemat because this was not considered in the standard plant design. This evaluation is documented in FSAR Subsection 3.8.5.5.1.

The applicant followed the method described in DCD Tier 2, Subsection 3.8.5.5, which was accepted by the staff during the review of the DCD and is therefore acceptable for the site-specific evaluation. In this method, the minimum FS against sliding is evaluated as the ratio of the total horizontal frictional resistance force to the horizontal seismic load.

The horizontal seismic load was conservatively evaluated from the results of the SSI analyses reported in the DCD, because site-specific seismic SSI analyses of the FWSC were not performed. This approach is acceptable because the seismic loads considered in the DCD are based on the FWSC CSDRS, which bounds the site-specific FWSC FIRS and is explained in Subsection 3.7.1.4 of this SER.

The applicant determined that the minimum horizontal frictional resistance force in the concrete fill corresponds to the shear resistance on a shear plane below the FWSC basemat shear keys. To ensure that a minimum FS of at least 1.1 is obtained for this shear plane, the FSAR indicates that a shear-friction reinforcement will be placed in the concrete fill. The specific amount of reinforcement will be selected during the detailed design phase with a minimum design margin of 10 percent. The staff finds this reinforcement acceptable because it results in a minimum sliding FS of 1.1 for any shear plane in the concrete fill below the FWSC basemat shear keys and is consistent with SRP Acceptance Criterion 3.8.5.II.5.

Soil Bearing Pressures

SRP Section 3.8.5 provides guidelines for the staff to review issues related to the foundations of seismic Category I structures. Specifically, the staff's review includes an assessment of the foundations for their capability to receive loads from the structures and transmit these loads to the soil media with appropriate safety margins.

The applicant performed SSI analyses with and without considering the effects of the engineered granular backfill. All SSI analyses without the engineered granular backfill yield greater bearing pressures than the corresponding SSI analyses with the engineered granular backfill.

The applicant's site-specific evaluations of maximum dynamic soil-bearing pressures (i.e., maximum toe pressures under worst-case static plus seismic loads) for the RB/FB complex and the CB are in FSAR Subsection 3.8.5.5.2, FSAR Table 3.8.5-203, and with more details in the Sargent & Lundy Report SL-012018, Revision 1 (ADAMS Accession No. ML13360A177). In these site-specific evaluations, the applicant used the results of the SSI analyses described in FSAR Section 3.7.2, which are documented in the Sargent & Lundy Reports SL-011864, Revision 1 (ADAMS Accession No. ML13354B536) and SL-011956, Revision 1 (ADAMS Accession No. ML13360A176).

The staff reviewed selected portions of the applicant's dynamic soil-bearing pressure calculations for the RB/FB and the CB during the onsite audit on November 18 through 22, 2013 (ADAMS Accession No. ML14028A245).

To calculate the site-specific dynamic soil-bearing pressures, the applicant followed the "Modified Energy Balance" (MEB) method (ESBWR DCD, Tier 2, Reference 3G.1-2). This is the same method referenced in ESBWR DCD, Tier 2, Subsections 3G.1.5.5 and 3G.2.5.5, which was accepted by the staff during the review of the DCD and is therefore acceptable for the site-specific evaluation. The staff notes that the ESBWR DCD refers to this method as the "Energy Balance" method. The response to ESBWR RAI Letter Number 363—RAI 3.8-94, Supplement 05— (ADAMS Accession No. ML092430127) clarified that the MEB method was used in all ESBWR DCD evaluations.

To account for additional uplift pressures from the rotation of the basemat around the two horizontal axes, the applicant followed a conservative approach to evaluate and envelope two cases for the (a) potential uplift in the X direction together with a full contact length in the Y direction; and (b) potential uplift in the Y direction together with a full contact length in the X direction. This is the same approach accepted by the staff during the review of the DCD and is therefore found acceptable by the staff for the site-specific evaluation.

The applicant determined that the maximum site-specific dynamic pressure exerted by the RB/FB on the underlying rock is 2.05 megapascal (MPa) (297.31 pounds per square inch [psi]) (FSAR Table 3.8.5-203), which corresponding to the SSI analysis of case RBFB1UB-DM without the engineered granular backfill (other SSI case analyses yield lower bearing pressures). This value is greater than the value of 1.10 MPa (159.53 psi) value reported in ESBWR DCD, Tier 2, Tables 2.0-1 and 3G.1-58 for the "hard" site condition, but less than 2.70 MPa (391.58 psi) value for the "medium" site condition.

Similarly, the applicant determined that the maximum site-specific dynamic pressure exerted by the CB on the underlying rock is 0.85 MPa (123.28 psi) (FSAR Table 3.8.5-203), corresponding to the SSI analysis of case CB1UB-DM without the engineered granular backfill (other SSI case analyses yield lower bearing pressures). This value is greater than the 0.42 MPa (60.91 psi) value reported in ESBWR DCD, Tier 2, Tables 2.0-1 and 3G.2-27 for the "hard" site condition, but less than the 2.20 MPa (319.07 psi) value for the "medium" site condition.

As indicated above, the site-specific maximum dynamic soil-bearing pressures for the RB/FB and the CB exceed the values reported in the ESBWR DCD for the "hard" site condition, which is the DCD condition that most resembles the underlying rock at the Fermi 3 site. The staff finds this acceptable because the site-specific maximum dynamic soil-bearing pressures are bounded by the site-specific allowable dynamic bearing capacities of the underlying rock, which are reported in FSAR Tables 2.0-201 and 2.5.4-227 as 5.98 MPa (867.28 psi) for the RB/FB and 18.70 MPa (2712.1 psi) for the CB. The staff concludes that the maximum toe pressures exerted by the RB/FB and the CB structures, under worst-case static plus seismic loads, do not exceed the allowable dynamic bearing capacities of the underlying rock at the Fermi 3 site and therefore the dynamic pressures meet the guidance in SRP Acceptance Criterion 3.8.5.II.4.

Because the site-specific maximum dynamic soil-bearing pressures exceed the values reported in the ESBWR DCD, the staff evaluated whether the site-specific stresses induced in the RB/FB and CB basemats from load combinations that include seismic loads, also exceed the stresses considered in the standard design. The staff concluded that site-specific stresses induced in the RB/FB and CB basemats are bounded by the stresses considered in the standard design, as discussed below.

In the standard design described in ESBWR DCD, Tier 2, Sections 3G.1.4, 3G.1.5, 3G.2.4, and 3G.2.5, three-dimensional linear-elastic finite element models of the RB/FB and the CB are used to analyze and design the basemats. In these DCD models, the underlying soil media are represented by elastic springs connected to the nodes at the bottom of the basemats. The stiffness of these springs corresponds to the "soft" site condition (see DCD Tier 2, Subsection 3G.1.4.2 and Table 3G.1-1 for the RB/FB and DCD Tier 2, Subsection 3G.2.4.2 and Table 3G.2-1 for the CB). The seismic loads (seismic shears, moments, and vertical accelerations) applied to the DCD models are shown in DCD Tier 2, Figures 3G.1-24, 3G.1-25, 3G.1-26, and Table 3G.1-9 for the RB/FB; and DCD Tier 2, Figure 3G.2-14 and Table 3G.2-5 for the CB.

ESBWR DCD, Tier 2, Subsection 3.8.5.4 indicates that basemat deformations and stresses for the "soft" site condition were compared to the corresponding values obtained assuming a "hard" site condition. The "soft" site condition was found to control the standard design of the basemats.

The staff compared the seismic loads applied to the ESBWR DCD models of the RB/FB and the CB to the corresponding site-specific seismic loads reported in Tables 3 through 15 of the supplemental response to RAI 03.07.02-9 dated December 13, 2013 (ADAMS Accession No. ML13354B536). The staff concluded that the site-specific seismic loads are bounded by the seismic loads applied to the DCD models by a significant margin.

Based on the above considerations, as well as considering the linearity of the ESBWR DCD analysis models, the staff concludes that if the site-specific seismic loads were to be applied to the DCD models of the RB/FB and the CB with a soil spring stiffness representative of the underlying rock at the Fermi 3 site, the site-specific stresses induced in the RB/FB and CB basemats would be bounded by the stresses considered in the standard design by a substantial margin and are therefore consistent with SRP Acceptance Criterion 3.8.5.II.4.

Other Review Topics

Prevention of Alkali-Silica Reaction-Induced Concrete Degradation

Per SRP Section 3.8.5, the staff's review includes an assessment of the materials and quality control programs for concrete used in foundations and other elements of seismic Category I structures in view of NRC Information Notice (IN) 2011-20, "Concrete Degradation by Alkali-Silica Reaction."

NRC IN 2011-20 (ADAMS Accession No. ML112241029) informs the licensees about the potential occurrence of alkali-silica reaction (ASR)-induced concrete degradation of a seismic Category I structure that occurred at the Seabrook Station Nuclear Power Plant. The IN indicates that the tests described in ASTM C227, "Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)," and ASTM C289, "Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)," may not accurately predict aggregate reactivity when dealing with late or slow-expanding aggregates containing strained quartz or micro-crystalline quartz. More appropriate in this regard are the updated testing standards in ASTM C1260, "Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)," and ASTM C1293, "Standard Test Method for Determination of Length of Change of Concrete Due to Alkali-Silica Reaction."

Neither Revision 4 of the FSAR nor the DCD referenced the updated testing standards of ASTM C1260 and C1293, either directly or by reference to ACI 349-01, "Code Requirements for Nuclear Safety Related Concrete Structures," or the ASME Code (2004 Edition). During the onsite audit on April 23 through 27, 2012 (ADAMS Accession No. ML12207A471), the staff requested the applicant to explain the measures implemented in the FSAR to prevent the problems that IN 2011-20 describes. In particular, whether testing in accordance with the updated ASTM C1260 and C1293 will be performed during construction.

To address the staff's concerns, the applicant submitted markups to FSAR Table 1.9-204 and FSAR Subsection 2.5.4.12 (Attachment 1 to DTE Letter NRC3-12-0012, ADAMS Accession No. ML12097A556) that identify and specify the testing of the concrete aggregate for seismic Category I and RTNSS structures in accordance with the testing standards in ASTM C1260-07 and ASTM 1293-08b. The staff finds the applicant's information acceptable because, as indicated above, updated testing standards in ASTM C1260 and C1293 have been better predictors of aggregate reactivity. The staff subsequently confirmed that these changes were incorporated into Revision 5 of the FSAR, which resolves this issue.

3.8.5.5 *Post Combined License Activities*

There are no post COL activities related to this section.

3.8.5.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG-1966 and NUREG-1966, Supplement 1. NRC staff reviewed the application and checked the referenced ESBWR DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. All nuclear safety issues relating to seismic Category I foundations that were incorporated by reference have been resolved.

The staff compared the supplemental information in the COL application to the relevant NRC regulations, the guidance in Section 3.8.5 of NUREG–0800, and other NRC RGs. The staff finds that the applicant has adequately addressed the site-specific issues related to the design of the foundations for Category I structures consistent with the acceptance criteria delineated in these guidance documents. On this basis, the staff concludes that the applicant has satisfied the relevant requirements of the regulations delineated in Subsection 3.8.5.3 of this SER.

3.8.6 Special Topics

Sections 3.8.6 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference, with no departures or supplements, Sections 3.8.6," Special Topics," of the ESBWR DCD, Revision 10. NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

outstanding information is expected to be addressed in the COL FSAR related to this section. All nuclear safety issues relating to this section have been resolved.

3.9 Mechanical Systems and Components

3.9.1 Introduction

Section 3.9 of the Fermi 3 COL FSAR addresses the structural integrity and functional capability of mechanical SSCs and incorporates by reference Section 3.9 of the ESBWR DCD, Revision 10. Following the issuance of the ESBWR FSER on March 9, 2011, the (NRC staff identified issues applicable to the ESBWR steam dryer structural analysis based on information obtained during the NRC review of a license amendment request for a power uprate at an operating boiling-water reactor nuclear power plant. As a result of resolving those issues, General Electric–Hitachi (GEH) revised the DCD to withdraw the licensing topical reports (LTRs) addressing the ESBWR steam dryer structural evaluation, and to reference new engineering reports that describe the updated ESBWR steam dryer analysis methodology. The staff reviewed the revised DCD sections, the new GEH engineering reports, and the RAI responses. NUREG-1966, Supplement 1, the Supplemental FSER related to the certified ESBWR DCD, Tier 2, Section 3.9.5 replaces in its entirety Section 3.9.5, "Reactor Pressure Vessel Internals," of the DCD FSER issued on March 9, 2011. Information related to ESBWR reactor pressure vessel (RPV) internals other than the steam dryer (such as core support structures) was copied from the FSER and placed in the Supplemental FSER to provide the description of the staff's review of all ESBWR RPV internals in one location.

3.9.2 Summary of Application

Section 3.9 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 3.9 of the ESBWR DCD, Revision 10. In addition, in Fermi 3 COL FSAR, the applicant provides the following:

COL Items

- EF3 COL 3.9.9-1-A — Reactor Internals Vibration Analysis, Measurement and Inspection Program

To address COL Item 3.9.9-1-A, the Fermi 3 COL applicant provides the following supplemental information in FSAR Subsection 3.9.2.4:

> For reactor internals other than the steam dryer, the vibration assessment program, as specified in Regulatory Guide (RG) 1.20, is provided in DCD Appendix 3L and the following referenced GEH Report:
>
> - NEDE-33259P-A, "Reactor Internals Flow Induced Vibration Program"
>
> The classification of the Fermi 3 reactor internals in accordance with RG 1.20 is dependent on ESBWR status, i.e., if Fermi 3 is the initial ESBWR to perform testing of the reactor internals, or if testing is performed at another reactor prior to Fermi 3 testing. There are two different scenarios:

1. A valid prototype for the Fermi 3 reactor internals does not exist. Under this scenario, Fermi 3 reactor internals classification is a prototype per RG 1.20.

2. A valid prototype for Fermi 3 reactor internals does exist. If the prototype testing is performed outside the United States, the guidance in RG 1.20, Revision 3, Regulatory Position 1.2, would need to be satisfied in order for this reactor to be considered a "valid prototype." Assuming that Fermi 3 reactor internals are substantially similar to the valid prototype and that the valid prototype does not experience inservice problems that result in component or operational modifications, Fermi 3 reactor internals will be classified as non-prototype Category I. If a change to classification for Fermi 3 reactor internals is later determined to be necessary, the classification change will be addressed at the time the change is proposed with proper evaluation/justification and documented in a revision to the FSAR.

Specific to the steam dryer, the comprehensive vibration assessment program, as specified in RG 1.20, is provided in DCD Appendix 3L and the following referenced GEH reports:

- NEDE-33312P, "ESBWR Steam Dryer Acoustic Load Definition"
- NEDE-33313P, "ESBWR Steam Dryer Structural Evaluation"
- NEDE-33408P, "ESBWR Steam Dryer- Plant Based Load Evaluation Methodology, PBLE01 Model Description"

Unlike the overall classification for the reactor internals described above, the steam dryer is definitively classified as a prototype according to RG 1.20, Revision 3. Section 10.2 of NEDE-33313P provides four elements of a steam dryer Comprehensive Vibration Assessment Program that must be addressed. The following describes the approach for the steam dryer Comprehensive Vibration Assessment Program elements, consistent with RG 1.20 and Section 10.2 of NEDE-33313P:

1. The ESBWR steam dryer Comprehensive Vibration Assessment Program is described in DCD Section 3.9, DCD Appendix 3L, and NEDE-33313P, Section 10.0, which includes a description for preparing and submitting to the NRC a Steam Dryer Monitoring Plan no later than 90 days before startup.

2. The detailed design of the steam dryer will follow the methodology described in DCD Appendix 3L and the incorporated engineering reports. As described in NEDE-33313P, Section 10.2(b), an example of a steam dryer predicted analysis that concludes the steam dryer will not exceed stress limits with applicable bias and uncertainties and the minimum alternating stress ratio of 2.0 is provided in NEDE-33408P. The final detailed design of the ESBWR steam dryer has not yet been completed. Therefore, the example of an as-designed steam dryer that has been subject to the predicted analysis process and successful startup testing

described in NEDE-33408P serves as the design analysis report for the steam dryer and provides sufficient information for licensing. The post licensing commitments in ITAAC and license conditions confirm the acceptability of the ESBWR steam dryer design.

3. The startup program and associated license conditions that include appropriate notification points during power ascension, providing data to the NRC at certain hold points and at full power, and providing to the NRC a full stress analysis report and evaluation within 90 days of reaching the full power level, are established in accordance with NEDE-33313P, Section 10.2(c).

4. Periodic steam dryer inspection during refueling outages is as described in NEDE-33313P, Section 10.2(d), and associated license conditions.

In addition, in FSAR Subsection 3.9.2.4, the applicant identifies two commitments—COM 3.9-001 and COM 3.9-006—related to the development of a comprehensive vibration assessment and the associated reports. These commitments are listed later in this section.

- STD COL 3.9.9-2-A — ASME Class 2 or 3 or Quality Group D Components with 60-Year Design Life

To address COL 3.9.9-2-A, the Fermi 3 COL applicant adds the following two commitments in FSAR Subsection 3.9.3.1:

<u>Commitment (COM 3.9-002)</u>:

The equipment stress reports identified in this DCD section will be completed within six months of completion of DCD ITAAC Table 3.1-1.

<u>Commitment (COM 3.9-004):</u>

The FSAR will be revised as necessary in a subsequent update to address the results of this analysis.

- STD COL 3.9.9-3-A — Inservice Testing Programs

To address COL Item 3.9.9-3-A, the Fermi 3 COL applicant specifies FSAR provisions to supplement ESBWR DCD, Tier 2, Section 3.9.6, “Inservice Testing of Pumps and Valves.” For example, the Fermi 3 FSAR specifies that in addition to the provisions in ESBWR DCD, Tier 2, Section 3.9.6, milestones for implementing the ASME *Code for Operation and Maintenance of Nuclear Power Plants* (OM Code) preservice and inservice testing programs are defined in FSAR Section 13.4. In addition to the provisions in ESBWR DCD, Tier 2, Subsection 3.9.6.1, “Inservice Testing of Valves,” the Fermi 3 FSAR specifies that valves are subject to preservice testing. In addition to the provisions in ESBWR DCD, Tier 2, Subsection 3.9.6.1.4, “Valve Testing,” the Fermi 3 FSAR provides additional provisions for valve exercise tests. The Fermi 3 FSAR also specifies additional provisions for the design and qualification process for explosively actuated valves. In addition to the power-operated valve test provisions in ESBWR DCD, Tier 2, Subsection 3.9.6.1.5, “Specific Valve Test Requirements,” the Fermi 3 FSAR refers to Subsection 3.9.6.8 for additional (non-Code) testing of power-operated valves as discussed in Regulatory Issue Summary (RIS) 2000-03, “Resolution of Generic Safety Issue 158:

Performance of Safety-Related Power-Operated Valves Under Design Basis Conditions." In addition to the check valve exercise test provisions in ESBWR DCD, Tier 2, Subsection 3.9.6.1.5, the Fermi 3 FSAR specifies that check valve testing includes verification that obturator movement is in the direction required for the valve to perform its safety function. The Fermi 3 FSAR also includes additional check valve test provisions for (1) acceptance criteria, (2) a disassembly examination program where test methods are impractical, (3) nonintrusive diagnostic techniques, (4) post-maintenance testing, (5) preoperational testing, and (6) data collection for testing and inspections. In addition to the provisions in ESBWR DCD, Tier 2, Subsection 3.9.6.5, "Valve Replacement, Repair and Maintenance," the Fermi 3 FSAR provides additional provisions for determining new reference values. In addition to the provisions in ESBWR DCD, Tier 2, Subsection 3.9.6.8, "Non-Code Testing of Power-Operated Valves," the Fermi 3 FSAR provides additional provisions for performing periodic tests of power-operated valves that are consistent with the guidance in NRC RIS 2000-03.

- STD COL 3.9.9-4-A Snubber Inspection and Test Program

To address COL Item 3.9.9-4-A, the Fermi 3 COL applicant specifies FSAR provisions that will supplement ESBWR DCD, Tier 2, Subsection 3.9.3.7.1(3)e, "Snubber Preservice and Inservice Examination and Testing." For example, the Fermi 3 FSAR provides additional provisions to supplement the provisions for preservice examination and testing, and inservice examination and testing, of snubbers in ESBWR DCD, Tier 2, Subsection 3.9.3.7.1(3)e. In addition, the Fermi 3 FSAR provides additional provisions for listing snubber information to supplement ESBWR DCD, Tier 2, Subsection 3.9.3.7.1(3)f, "Snubber Support Data."

In addition, in FSAR Subsection 3.9.3.7.1(3)f, the applicant identifies two commitments (COM 3.9-003 and COM 3.9-005) for preparing a piping and components plant-specific table that will include snubber information and the scheduled update of the FSAR to include snubber information. These commitments are listed later in this section.

Supplemental Information

- STD SUP 3.9-1 10 CFR 50.55a Relief Requests and Code Cases

The Fermi 3 FSAR supplements ESBWR DCD, Tier 2, Subsection 3.9.6.6, "10 CFR 50.55a Relief Requests and Code Cases," by specifying that no relief from or alternative to the ASME OM Code is being requested.

- STD SUP 3.9-2 Risk-Informed Inservice Testing

The Fermi 3 FSAR supplements ESBWR DCD, Tier 2, Section 3.9.7, "Risk-Informed Inservice Testing," by specifying that risk informed inservice testing is not being utilized.

- STD SUP 3.9-3 Risk-Informed Inservice Inspection of Piping

The Fermi 3 FSAR supplements ESBWR DCD, Tier 2, Section 3.9.8, "Risk-Informed Inservice Inspection of Piping," by stating that "risk informed inservice inspection is not being utilized."

Commitments

Fermi 3 FSAR Section 3.9 includes the following commitments for specific components:

Commitment (COM 3.9-001):

Fermi 3 FSAR Section 3.9.2.4: For reactor internals other than the steam dryer, the comprehensive vibration assessment program will be developed and implemented as described in DCD Appendix 3L with no departures. The vibration measurement and inspection programs will comply with the guidance specified in RG 1.20, Revision 3, consistent with the Fermi 3 reactor internals classification. A summary of the vibration analysis program and description of the vibration measurement (including measurement locations and analysis predictions) and inspection phases of the comprehensive vibration inspection program will be submitted to the NRC six months prior to implementation.

Commitment (COM 3.9-002):

Fermi 3 FSAR Section 3.9.3.1: The equipment stress reports identified in this DCD section will be completed within six months of completion of DCD ITAAC Table 3.1-1.

Commitment (COM 3.9-003):

Fermi 3 FSAR Section 3.9.3.7.1(3)f: For the ASME Class 1, 2, and 3 systems listed in DCD Tier 1, Section 3.1, that contain snubbers, a plant-specific table will be prepared in conjunction with the closure of the system-specific ITAAC for piping and component design and will include specific snubber information.

Commitment (COM 3.9-004):

Fermi 3 FSAR Section 3.9.3.1 on stress analysis: The FSAR will be revised as necessary in a subsequent update to address the results of this analysis.

Commitment (COM 3.9-005):

Fermi 3 FSAR Section 3.9.3.7.1(3)f on specific snubber information: This information will be included in the FSAR as part of a subsequent FSAR update.

Commitment (COM 3.9-006):

Fermi 3 FSAR Section 3.9.2.4: For reactor internals other than the steam dryer, the preliminary and final reports (as necessary), which together summarize the results of the vibration analysis, measurement and inspection programs will be submitted to the NRC within 60 and 180 days, respectively, following the completion of the programs.

License Conditions

Part 10 of the Fermi 3 COL application specifies proposed license conditions in such technical areas as the steam dryer, explosively actuated valves, initial test program, and the operational program implementation schedule.

3.9.3 Regulatory Basis

The regulatory basis of the design-related information incorporated by reference is in NUREG-1966 and NUREG-1966, Supplement 1. In addition, the relevant requirements of the Commission regulations for the mechanical systems and components, and the associated acceptance criteria, are listed in Section 3.9 of NUREG-0800 and include the following:

- The guidance associated with the reactor internals startup testing is provided in RG 1.20, (Revision 3), "Comprehensive Vibration Assessment Program for Reactor Internals During Preoperational and Initial Startup Testing."

- 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," GDC 1, "Quality standards and records," which requires (in part) that components important to safety be designed, fabricated, erected, and, tested to quality standards commensurate with the importance of the safety functions to be performed.

- GDC 2, "Design bases for protection against natural phenomena," which requires (in part) that components important to safety be designed to withstand seismic events without a loss of capability to perform their safety functions.

- GDC 4, "Environmental and dynamic effects design bases," which requires that SSCs important to safety be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operations, maintenance, testing, and postulated pipe ruptures including loss-of-coolant accidents.

- GDC 14, "Reactor coolant pressure boundary," which requires that the RCPB be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage; rapidly propagating failures; and gross ruptures.

- GDC 15, "Reactor coolant system design," which requires that the reactor coolant system and associated auxiliary, control, and protection systems be designed with sufficient margins to assure that the design conditions of the RCPB are not exceeded during any condition of normal operation, including anticipated operational occurrences.

- 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," as it relates to the suitability of the plant design bases for mechanical components established in consideration of site seismic characteristics.

The regulatory basis for the staff's review of the Fermi 3 FSAR is provided by 10 CFR Parts 50 and 52. Specifically, the NRC regulations in 10 CFR 52.79(a)(11) require that a COL application provide a description of the programs and their implementation necessary to ensure that the systems and components meet the requirements of the ASME Boiler and Pressure Vessel Code (BPV Code) and the ASME OM Code, in accordance with 10 CFR 50.55a. As discussed in the ESBWR DCD FSER, GDC 1, 2, 4, 14, 15, 37, "Testing of emergency core cooling system"; 40, "Testing of containment heat removal system"; 43, "Testing of containment atmospheric cleanup system"; 46, "Testing of cooling water system"; and 54, "Piping systems penetrating containment"; in Appendix A to 10 CFR Part 50 establish the necessary design, fabrication, construction, testing, and performance requirements for SSCs that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public. The quality assurance (QA) criteria in 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," provide assurance that the design, tests, and documentation related to functional design, qualification, and inservice testing (IST) programs for pumps, valves, and dynamic restraints will comply with established standards and criteria; thereby ensuring that such equipment will be capable of performing the intended functions.

RG 1.206 provides guidance for a COL applicant in preparing and submitting the COL application in accordance with NRC regulations. For example, Section C.IV.4 in RG 1.206 discusses the requirement in 10 CFR 52.79(a) that descriptions of operational programs need to be included in the FSAR for a COL application to allow reasonable assurance for a finding of acceptability. In particular, a COL applicant should fully describe the IST and other operational programs defined in Commission Paper SECY-05-0197, "Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria," to avoid the need for ITAAC for operational programs. The term "fully described" for an operational program should be understood to mean that the program is clearly and sufficiently described in terms of scope and level of detail to allow a reasonable assurance finding. Further, operational programs should be described at a functional level with an increasing level of detail, where implementation choices could materially and negatively affect the program's effectiveness and acceptability. In the SRM for SECY-05-0197 dated February 22, 2006, the Commission approved the SECY—including the use of a license condition for operational program implementation milestones that are fully described or referenced in the FSAR.

The staff's review of the Fermi 3 COL application followed the applicable guidance in SRP Section 3.9. Fermi 3 FSAR Table 1.9-201, "Conformance with Standard Review Plan," specifies that the COL application conform to the subsections in SRP Section 3.9. The staff also compared the Fermi 3 FSAR information with the guidance in RG 1.206, as listed in Fermi 3 FSAR Table 1.9-203, "Conformance with the FSAR Content Guidance in RG 1.206."

3.9.4 Technical Evaluation

As documented in NUREG–1966 and in NUREG-1966, Supplement 1, the NRC staff reviewed and approved Section 3.9 of the ESBWR DCD. The staff reviewed Section 3.9 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the relevant information related to this section.

The staff reviewed the information in the Fermi 3 COL FSAR as follows:

<u>*COL Items*</u>

- EF3 COL 3.9.9-1-A — Reactor Internals Vibration Analysis, Measurement and Inspection Program

DCD COL Item 3.9.9-1-A in Section 3.9.9 of the ESBWR DCD states that the COL applicant will perform the following:

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

(1) For the reactor internals, other than steam dryer, classify its reactor per the guidance in RG 1.20 and provide a milestone for submitting a description of the inspection and measurement programs to be performed (including measurement locations and analysis predictions) and the results of the vibration analysis, measurement and test program (Subsection 3.9.2.4).

(2) For the steam dryer, which is classified as a prototype per the guidance in RG 1.20, (a) provide a milestone of no later than 90 days before startup to prepare and provide to the NRC a Steam Dryer Monitoring Plan as described in NEDE-33313P, Section 10; (b) submit or reference a steam dryer predicted analysis (for the plant-specific or a sample steam dryer) that concludes the steam dryer will not exceed stress limits with applicable bias and uncertainties and the minimum alternating stress ratio (MASR) of 2.0; (c) describe startup program (with proposed license conditions) that includes appropriate notification points during power ascension, and submittal of the completed analysis of steam dryer data within 90 days following completion of the power ascension testing and monitoring of the steam dryer; and (d) specify periodic steam dryer inspections during refueling outages (Subsection 3.9.2.4).

To address COL Item 3.9.9-1-A, the applicant states in FSAR Subsection 3.9.2.4 that the vibration assessment program for reactor internals other than the steam dryer, as specified in RG 1.20, is provided in ESBWR DCD Appendix 3L and NEDE-33259P-A ADAMS Accession No. ML091660432 (non-public proprietary version), ADAMS Accession No. ML091660433 (transmittal letter), and ADAMS Accession No. ML091660434 (public version). In addition, the classification of the Fermi 3 reactor internals in accordance with RG 1.20 is dependent on the ESBWR status (i.e., whether Fermi 3 or another reactor before Fermi 3 is the initial ESBWR to test the reactor internals).

Specific to the steam dryer, the comprehensive vibration assessment program, as specified in RG 1.20 is provided in ESBWR DCD Appendix 3L, NEDE-33312P (ADAMS Accession No. ML13344B163), NEDE-33313P (ADAMS Accession No. ML13344B164), and NEDE-33408P (ADAMS Accession No. ML13344B176).

The steam dryer is classified as a prototype according to RG 1.20, Revision 3, and the applicant presents an approach that is consistent with RG 1.20 and Section 10.2 of NEDE-33313P, including four elements of a steam dryer Comprehensive Vibration Assessment Program (CVAP) that must be addressed.

The staff reviewed the classification of the Fermi 3 reactor internals. The Fermi 3 classification of the reactor internals has two scenarios. In the first scenario, the Fermi 3 reactor internals are classified as the ESBWR prototype for testing the reactor internals. In the second scenario, should a CVAP for an ESBWR unit other than Fermi 3 be completed and approved by the NRC as a valid prototype before the initiation of startup testing at Fermi 3, the Fermi 3 reactor internals will be classified as non-prototype Category I. As described in NUREG-1966, Supplement 1, the Supplemental FSER related to the certified ESBWR DCD, Tier 2, Section 3.9.5, the steam dryer will be classified as a prototype regardless of the presence of another ESBWR unit. The staff finds the classification approach for the Fermi 3 reactor internals to be acceptable because the classification of the reactor internals for Fermi 3 is consistent with RG 1.20, and the classification of the steam dryer as a prototype regardless of the presence of another ESBWR unit is conservative.

For reactor internals (other than the steam dryer) to be installed in Fermi 3, the staff finds the review and acceptance of the CVAP specified in the ESBWR DCD to be acceptable as described in NUREG-1966, Supplement 1, the supplemental FSER related to the certified ESBWR DCD, Tier 2, Section 3.9.5. Therefore, the staff finds the portion of COL Item 3.9.9-1-A related to the reactor internals (other than the steam dryer) for Fermi 3 to be satisfied.

For the steam dryer, a description of the staff's review and acceptance of the ESBWR steam dryer evaluation methodology is in NUREG-1966, Supplement 1, the Supplemental FSER related to the certified ESBWR DCD, Tier 2, Section 3.9.5. The Fermi 3 FSAR specifies the COL applicant's actions that are necessary to satisfy the portion of COL Item 3.9.9-1-A related to the steam dryer. For the Fermi 3 steam dryer —Item (a) of COL Item 3.9.9-1-A— the CVAP to be applied is described in ESBWR DCD, Tier 2, Section 3.9 and Appendix 3L and in NEDE-33313P, Section 10.0. The CVAP includes preparing and submitting to the NRC a Steam Dryer Monitoring Plan (SDMP) no later than 90 days before startup. For Item (b) of COL Item 3.9.9-1-A, the detailed design of the Fermi 3 steam dryer will follow the methodology described in DCD Appendix 3L and in the incorporated engineering reports. As described in NEDE-33313P, Section 10.2(b), an example of a steam dryer predictive analysis that concludes the steam dryer will not exceed stress limits with the applicable bias and uncertainties and the minimum alternating stress ratio of 2.0 is provided in NEDE-33408P. The example of an as-designed steam dryer that was subject to the predictive analysis process and successful startup testing described in NEDE-33408P serves as the design analysis report for the steam dryer and provides sufficient information for licensing. For Item (c) of COL Item 3.9.9-1-A, the Fermi 3 startup program is based on NEDE-33313P, Section 10.2(c), which includes (1) providing appropriate notification points during power ascension; (2) providing data to the NRC at certain hold points and at full power; and (3) providing a full stress analysis report and evaluation to the NRC within 90 days of reaching the full power level. For Item (d) of COL Item 3.9.9-1-A, the periodic steam dryer inspection program for Fermi 3 during refueling outages is described in NEDE-33313P, Section 10.2(d). Part 10 of the Fermi 3 COL application provides a proposed license condition for the steam dryer startup program and the periodic inspection program.

The NRC staff has reviewed the actions specified in the Fermi 3 FSAR for each of the individual portions of COL Item 3.9.9-1-A regarding the steam dryer. The staff determined that the Fermi 3 FSAR actions related to the steam dryer satisfy the provisions in ESBWR DCD, Tier 2 and NEDE-33312P, NEDE-33313P, and NEDE-33408P incorporated in the ESBWR DCD as accepted in NUREG-1966, Supplement 1 on ESBWR DCD, Tier 2, Section 3.9.5. These Fermi 3 actions include application of the CVAP for the steam dryer described in the ESBWR DCD, Tier 2 and NEDE-33313P, reference of the example steam dryer predictive analysis in NEDE-33408P, preparation of a Fermi 3 startup program that incorporates the steam dryer monitoring plan in NEDE-33313P, and specification of a periodic steam dryer inspection program consistent with NEDE-33313P. The Fermi 3 steam dryer monitoring and inspection program will be verified by the license condition specified later in this SER section. The staff notes that the license condition proposed in this SER, as compared to the model condition proposed in NEDE-33313P, has been reformatted to better conform with standard license condition format and has been rewritten for clarity and to remove redundancy. Some of these changes resulted in minor changes in substance, such as more clearly specifying power levels for steam dryer monitoring and methods for informing the NRC of the results of monitoring. The staff reviewed and accepted the ESBWR DCD and its referenced engineering reports on the steam dryer as part of the NRC review of the ESBWR design certification application. Therefore, the staff finds that the actions specified by the Fermi 3 COL applicant satisfy the steam dryer portion of COL Item 3.9.9-1-A.

The NRC staff notes that the ESBWR DCD identifies specific portions of the information on the structural integrity and functional capability of mechanical systems and components to be Tier 2* information. As part of this identification of Tier 2* information, the ESBWR DCD identifies Tier 2, Section 3.9.2.3 as well as the GEH engineering reports NEDE-33312P, NEDE-33313P, and NEDE-33408P on the ESBWR steam dryer incorporated by reference in the DCD as Tier 2* in their entirety. Therefore, the Fermi 3 steam dryer evaluation methodology will be implemented as Tier 2* information in accordance with the ESBWR design certification.

In FSAR Subsection 3.9.2.4, the Fermi 3 COL applicant identifies two commitments—COM 3.9-001 and COM 3.9-006—related to the development of a comprehensive vibration assessment and the associated reports. The NRC staff finds that the commitments are consistent with the provisions in the ESBWR DCD as accepted by the NRC as part of its ESBWR design certification review. These commitments provide an additional mechanism for additional licensee tracking of activities related to the comprehensive vibration assessment program. The NRC staff has reviewed and approved this program under the ESBWR DCD; in addition, license conditions exist for the most critical elements of the program related to the steam dryer, and license conditions and NRC inspections are already planned in conjunction with the initial test program (ITP). Therefore, the use of a commitment to track completion of these activities is acceptable.

Based on the review described above, the staff finds that the Fermi 3 COL applicant has satisfied the provisions in COL Item COL 3.9.9-1-A. The staff discusses the applicable license conditions related to reactor internals for Fermi 3 later in this SER section. The staff finds that the information related to reactor internals classification and testing adequately meets RG 1.20 guidance and NRC regulatory requirements and is thus acceptable.

- STD COL 3.9.9-2-A — ASME Class 2 or 3 or Quality Group D Components with 60-Year Design Life

DCD COL Item 3.9.9-2-A in Section 3.9.9 of the ESBWR DCD states the following:

> The COL Applicant will provide a milestone for completing the required equipment stress reports, per ASME BPV Code, Subsection NB, for equipment segments that are subject to loadings that could result in thermal or dynamic fatigue and for updating the FSAR, as necessary, to address the results of the analysis (Subsection 3.9.3.1).

Fermi 3 COL FSAR, Revision 7, Subsection 3.9.3.1, "Loading Combinations, Design Transients and Stress Limits," states that the required equipment stress reports will be completed within 6 months of the completion of DCD ITAAC Table 3.1-1 (Commitment 3.9-002). In addition, the Fermi 3 FSAR specifies that the FSAR will be revised as necessary in a subsequent update to address the results of this analysis in Commitment 3.9-004. The staff observes that in order to complete the referenced ITAAC related to the pipe break analyses listed in DCD Tier 1, Table 3.1-1, the applicant will first perform equipment and piping stress analyses that support the determination of pipe break locations. Additional ITAAC related to the completion of component and piping stress analyses in accordance with ASME BPV Code requirements are in DCD Tier 1. Furthermore, in both a public teleconference on February 20, 2014 (ADAMS Accession No. ML14078A005), and a letter dated February 28, 2014 (ADAMS Accession No. ML14064A283), the applicant clarified that there are currently no non-Class 1 components subjected to cyclic loadings of a magnitude and/or duration so severe that the 60-year design life cannot be assured. Therefore, the staff finds that no supplemental information that provides an analysis or design per the Tier 2* provisions of ESBWR DCD, Tier 2, Subsection 3.9.3.1, is necessary at this time. The staff also observes that the original basis for including these requirements in the ESBWR DCD related to the NRC staff's concerns regarding environmentally assisted fatigue, which have been resolved through the final staff position in RG 1.207, "Guidelines for Evaluating Fatigue Analyses Incorporating the Life Reduction of Metal Components Due To the Effects of the Light-Water Reactor Environment for New Reactors," which is committed to in ESBWR DCD, Tier 2, Section 3.9.1. Therefore, the applicant has provided an acceptable milestone related to the development of the required equipment stress reports, as requested in the COL item. The use of Commitments 3.9-002 and 3.9-004 to track these activities is acceptable to the staff, as they address one detail of the overall stress analysis that will be confirmed through completion of ITAAC related to ASME BPV Code requirements, as well as periodic FSAR updates required by the regulations. Licensing and inspection processes are already in place to provide final verification of these overall activities. Based on the provision of a reasonable milestone in response to the COL item and the associated ITAAC, the staff thus finds the applicant's response to COL Item 3.9.9-2-A acceptable.

- STD COL 3.9.9-3-A Inservice Testing Programs

This COL item is related to the functional design, qualification, and IST Programs for pumps, valves, and dynamic restraints. The NRC staff reviewed the Fermi 3 COL application and the applicable sections in the ESBWR DCD incorporated by reference in the Fermi 3 FSAR for the functional design, qualification, and IST Programs for safety-related pumps, valves, and dynamic restraints to determine whether the Fermi 3 COL application meets the regulatory requirements to provide reasonable assurance that the applicable safety-related components at Fermi 3 will be capable of performing their safety functions. In response to RAIs on the ESBWR design certification (DC) application, GEH revised the ESBWR DCD to specify provisions for the IST Programs to support COL applications referencing the ESBWR design. Detroit Edison notified the NRC in letters dated February 16, 2009; July 19, 2010; and September 21, 2010 (ADAMS Accession Nos. ML102660145, ML090620123, and ML102660145, respectively), that Detroit Edison had assumed the role of the reference COL (R-COL) application for the ESBWR design and adopted the RAI responses related to FSAR Section 3.9.6 provided by Dominion Power for the previous R-COL application plant. The staff's review of the description of the IST Programs for Fermi 3 is as follows:

COL Item 3.9.9-3-A in Section 3.9.9 of the ESBWR DCD states the following:

> The COL Applicant shall provide a full description of the IST Program and a milestone for full program implementation as identified in Subsection 3.9.6.1.

The staff reviewed Section 3.9.6 of the ESBWR DCD. The staff's technical evaluation included the information incorporated by reference related to the functional design, qualification, and IST Programs for safety-related pumps, valves, and dynamic restraints. The evaluation is documented in NUREG-1966, the staff's FSER for the ESBWR DC application. ESBWR DCD, Tier 2, Section 3.9.6 provides a general description of the IST Operational Programs to be developed for an ESBWR plant.

ESBWR DCD Subsection 3.9.3.5, "Valve Operability Assurance," describes the process for the functional design and qualification of valves to be used in the ESBWR. Subsection 3.9.3.5 in ESBWR DCD, Tier 2 specifies that valve designs not previously qualified will meet the requirements of ASME Standard QME-1-2007, "Qualification of Active Mechanical Equipment

Used in Nuclear Power Plants." For valve designs previously qualified to standards other than ASME QME-1-2007, ESBWR DCD, Tier 2, Subsection 3.9.3.5 specifies an approach for valve qualification that follows the key principles of ASME QME-1-2007. The Fermi 3 FSAR incorporates by reference this section of the ESBWR DCD without supplemental information. The NRC issued Revision 3 to RG 1.100, "Seismic Qualification of Electric and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," which accepts the use of ASME QME-1-2007 for the functional design and qualification of pumps, valves, and dynamic restraints, with certain conditions. Based on the lessons learned from valve research and operating experience incorporated in ASME QME-1-2007 as accepted in Revision 3 to RG 1.100, the staff found the provisions in the ESBWR DCD for the functional design and qualification of safety-related valves to be acceptable.

ESBWR DCD, Tier 2, Section 3.9.6, "Inservice Testing of Pumps and Valves," provides a general description of the IST Program to be developed for an ESBWR plant. DCD Tier 2, Table 1.9-22 specifies that the ASME OM Code (2001 Edition through the 2003 Addenda) is the basis for the IST Program to be described in COL applications referencing the ESBWR design. ESBWR DCD, Tier 2, Table 3.9-8, "Inservice Testing," provides a list of the valves and other information to be included in the IST Program for an ESBWR plant, such as the valve number; quantity; description; valve and actuator type; ASME Code Class and category; valve function; normal, safety, and fail-safe positions; containment isolation function; and test parameters and frequencies. The ESBWR does not include safety-related, motor-operated valves (MOVs).

As part of the response to COL Item 3.9.9.3-A, the applicant provides supplemental information in the Fermi 3 FSAR on the IST Program for Fermi 3. For example, the Fermi 3 FSAR describes the overall IST Program, preservice testing, power-operated valve testing, and check valve testing. The Fermi 3 COL FSAR does not identify any additional plant-specific valves to be included in the IST Program beyond those listed in ESBWR DCD, Tier 2, Table 3.9-8. ESBWR DCD, Tier 2, Subsection 3.9.6.1.4, "Valve Testing," references NUREG–1482 (Revision 1), "Guidelines for Inservice Testing at Nuclear Power Plants." Following the issuance of the Fermi 3 COL, the guidance in NUREG–1482, (Revision 2 issued in October 2013) can be used to develop the IST Program for Fermi 3, including the specific information to be included in IST Program documentation and tables for NRC inspection.

The staff reviewed the description of the ASME OM Code requirements in the Fermi 3 FSAR on the IST Program that supplements the provisions in the ESBWR DCD. For example, Fermi 3 FSAR Subsection 3.9.6.1 describes the IST provisions for the (a) establishment of reference values; (b) prohibition of preconditioning that undermines the purpose of IST activities; (c) comparisons of stroke time to the reference value, except for fast-acting valves assigned a stroke time limit of 2 seconds; (d) testing of solenoid-operated valves; (e) preoperational testing of check valves; (f) acceptance criteria for check valve tests; (g) use of nonintrusive techniques for check valve tests; (h) test conditions for the check valve tests; (i) post-maintenance testing for the check valves; (j) check valve disassembly and testing; (k) re-establishment of reference values following maintenance; and (l) valve replacement, repair, and maintenance. The staff finds the Fermi 3 FSAR to be consistent with Subsection ISTC, "Inservice Testing of Valves in Light-Water Reactor Nuclear Power Plants," of the ASME OM Code incorporated by reference in 10 CFR 50.55a, and therefore, the FSAR description of the use of ASME OM Code, Subsection ISTC, is acceptable.

ESBWR DCD, Tier 2, Section 3.9.6 specifies that the IST of the applicable ASME BPV Code, Section III, Class 1, 2, and 3 pumps and valves will be performed in accordance with the ASME

OM Code required by 10 CFR 50.55a(f), including limitations and modifications set forth in 10 CFR 50.55a. ESBWR DCD, Tier 2, Section 3.9.10, “References,” specifies the application of the 2001 Edition with the 2003 Addenda of the ASME OM Code for use in the ESBWR design. The Fermi 3 FSAR incorporates these provisions by reference in the ESBWR DCD.

Supplemental Information STD SUP 3.9-1 to Fermi 3 FSAR Subsection 3.9.6.6 specifies that no relief from or alternative to the ASME OM Code is being requested beyond what is identified in the DCD. The ASME OM Code (2001 Edition through 2003 Addenda) is incorporated by reference in 10 CFR 50.55a of the NRC regulations with certain limitations and modifications. Therefore, the staff considers the application of the ASME OM Code, 2001 Edition through 2003 Addenda, as specified in the NRC regulations with applicable limitations and modifications, to be acceptable for the Fermi 3 IST Program description. As specified in 10 CFR 50.55a, a COL licensee is required to incorporate in the IST Program the latest edition and addenda of the ASME OM Code approved in 10 CFR 50.55a(f), on the date 12 months before initial fuel load.

The ESBWR DCD specifies that the ESBWR reactor design does not require the use of pumps to mitigate the consequences of design-basis accidents or to achieve or maintain a safe-shutdown condition. Therefore, the IST Program for the ESBWR design does not include any pumps. As indicated in a GEH response to RAI 3.9-152 (MFN 06-489) dated November 30, 2006 (ADAMS Accession No. ML063460294), post-accident long-term decay heat removal for the ESBWR is performed by nonsafety-related systems as accepted in Commission paper SECY-94-084, “Policy and Technical Issues Associated with the Regulatory Treatment of Non-safety Systems [RTNSS] in Passive Plant Designs.” The availability of systems relied on after 72 hours that is addressed under the RTNSS Program is discussed in Chapter 19.0, “Probabilistic Risk Assessment and Severe Accidents,” of the Fermi 3 SER.

In RAI 03.09.06-1 for the previous R-COL application plant, the staff requested Dominion to discuss the process for implementing the provisions specified in ESBWR DCD, Tier 2, Subsection 3.9.3.5 for the functional design and qualification of valves and dynamic restraints. In a letter dated February 16, 2009 (ADAMS Accession No. ML090620123), Detroit Edison adopted Dominion’s RAI response dated September 11, 2008, specifying that GEH is responsible for the design and qualification of mechanical equipment including valves and dynamic restraints. In July 2009, the staff conducted an audit of the design and procurement specifications for valves and environmental qualification (EQ) at the GEH office in Wilmington, NC. The purpose of the audit was to confirm the implementation of the ESBWR DCD provisions for the design and qualification of applicable pumps, valves, and dynamic restraints and to support the full description of the IST and EQ operational programs provided by COL applicants. As discussed in an NRC memorandum dated September 1, 2009 (ADAMS Accession No. ML092390403) documenting the results of the July 2009 audit, the staff reviewed ESBWR DCD IST Table 3.9-8 and several design and purchase specifications for various valve types. The audit identified specific provisions of the ESBWR DCD IST Table and component specifications that needed to be clarified regarding aspects such as the valve types identified in the IST Program Table and the consideration of lessons learned from valve operating experience. In the response to the audit follow-up items in a letter dated September 21, 2009 (ADAMS Accession Number ML092650083), GEH indicated that the ESBWR DCD IST Table and component specifications would be revised to incorporate the necessary clarifications identified during the audit. In a letter dated November 12, 2009 (ADAMS Accession No. ML093170020), GEH discussed its review of Revision 3 to RG 1.100 for any necessary modifications to its valve specifications that reference the application of ASME Standard QME-1-2007. As indicated in the GEH response to the audit follow-up actions, GEH revised the ESBWR DCD (beginning with Revision 6) to include the necessary clarifications to the DCD IST

Table identified during the audit. On March 19, 2010, the staff conducted a follow-up audit at the GEH office in Washington, DC, to review the implementation of the actions specified by GEH in the letter dated September 21, 2009. Based on that GEH letter and the NRC follow-up audit conducted on March 19, 2010, the staff considers that GEH has resolved the audit follow-up actions related to the functional design and qualification of valves in support of the ESBWR DCD. The staff finds that the ESBWR DCD provisions for the functional design and qualification of valves are being implemented in the component specifications in an adequate manner to support the Fermi 3 COL application. Therefore, RAI 03.09.06-1 is resolved.

In RAI 03.09.06-2 for the previous R-COL application plant, the staff requested Dominion to clarify the ASME OM Code edition and addenda that are the basis for the IST Program described in the COL application. In a letter dated February 16, 2009 (ADAMS Accession No. ML090620123), Detroit Edison adopted Dominion's RAI response dated September 11, 2008, which indicates that the ASME OM Code, 2001 Edition with the 2003 Addenda, is the basis for the IST Program for the R-COL application plant. The staff finds that the RAI response clarifies the specific ASME OM Code edition and addenda to be used in describing the IST Program for the Fermi 3 COL application. Therefore, RAI 03.09.06-2 is resolved.

RAI 03.09.06-3 for the previous R-COL application plant requested Dominion to discuss (1) the provisions in the FSAR for the periodic verification of air-operated valve (AOV) capability; (2) the application of lessons learned from valve performance to power-operated valves (POVs) other than AOVs; and (3) the basis for the statement in FSAR Section 3.9.6 that post-maintenance procedures are applied where high-risk valve performance could be affected. In a letter dated February 16, 2009 (ADAMS Accession No. ML090620123), Detroit Edison adopted Dominion's RAI response dated September 11, 2008, which discussed the IST Program for AOVs and other POVs (with the exception of safety-related MOVs, which are not used in the ESBWR design). As a result, Fermi 3 FSAR Section 3.9.6 describes the incorporation of lessons learned from valve experience at operating nuclear power plants into the AOV IST Program for Fermi 3. The Fermi 3 FSAR supplements the ESBWR DCD with a description of the testing program for POVs to be used at Fermi 3. For example, the AOV program will include the key elements of the Joint Owners Group AOV Program discussed in RIS 2000-03, which also references the staff's comments on the program. Among the key lessons learned in the AOV Program, the Fermi 3 FSAR specifies that periodic dynamic testing of AOVs will be performed (if necessary) to re-verify the capability of the valve to perform its required functions based on valve qualification or operating experience. The Fermi 3 FSAR states that the attributes of the AOV Testing Program are applied to other POVs to the extent that they apply to and can be implemented for those valves. The Fermi 3 FSAR also clarifies that post-maintenance procedures ensure that baseline testing is re-performed as necessary, when maintenance on the valve (such as valve repair or replacement) has the potential to affect valve functional performance. The staff finds that the provisions included in the Fermi 3 FSAR to supplement the ESBWR DCD are sufficient to apply the lessons learned from valve testing to the POV Testing Program at Fermi 3. Therefore, RAI 03.09.06-3 is resolved.

ESBWR DCD, Tier 2, Subsection 3.9.3.7, "Component Supports," discusses piping supports; spring hangers; struts; and snubbers (dynamic restraints). To address COL Item 3.9.9-4 A, the Fermi 3 FSAR provides supplemental information on the snubber Inservice Examination and Testing Program. In particular, the Fermi 3 FSAR specifies that the program will satisfy ASME OM Code, Subsection ISTD, and provides specific examples of the program content to supplement the ESBWR DCD.

ESBWR DCD, Tier 2, Subsection 3.9.3.7.1, "Piping Supports," specifies provisions for snubber design, testing, installation, and preservice examination and testing. For example, ESBWR DCD, Tier 2, Subsection 3.9.3.7.1 states in paragraph c, "Snubber Design and Testing," that the codes and standards used for snubber qualification and production testing are the ASME BPV Code (Section III and Subsection NF); the ASME OM Code (Subsection ISTD); and the ASME Standard QME-1-2007 (Subsection QDR). ESBWR DCD, Tier 2, Subsection 3.9.3.7.1 states in paragraph e, "Snubber Pre-service and In-service Examination and Testing," that the COL applicant will provide a full description of the snubber IST Program. In ESBWR DCD, Tier 2, Section 3.9.9, COL Item STD COL 3.9.9-4-A specifies that the COL applicant shall provide a full description of the snubber preservice and inservice inspection and testing programs and a milestone for program implementation, including development of a data table identified in Subsection 3.9.3.7.1(3)f. Fermi 3 FSAR Section 3.9.9 states that COL Item STD COL 3.9.9-4-A is discussed in Subsections 3.9.3.7.1(3)e and f. Table 1.9-203 in the Fermi 3 FSAR states that the COL application conforms to paragraph C.III.1.3.9.6.4 of RG 1.206, with the exception that a plant-specific snubber table will be prepared in conjunction with the closure of ITAAC Table 3.1-1. Section 3.9 in the Fermi 3 FSAR describes the snubber Inservice Examination and Testing Program. This description specifies that the program will satisfy ASME OM Code, Subsection ISTD, and includes specific examples of the program content to supplement the ESBWR DCD. The staff reviewed the description of the IST Program for dynamic restraints in comparison to ASME OM Code, Subsection ISTD. As discussed below regarding COL Item 3.9.9-4-A, the staff has reviewed the description of the snubber Inservice Examination and Testing Program provided in the Fermi 3 FSAR and the referenced provisions in the ESBWR DCD. The staff determined that the description of the Fermi 3 snubber Inservice Examination and Testing Program is consistent with the ASME OM Code, Subsection ISTD, as incorporated by reference in 10 CFR 50.55a. Therefore, the staff finds that the Fermi 3 FSAR and the ESBWR DCD provide an acceptable description of the Operational Program for Dynamic Restraints at Fermi 3 in support of the Fermi 3 COL application.

In RAI 03.09.06-4 for the previous R-COL application plant, the staff requested Dominion to clarify the reference to ASME BPV Code, Section XI, with respect to snubbers that are described in paragraph 3(b) of ESBWR DCD, Tier 2, Subsection 3.9.3.7.1. In a letter dated February 16, 2009 (ADAMS Accession No. ML090620123), Detroit Edison adopted Dominion's RAI response dated September 11, 2008, which referenced an RAI response from GEH indicating that the specifications referring to ASME BPV Code, Section XI, would be deleted from this section in ESBWR DCD, Tier 2. Subsequently, the staff found that the revised ESBWR DCD, Tier 2 is consistent with the RAI response. Therefore, RAI 03.09.06-4 is resolved.

Fermi 3 FSAR Section 13.4 indicates that FSAR Table 13.4-201, "Operational Programs Required by NRC Regulations," lists each operational program; the regulatory source for the program; the associated implementation milestones; and the FSAR section that fully describes the operational program (as discussed in RG 1.206). FSAR Table 13.4-201 specifies the implementation milestone for the IST Program as "after generator online on nuclear heat." The implementation milestone for the Preservice Testing (PST) Program is specified as "prior to fuel load." A note in FSAR Table 13.4-201 specifies that the "snubber inservice examination is initially performed not less than two months after attaining 5 % reactor power operation and will be completed within 12 calendar months after attaining 5 % reactor power."

In RAI 03.09.06-5 for the previous R-COL application plant, the staff requested Dominion to discuss the commencement of the PST Program. In a letter dated February 16, 2009 (ADAMS Accession No. ML090620123), Detroit Edison adopted Dominion's RAI response dated

September 11, 2008, which states that the COL will contain a license condition that requires the licensee to submit to the NRC a schedule that supports planning for and conducting NRC inspections of operational programs (including the PST Program). The schedule will be submitted 12 months after the issuance of the COL and will be updated every 6 months until 12 months before the scheduled fuel loading, and every month thereafter until either the operational programs listed in FSAR Table 13.4-201 are fully implemented or the plant is placed in commercial service—whichever comes first. According to the RAI response, commencement of PST will be concurrent with the operational status of the equipment and the readiness to support PST, with completion of the PST before fuel load as indicated in FSAR Table 13.4-201. This provision is indicated to mean, for example, that the installation of the valves in the piping system must be complete—along with most of the piping system—when the valve power and controls are in place to support valve operation. Further, any post-installation construction testing and valve setup activities (such as setting torque or limit switches; lubricating the valve; packing installation; or adjustment) must be complete. The accomplishment of these activities will depend on the plant construction and turnover schedules. The staff finds that the RAI response clarifies the commencement of the PST Program. As discussed later in this SER section, the licensee will submit a schedule that supports planning and conducting NRC inspections of operational programs, including the PST Program listed in Fermi 3 FSAR Table 13.4-201. Based on this license condition (License Condition 03.09-01), the staff will be aware of the commencement of the PST Program in preparation for NRC inspection activities. Therefore, RAI 03.09.06-5 is resolved.

In RAI 03.09.06-6 for the previous R-COL application plant, the staff requested Dominion to describe the planned implementation of the program to address potential adverse flow effects on safety-related valves and dynamic restraints within the IST Program in the reactor coolant, steam and feedwater systems from hydraulic loading and acoustic resonance during plant operation. In a letter dated February 16, 2009 (ADAMS Accession No. ML090620123), Detroit Edison adopted Dominion's RAI response dated September 11, 2008, (ADAMS Accession No. ML082730754) stating the intent to use the overall ITP (including preoperational and startup testing) to address potential adverse flow effects on safety-related valves and dynamic restraints. As discussed in the RAI response, the objective of the program is to confirm the attributes of the component design as indicated in the ESBWR DCD, with implementation described in FSAR Section 14.2 and Table 13.4-201. ESBWR DCD, Tier 2, Section 3.9.2, "Dynamic Testing and Analysis of Systems, Components, and Equipment," addresses criteria; testing procedures; and dynamic analyses employed to ensure the structural and functional integrity of piping systems, mechanical equipment, reactor internals, and their supports under vibratory loadings. ESBWR DCD, Tier 2, Subsection 3.9.2.1, "Piping Vibration, Thermal Expansion and Dynamic Effects," states that the overall testing program is divided into the preoperational test phase and the initial startup test phase where piping vibration, thermal expansion, and dynamic effects testing are performed during both phases, as described in ESBWR DCD, Tier 2, Chapter 14. ESBWR DCD, Tier 2, Subsection 3.9.2.1.1, "Vibration and Dynamic Effects Testing," states that the purpose of these tests is to confirm that the piping, components, restraints, and supports of specified high and moderate energy systems have been designed to withstand the dynamic effects of steady-state flow-induced vibration (FIV) and anticipated operational transient conditions. The DCD specifies that vibration testing will be performed in accordance with ANSI/ASME OM-S/G-1990, Part 3, "Requirements for Preoperational and Initial Start-up Vibration Testing of Nuclear Power Plant Piping Systems." ESBWR DCD, Tier 2, Subsection 3.9.3.5 requires valve specifications to incorporate lessons learned from nuclear power plant operations and research programs—including applicable load combinations. ESBWR DCD, Tier 2, Subsections 3.9.3.7 and 3.9.3.8 require analyses or tests for component supports to assure that their structural capability will withstand seismic and other dynamic excitations. ESBWR DCD, Tier 2, Section 3.10, "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment," addresses methods of testing and analyses employed to ensure the operability of mechanical and electrical equipment under the full range of normal and accident loadings, to ensure conformance with NRC regulations. ESBWR DCD, Tier 2, Subsection 14.2.8.1.42, "Expansion, Vibration and Dynamic Effects Preoperational Test," states that its objective is to verify that critical components and piping runs are properly installed and supported, so that expected steady-state and transient vibration and movement due to thermal expansion do not result in excessive stress or fatigue to safety-related plant systems and equipment. ESBWR DCD, Tier 2, Subsection 14.2.8.2.10, "System Vibration Test," describes the applicable preoperational and startup tests for plant systems.

Based on the above information, the staff finds that the ESBWR DCD includes provisions to address potential adverse flow effects for safety-related valves and dynamic restraints at Fermi 3 that reflect nuclear power plant operating experience. The staff reviewed the qualification provisions for potential adverse flow effects as part of the audit of ESBWR design and procurement specifications discussed in this SER section. In Part 10, "ITAAC," of the Fermi 3 COL application, the Fermi 3 COL applicant in Section 3.2, "License Conditions for Initial Test Program," specifies a detailed license condition related to the startup administrative manual, preoperational and startup test procedures, power ascension test phase reports, and test changes. In Chapter 14.0, "Initial Test Program," of this SER, the staff describes its review of the Fermi 3 ITP including the proposed license conditions in Part 10 of the Fermi 3 COL application. The Fermi 3 COL applicant's use of the ITP to address potential adverse flow effects on plant components through implementation of the provisions in ESBWR DCD, Tier 2, Chapter 14 will be verified as part of future NRC inspections at Fermi 3. Therefore, RAI 03.09.06-6 is resolved.

Subsection ISTC-5260, "Explosively Actuated Valves," in the ASME OM Code specifies that at least 20 percent of the charges in explosively actuated (i.e., squib) valves shall be fired and replaced at least once every 2 years. If a charge fails to fire, the ASME OM Code states that all charges with the same batch number shall be removed, discarded, and replaced with charges from a different batch. In light of the updated design and safety significance of squib valves in new reactors, the need for improved surveillance activities for squib valves is being considered by the nuclear industry; ASME; and U.S. and international nuclear regulators. In RAI 03.09.06-1 for the Fermi 3 COL application, the staff requested Detroit Edison to describe its plans for addressing the surveillance of squib valves that will provide reasonable assurance of the operational readiness of those valves to perform their safety functions in support of the Fermi 3 COL application. In a letter dated November 9, 2010 (ADAMS Accession No. ML103140611), Detroit Edison submitted a planned revision to Fermi 3 COL FSAR Section 3.9.6 to specify that industry and regulatory guidance will be considered in the development of the IST Program for squib valves. Detroit Edison indicated that the FSAR would also state that the IST Program for squib valves will incorporate lessons learned from the design and qualification process for these valves, such that surveillance activities provide reasonable assurance of the operational readiness of squib valves to perform their safety functions. The staff found that the planned changes to the Fermi 3 COL FSAR are sufficient to describe the IST Program for squib valves for incorporating the lessons learned from the design and qualification process in developing surveillance activities that will provide reasonable assurance of the operational readiness for squib valves to perform their safety functions. In Fermi 3 COL FSAR (Revision 3 through Revision 7), Subsection 3.9.6.1.4, "Valve Testing"; Item (4), "Special Tests," includes the provisions for surveillance of squib valves as specified in the RAI response. Therefore, RAI 03.09.06-1 is closed.

As discussed later in this SER section, the staff has prepared License Condition 03.09-2 directing the implementation of a surveillance program for squib valves in the gravity-driven cooling system and the automatic depressurization system at Fermi 3 prior to fuel load to supplement the IST requirements in the ASME OM Code, consistent with the licensing of other passive design new reactors. The staff considers the application of the ASME OM Code as incorporated by reference in 10 CFR 50.55a prior to startup of Fermi 3 to be sufficient for squib valves in the standby liquid control (SLC) system at Fermi 3, without the additional provisions of License Condition 03.09-2 that are necessary for the gravity driven cooling system and automatic depressurization system, based on operating experience with SLC squib valves in current boiling-water reactor nuclear power plants.

- STD COL 3.9.9-4-A Snubber Inspection and Test Program

DCD COL Item 3.9.9-4-A in Section 3.9.9 of the ESBWR DCD states the following:

> The COL Applicant shall provide a full description of the snubber preservice and inservice inspection and testing programs, and a milestone for program implementation, including development of a data table identified in Subsection 3.9.3.7.1(3)f (Subsection 3.9.3.7.1(3)e).

The staff reviewed the applicant's information related to the snubber preservice and inservice examination and testing programs included under Subsection 3.9.3.7.1(3)e of the Fermi 3 COL FSAR, which states the following:

> A preservice thermal movement examination is also performed; during initial system heatup and cooldown, for systems whose design operating temperature exceeds 121°C (250°F), snubber thermal movement is verified.
>
> Additionally, preservice operational readiness testing is performed on all snubbers. The operational readiness test is performed to verify the parameters of ISTD-5120. Snubbers that fail the preservice operational readiness test are evaluated to determine the cause of failure, and are retested following completion of corrective action(s).
>
> Snubbers that are installed incorrectly or otherwise fail preservice testing requirements are re-installed correctly, adjusted, modified, repaired or replaced, as required. Preservice examination and testing is re-performed on installation-corrected, adjusted, modified, repaired or replaced snubbers as required.
>
> Inservice examination and testing of all safety-related snubbers is conducted in accordance with the requirements of the ASME OM Code, Subsection ISTD. Inservice examination is initially performed not less than two months after attaining 5 percent reactor power operation and will be completed within 12 calendar months after attaining 5 percent reactor power. Subsequent examinations are performed at intervals defined by ISTD-4252 and Table ISTD-4252-1. Examination intervals, subsequent to the third interval, are adjusted based on the number of unacceptable snubbers identified in the then current interval.
>
> An inservice visual examination is performed on all snubbers to identify physical damage, leakage, corrosion, degradation, indication of binding, misalignment or

deformation and potential defects generic to a particular design. Snubbers that do not meet visual examination requirements are evaluated to determine the root cause of the unacceptability, and appropriate corrective actions (e.g., snubber is adjusted, repaired, modified, or replaced) are taken. Snubbers evaluated as unacceptable during visual examination may be accepted for continued service by successful completion of an operational readiness test.

Snubbers are tested inservice to determine operational readiness during each fuel cycle, beginning no sooner than 60 days before the scheduled start of the applicable refueling outage. Snubber operational readiness tests are conducted with the snubber in the as-found condition, to the extent practical, either in place or on a test bench, to verify the test parameters of ISTD-5210. When an in-place test or bench test cannot be performed, snubber subcomponents that control the parameters to be verified are examined and tested. Preservice examinations are performed on snubbers after reinstallation when bench testing is used (ISTD-5224), or on snubbers where individual subcomponents are reinstalled after examination (ISTD-5225).

Defined test plan groups (DTPG) are established and the snubbers of each DTPG are tested according to an established sampling plan each fuel cycle. Sample plan size and composition are determined as required for the selected sample plan, with additional sampling as may be required for that sample plan based on test failures and failure modes identified. Snubbers that do not meet test requirements are evaluated to determine root cause of the failure, and are assigned to failure mode groups (FMG) based on the evaluation, unless the failure is considered unexplained or isolated. The number of unexplained snubber failures not assigned to an FMG determines the additional testing sample. Isolated failures do not require additional testing. For unacceptable snubbers, additional testing is conducted for the DTPG or FMG until the appropriate sample plan completion criteria are satisfied.

Unacceptable snubbers are adjusted, repaired, modified, or replaced. Replacement snubbers meet the requirements of ISTD-1600. Post-maintenance examination and testing, and examination and testing of repaired snubbers, is done to ensure that test parameters that may have been affected by the repair or maintenance activity are verified acceptable.

Service life for snubbers is established, monitored and adjusted as required by ISTD-6000 and the guidance of ASME OM Code, Non-mandatory Appendix F.

In Commitment 3.9-003, the Fermi 3 applicant specifies in the Fermi 3 FSAR that for the ASME Class 1, 2, and 3 systems listed in DCD Tier 1, Section 3.1, that contain snubbers, a plant-specific table will be prepared in conjunction with the closure of the system-specific ITAAC for piping and component design and will include specific snubber information.

In Commitment 3.9-005, the Fermi 3 applicant specifies in the Fermi 3 FSAR that this information will be included in the FSAR as part of a subsequent FSAR update.

The staff finds that the provisions specified in the Fermi 3 FSAR on the snubber inspection and test program together with the ESBWR DCD provisions incorporated by reference in the Fermi 3 FSAR adequately describe the snubber inspection and test program as consistent with the

ASME OM Code provisions in accordance with Commission policy to review a description of the operational programs (including the snubber IST program) in support of the COL application review. As indicated in License Condition 03.09-01 specified later in this SER section, the licensee will submit a schedule that supports planning and conducting NRC inspections of operational programs. During inspections of the Fermi 3 operational programs, the staff will confirm that the PST and IST Operational Programs (including the snubber program) have been established consistent with the Fermi 3 FSAR and this SER section, including completion of the applicable commitments specified in the Fermi 3 FSAR. Therefore, COL Item 3.9.9-4-A is satisfied.

Supplemental Information

The Fermi 3 COL application also provides three instances of standard supplemental information in Section 3.9. In Section 3.9.6.6, STD SUP 3.9-1 states that no relief from or alternative to the ASME OM Code is being requested. In Section 3.9.7, STD SUP 3.9-2 states that risk-informed IST is not being utilized, replacing a statement in the ESBWR DCD that risk-informed IST initiatives, if any, are included in IST Program implementation plans. Similarly, in Section 3.9.8, STD SUP 3.9-3 states that risk-informed inservice inspection is not being utilized, replacing a statement in the ESBWR DCD that initiatives for risk-informed inservice inspection of piping, if any, are included in inservice inspection implementation plans. All three of these supplemental statements confirm that the Fermi 3 applicant intends to follow the processes for ASME OM Code implementation, IST Program implementation, and inservice inspection implementation described in the ESBWR DCD, as supplemented in the Fermi 3 COL application and evaluated as described in this SER section. Therefore, the staff finds this supplemental information acceptable.

Interfaces for Standard Design

ESBWR DCD, Tier 2, Section 1.8, "Interfaces with Standard Design," identifies site-specific interfaces with the standard ESBWR design. DCD Table 1.8-1, "Matrix of NSSS Interfaces," references Section 3.9 for the supporting interface areas of mechanical SSCs. The staff reviewed the Fermi 3 COL application for interface requirements with the ESBWR standard design regarding the functional design, qualification, and IST Programs for safety-related valves and dynamic restraints using the review procedures described in SRP Section 3.9.6. The staff finds that the applicant's consideration of design interface items is acceptable based on compliance with NRC regulations discussed in this SER section.

License Conditions

The staff's review of the Fermi 3 COL application determined the need for three license conditions related to mechanical systems and components described in Fermi 3 FSAR Section 3.9. These conditions are listed in Section 3.9.5, "Post Combined License Activities," of this SER.

3.9.5 Post Combined License Activities

License Conditions

The staff's review of the Fermi 3 COL application determined the need for the following three license conditions related to mechanical systems and components described in Fermi 3 FSAR Section 3.9:

License Condition 03.09-01: FSAR Section 13.4 indicates that FSAR Table 13.4-201 lists each operational program, the regulatory source for the program, the associated implementation milestones, and the FSAR section where the operational program is fully described, as discussed in RG 1.206. RG 1.206, Regulatory Position Section C.IV.4.3 states that the COL will contain a license condition that requires the licensee to submit to the NRC a schedule that supports planning and conducting NRC inspections of operational programs. The schedule must be submitted 12 months after the NRC issues the COL. The schedule will be updated every 6 months, until 12 months before scheduled fuel loading, and every month thereafter until either the operational programs in FSAR Table 13.4-201 have been fully implemented or the plant has been placed in commercial service, whichever comes first.

License Condition 03.09-02: Consistent with the licensing of other passive design new reactors, the NRC staff has prepared a license condition directing the implementation of a surveillance program for squib valves in the gravity driven cooling system (GDS) and the automatic depressurization system (ADS) at Fermi 3 prior to fuel load to supplement the IST requirements in the ASME OM Code. The license condition is as follows:

Before initial fuel load, the licensee shall implement a surveillance program for explosively actuated valves (squib valves) in the GDS and the ADS at Fermi 3 that includes the following provisions in addition to the requirements specified in the ASME *Code for Operation and Maintenance of Nuclear Power Plants* (OM Code) as incorporated by reference in 10 CFR 50.55a.

a. Preservice Testing

All explosively actuated valves shall be preservice tested by verifying the operational readiness of the actuation logic and associated electrical circuits for each explosively actuated valve with its pyrotechnic charge removed from the valve. This must include confirmation that sufficient electrical parameters (voltage, current, resistance) are available at the explosively actuated valve from each circuit that is relied upon to actuate the valve. In addition, a sample of at least 20 percent of the pyrotechnic charges in all explosively actuated valves shall be tested in the valve or a qualified test fixture to confirm the capability of each sampled pyrotechnic charge to provide the necessary motive force to operate the valve to perform its intended function without damage to the valve body or connected piping. The sampling must select at least one explosively actuated valve from each redundant safety train. Corrective action shall be taken to resolve any deficiencies identified in the operational readiness of the actuation logic or associated electrical circuits, or the capability of a pyrotechnic charge. If a charge fails to fire or its capability is not confirmed, all charges with the same batch number shall be removed, discarded, and replaced with charges from a different batch number that has demonstrated successful 20 percent sampling of the charges.

b. Operational Surveillance

Explosively actuated valves shall be subject to the following surveillance activities after commencing plant operation:

(1) At least once every 2 years, each explosively actuated valve shall undergo visual external examination and remote internal examination (including evaluation and

removal of fluids or contaminants that may interfere with operation of the valve) to verify the operational readiness of the valve and its actuator. This examination shall also verify the appropriate position of the internal actuating mechanism and proper operation of remote position indicators. Corrective action shall be taken to resolve any deficiencies identified during the examination with post-maintenance testing conducted that satisfies the PST requirements.

(2) At least once every 10 years, each explosively actuated valve shall be disassembled for internal examination of the valve and actuator to verify the operational readiness of the valve assembly and the integrity of individual components and to remove any foreign material, fluid, or corrosion. The examination schedule shall provide for each valve design used for explosively actuated valves at the facility to be included among the explosively actuated valves to be disassembled and examined every 2 years. Corrective action shall be taken to resolve any deficiencies identified during the examination with post-maintenance testing conducted that satisfies the PST requirements.

(3) For explosively actuated valves selected for test sampling every 2 years in accordance with the ASME OM Code, the operational readiness of the actuation logic and associated electrical circuits shall be verified for each sampled explosively actuated valve following removal of its charge. This must include confirmation that sufficient electrical parameters (voltage, current, resistance) are available for each valve actuation circuit. Corrective action shall be taken to resolve any deficiencies identified in the actuation logic or associated electrical circuits.

(4) For explosively actuated valves selected for test sampling every 2 years in accordance with the ASME OM Code, the sampling must select at least one explosively actuated valve from each redundant safety train. Each sampled pyrotechnic charge shall be tested in the valve or a qualified test fixture to confirm the capability of the charge to provide the necessary motive force to operate the valve to perform its intended function without damage to the valve body or connected piping. Corrective action shall be taken to resolve any deficiencies identified in the capability of a pyrotechnic charge in accordance with the PST requirements.

This license condition shall expire upon (1) incorporation of the above surveillance provisions for explosively actuated valves into the facility's inservice testing program, or (2) incorporation of inservice testing requirements for explosively actuated valves in new reactors (i.e., plants receiving a construction permit, or COL for construction and operation, after January 1, 2000) to be specified in a future edition of the ASME OM Code as incorporated by reference in 10 CFR 50.55a, including any conditions imposed by the NRC, into the facility's inservice testing program.

This license condition supplements the current requirements in the ASME OM Code for explosively actuated valves, and sets forth requirements for both pre-service testing and operational surveillance, as well as any necessary corrective action. The license condition will expire when either (1) the license condition is incorporated into the Fermi 3 IST program; or (2) the updated ASME OM Code requirements for squib valves in new reactors, as accepted by the NRC in 10 CFR 50.55a, are incorporated into the Fermi 3 IST program. For the purpose of satisfying the license condition, the licensee retains the option of including in its IST program either the requirements stated in this condition, or including updated ASME Code requirements.

License Condition 03.09-03: Steam Dryer Monitoring Plan

1. The licensee shall prepare a Steam Dryer Monitoring Plan (SDMP) and submit the SDMP to the NRC no later than 90 days before the scheduled date for initial fuel loading.

2. The licensee shall provide Power Ascension Test (PAT) procedures for steam dryer monitoring to the NRC resident inspectors at least 10 days before the scheduled date for initial fuel loading. The PAT procedures must include the following:

   - Level 1 and Level 2 acceptance limits, as defined in Report NEDE-33313P (Revision 5, December 2013), for on-dryer strain gage and on-dryer accelerometer measurements to be used up to 100 percent power;

   - The power levels at which the steam dryer will be monitored (subject to Conditions 3 and 4) during power ascension, and the duration of monitoring at each power level;

   - A description of activities to be accomplished during monitoring at each power level;

   - Plant parameters to be monitored;

   - A description of the actions to be taken if acceptance criteria are not satisfied; and

   - A description of the process for verification of the completion of commitments and planned actions specified in the PAT procedures.

3. The licensee shall complete the actions specified in Item 2 of the model license condition specified in paragraph (c) of Section 10.2, “Comprehensive Vibration Program Elements for a COL Applicant,” in NEDE-33313P (Revision 5) between 65 and 75 percent thermal power.

4.. DTE shall measure, record, and evaluate pressures, strains, and accelerations from the steam dryer instrumentation at power levels approximately 5 percent higher than the previous power level at which DTE measured, recorded, and evaluated such parameters until 100 percent thermal power is reached. DTE shall generate data trending and a projection of strain levels for each successive power level, including full power. DTE shall use data trending analysis to assess whether the Level 1 or Level 2 acceptance limits would be exceeded at the next higher power level for which the PAT specifies monitoring. DTE shall provide the data trending results and revised limit curves to the NRC project manager by facsimile or electronic transmission.

5. At each power level for which Conditions 3 and 4 require steam dryer monitoring, DTE shall measure and record pressure, strain, and acceleration responses over a range of plant conditions sufficient to confirm that loading and fatigue effects from

normal variations in plant conditions at power levels up to and including 100 percent thermal power will not adversely affect the life of the dryer. DTE shall include its evaluation of steam dryer performance during such variations in plant conditions, including during Power Maneuvering in the Feedwater Temperature Operating Domain testing, in the dryer structural response as part of the full stress analysis report described in Condition 9 below.

6. If a flow-induced resonance is identified at any power level at which Conditions 3 and 4 require steam dryer monitoring, and the strains or vibrations exceed the pre-determined Level 1 or Level 2 limit curve, DTE shall cease power ascension until completing the actions specified in Item 5 of the model license condition specified in paragraph (c) of Section 10.2 in NEDE-33313P (Revision 5) and the following:

   a. If a Level 1 limit curve is exceeded, DTE shall reduce power to the last power level at which DTE performed steam dryer monitoring pursuant to Conditions 3 and 4 and at which the Level 1 limit curve was not exceeded. DTE shall perform a stress analysis to develop a new Level 1 limit curve before increasing power to the next level at which Conditions 4 requires steam dryer monitoring.

   b. If a Level 2 limit curve is exceeded, or if data trending indicates that a Level 1 limit curve may be challenged before the next power level at which Conditions 4 requires steam dryer monitoring is reached, DTE shall evaluate the Level 1 and Level 2 limit curves and perform a stress analysis that demonstrates that the stress acceptance limits are satisfied at the higher power level before power is increased.

7. DTE shall determine end-to-end bias and uncertainties by comparing the predicted and measured strain or acceleration on the steam dryer at each power level at which DTE performs steam dryer monitoring pursuant to Conditions 3 and 4 and confirm the conservatism of the predicted dryer stress field. At each such power level, DTE shall adjust the predicted strain and acceleration responses using the frequency-dependent end-to-end bias errors and uncertainty values. If any of the measured sensor data at that power level exceeds the adjusted predictions, DTE shall either (A) modify the bias errors and uncertainty values and limit curves and ensure measured sensor responses do not exceed the adjusted predictions, or (B) quantitatively evaluate the effect on fatigue life.

8. At the initial power level at which Condition 3 requires steam dryer monitoring and at approximately 85 and 95 percent power, DTE shall provide the steam dryer data analysis and results to the NRC project manager by facsimile or electronic transmission; and shall not exceed the power level at which it performed the steam dryer monitoring for at least 72 hours after the NRC project manager has confirmed receipt of the transmission.

9.. DTE shall provide data collected from the steam dryer monitoring required by Condition 4 at 100 percent power to the NRC project manager by facsimile or electronic transmission within 72 hours of completing the collection of that data, with receipt confirmation from the NRC project manager. DTE shall submit a full stress analysis report and evaluation to the NRC document control desk in accordance with 10 CFR 52.4 within 90 days of first reaching 100 percent thermal power. The report must include the minimum stress ratio and the final dryer load definition using steam dryer data, and associated bias errors and uncertainties, and must demonstrate that the steam dryer will maintain its structural integrity over its design life considering variations in plant parameters, including, but not limited to, reactor pressure and core flow rate. If the structural integrity of the steam dryer for the full plant life is not demonstrated by the stress analysis, DTE shall describe its compensatory actions, such as future dryer replacement, in the stress analysis report.

10. The licensee shall implement a periodic steam dryer inspection program as follows:

    a. During the first two refueling outages after first reaching 100 percent thermal power, DTE shall perform a visual inspection of all accessible areas and susceptible locations of the steam dryer in accordance with industry guidance on steam dryer inspections in the latest NRC staff-approved version of BWRVIP-139-A, “BWR Vessel and Internals Project, Steam Dryer Inspection and Flaw Evaluation Guidelines,” with any conditions or limitations specified in the NRC staff approval. The results of these baseline inspections shall be submitted to the NRC within 60 days following startup after each outage.

    b. At the end of the second refueling outage after reaching 100 percent thermal power, DTE shall update the Steam Dryer Monitoring Program to include a long-term inspection plan based on plant-specific and industry operating experience, and shall submit the updated program to the NRC within 180 days following startup from the second refueling outage.

In addition to the above three license conditions, the NRC staff notes that, as discussed earlier in this SER section, Part 10 of the Fermi 3 COL application lists a detailed license condition for the ITP that includes activities to address COL Item STD COL 14.2.3-A, “Preoperational and Startup Test Procedures.” This license condition will ensure that the COL licensee implements the ITP, which includes the reactor internals initial start-up FIV testing.

Commitments

In Section 3.9 of the Fermi 3 FSAR, the applicant specifies the following commitments:

- Commitment (COM 3.9-001) – For reactor internals other than the steam dryer, the comprehensive vibration assessment program will be developed and implemented as described in DCD Appendix 3L with no departures. The vibration measurement and inspection programs will comply with the guidance specified in RG 1.20, Revision 3, consistent with the Fermi 3 reactor internals classification. A summary of the vibration analysis program and description of the vibration measurement (including measurement locations and analysis predictions) and inspection phases of the comprehensive vibration inspection program will be submitted to the NRC six months prior to implementation.

- Commitment (COM 3.9-002) – The equipment stress reports identified in this DCD section will be completed within six months of completion of DCD ITAAC Table 3.1-1.

- Commitment (COM 3.9-003) – For the ASME Class 1, 2, and 3 systems listed in DCD, Tier 1, Section 3.1, that contain snubbers, a plant-specific table will be prepared in conjunction with the closure of the system-specific ITAAC for piping and component design and will include the following specific snubber information.

- Commitment (COM 3.9-004) – The FSAR will be revised as necessary in a subsequent update to address the results of this analysis.

- Commitment (COM 3.9-005) – This information will be included in the FSAR as part of a subsequent FSAR update.

- Commitment (COM 3.9-006) – For reactor internals other than the steam dryer, the preliminary and final reports (as necessary), which together summarize the results of the vibration analysis, measurement and inspection programs will be submitted to the NRC within 60 and 180 days, respectively, following the completion of the programs.

<u>ITAAC</u>

ESBWR DCD, Tier 1 includes numerous ITAAC to verify the acceptability of the as-built mechanical systems and components at Fermi 3. A sample of the ITAAC related to the Fermi 3 steam dryer includes the following:

ESBWR DCD, Tier 1, Table 2.1.1-3, "ITAAC for the Reactor Pressure Vessel and Internals"

ITAAC Item 8b. The RPV internal structures listed in Table 2.1.1-1 (chimney and partitions, chimney head and steam separators assembly, and steam dryer assembly) meet the requirements of ASME BPV Code, Subsection NG-3000, except for the weld quality and fatigue factors for secondary structural non-load bearing welds.

ITAAC Item 12. The number and locations of pressure sensors installed on the steam dryer for startup testing ensure accurate pressure predictions at critical locations.

ITAAC Item 13. The number and locations of strain gages and accelerometers installed on the steam dryer for startup testing are capable of monitoring the most highly stressed components, considering accessibility and avoiding discontinuities in the components.

ITAAC Item 14. The number and locations of accelerometers installed on the steam dryer for startup testing are capable of identifying potential rocking and of measuring the accelerations resulting from support and vessel movements.

ITAAC Item 16. The as-built steam dryer predicted peak stress is below the fatigue limitation.
ESBWR DCD, Tier 1, Table 2.1.2-3, "ITAAC for the Nuclear Boiler System"

ITAAC Item 36. The main steam line and SRV/SV [safety relief valve/safety valve] branch piping geometry precludes first and second shear layer wave acoustic resonance conditions from occurring and avoids pressure loads on the steam dryer at plant normal operating conditions.

With respect to the ESBWR steam dryer, NEDE-33313P specifies Tier 2* provisions for the COL licensee to complete the design and construction of the steam dryer for an ESBWR nuclear power plant. For example, Section 9.1, "Instrumentation for Monitoring Steam Dryer Response," in NEDE-33313P describes the process to meet ITAAC Items 12, 13, and 14 in DCD Tier 1, Table 2.1.1-3, for the installation of pressure sensors; strain gages; and accelerometers on the as-built steam dryer to monitor its performance during power ascension. Section 10.1.1, "Steam Dryer Design Analysis Report," in NEDE-33313P specifies the elements for the as-designed ESBWR steam dryer analysis report. Section 10.1.2, "Steam Dryer As-Built

Analysis Report," in NEDE-33313P specifies the process to satisfy ITAAC Item 16 in DCD Tier 1, Table 2.1.1-3, for verifying that the as-built steam dryer fatigue analysis provides at least a minimum alternating stress ratio (MASR) of 2.0 to the allowable alternating stress intensity of 93.7 MPa (13,600 psi). Appendix A, "ITAAC for Reactor Pressure Vessel Internals," to NEDE-33313P describes the process to meet ITAAC Item 8b in DCD Tier 1, Table 2.1.1-3, so as to provide assurance that the reactor internal structures will meet the provisions of ASME BPV Code, Subsection NG-3000, except for the weld quality and fatigue factors for secondary structural non-load bearing welds. Appendix B, "ITAAC for Main Steam Line and SRV/Safety Valve Branch Piping Acoustic Resonance," to NEDE-33313P describes the process to meet ITAAC 36 in DCD Tier 1, Table 2.1.2-3, to provide assurance that the main steam line and SRV/SV branch piping geometry will preclude first and second shear layer wave acoustic resonance conditions from occurring and avoids excessive pressure loads on the steam dryer at plant normal operating conditions. These post COL activities for the ESBWR steam dryer will be performed by the COL licensee for Fermi 3, as described by the Tier 2* provisions in the ESBWR DCD and its referenced engineering reports, unless the COL licensee obtains regulatory approval for an alternative process.

3.9.6 Conclusion

The NRC staff reviewed Fermi 3 FSAR Section 3.9 and the provisions specified in ESBWR DCD, Tier 2, Section 3.9 that are incorporated by reference in the Fermi 3 FSAR for structural integrity and functional capability of mechanical systems and components for the Fermi 3 nuclear power plant. The staff review of the information provided in Section 3.9 of the ESBWR DCD, Tier 2 is provided in the FSER on the ESBWR design certification applicant as modified by NUREG-1966, Supplement 1 on Section 3.9.5 of the ESBWR DCD, Tier 2. Based on its review, the staff concludes that the Fermi 3 COL applicant has provided reasonable assurance that mechanical systems and components to be installed in Fermi 3 will have the structural integrity and functional capability to perform their design functions for the safe operation of the Fermi 3 nuclear power plant.

3.10 Seismic and Dynamic Qualification of Mechanical and Electrical Equipment

3.10.1 Introduction

Seismic and dynamic qualification of seismic Category I equipment include the following types:

- Safety-related active mechanical equipment that performs a mechanical motion while accomplishing a system safety-related function. Examples include pumps, valves, and valve operators.

- Safety-related, non-active mechanical equipment whose mechanical motion is not required while accomplishing a system safety-related function, but whose structural integrity must be maintained in order to fulfill its design safety-related function.

- Safety-related instrumentation and electrical equipment and certain monitoring equipment.

Mechanical and electrical equipment (including instrumentation and controls and where applicable, their supports) classified as seismic Category I must demonstrate that they are capable of performing their intended safety-related functions under the full range of normal and accident (including seismic) loadings. This equipment includes devices associated with systems that are essential to safe shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or are otherwise essential in preventing a significant release of radioactive material into the environment or in mitigating the consequences of accidents.

The criteria for the seismic and dynamic qualification include the following considerations:

- Adequacy of seismic and dynamic qualification input motions.
- Methods and procedures for qualifying electrical equipment, instrumentation, and mechanical components.
- Methods and procedures for qualifying supports of electrical equipment, instrumentation, and mechanical components.
- Documentation.

3.10.2 Summary of Application

Section 3.10 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 3.10 of the ESBWR DCD, Revision 10. In addition, in FSAR Section 3.10, the applicant provided the following:

COL Items

- STD COL 3.10.4-1-A — Dynamic Qualification Report

In FSAR Subsection 3.10.1.4, the applicant adds Commitment (COM 3.10-001), Commitment (COM 3.10-002), and Commitment (COM 3.10-003) to develop the dynamic qualification report ITAAC and an implementation schedule for the ITAAC.

Supplemental Information

- STD SUP 3.10-1 — Quality Assurance Program for Equipment Qualification

In FSAR Subsection 3.10.1.4, the applicant states that the Fermi 3 QA Program is in FSAR Section 17.5, including requirements for handling safety-related quality records; control of purchased material, equipment, and services; test control; and other quality related processes.

3.10.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1966, the FSER related to the certified ESBWR DCD. In addition, the relevant requirements of the Commission regulations for the seismic and dynamic qualification of mechanical and electrical equipment, and the associated acceptance criteria are in Section 3.10 of NUREG-0800. Specific requirements include the following:

- GDC 1 and GDC 30, "Quality of reactor coolant pressure boundary," as they relate to qualifying equipment to appropriate quality standards commensurate with the importance of the safety functions to be performed.

- GDC 2 and Appendix S to 10 CFR Part 50, as they relate to designing equipment to withstand the effects of natural phenomena such as earthquakes.

- GDC 4 as it relates to qualifying equipment as capable of withstanding the dynamic effects associated with external missiles and internally generated missiles, pipe whip, and jet impingement forces.

- GDC 14, "Reactor coolant pressure boundary," as it relates to qualifying equipment associated with the reactor coolant boundary so that there is an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture.

- 10 CFR Part 50, Appendix B, as it relates to qualifying equipment using the quality assurance criteria.

- 10 CFR Part 50, Appendix B, Criterion III, as it relates to verifying and checking the adequacy of a design by the performance of a suitable test program (among other options), which specifically requires that a test program used to verify the adequacy of a specific design feature shall include suitable qualification testing of a prototype unit under the most adverse design conditions.

- 10 CFR 52.80(a), which requires that a COL application to contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the COL, the provisions of the Atomic Energy Act, and NRC's regulations.

3.10.4 Technical Evaluation

As documented in NUREG–1966, NRC staff reviewed and approved Section 3.10 of the certified ESBWR DCD. The staff reviewed Section 3.10 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the ESBWR DCD and the information in the Fermi 3 COL FSAR, Revision 7, appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the relevant information related to this section.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on the standard content that were documented in the SER with open items issued for the North Anna Unit 3

[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

application were equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna 3 COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes to the Fermi 3 COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the North Anna SER with open items.

- The staff confirmed that the applicant has endorsed all responses to the RAIs identified in the corresponding standard content (the North Anna SER) evaluation.

- The staff verified that the site-specific differences were not relevant to this section.

The staff has completed the review and found the evaluation performed for the North Anna Unit 3standard content to be directly applicable to the Fermi 3 COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting.

The staff reviewed the information in the Fermi 3 COL FSAR, Revision 7, as follows:

COL Items

- STD COL 3.10.4-1-A Dynamic Qualification Report

The staff reviewed the applicant's information related to the dynamic qualification report that was included under Subsection 3.10.1.4 of the Fermi 3 COL FSAR. In this subsection, the applicant adds the following commitments:

- **Commitment (COM 3.10-003**) Detroit Edison shall submit to the NRC, no later than 1 year after issuance of the combined license or at the start of construction as defined in 10 CFR 50.10(a), whichever is later, its implementation schedules for completing of the following ITAACs. Detroit Edison shall submit updates to the ITAAC schedules every 6 months thereafter and, within 1 year of its scheduled date for initial loading of fuel, and shall submit updates to the ITAAC schedules every 30 days until the final notification is provided to the NRC under paragraph (c)(1) of this section [10 CFR 52.99].

- **Commitment (COM 3.10-001)** The Dynamic Qualification Report and documentation that describe the seismic and dynamic qualification methods will be made available for NRC staff review, inspection, and audit. Information that verifies the seismic and dynamic qualification will be made available to the NRC to facilitate reviews, inspections, and audits throughout the process.

- **Commitment (COM 3.10-002)** FSAR information will be revised, as necessary, as part of a subsequent FSAR update.

The staff's review finds that the applicant's response adequately addresses COL Item STD COL 3.10.4-1-A per the guidance in RG 1.206.

Supplemental Information

- STD SUP 3.10-1 Quality Assurance Program for Equipment Qualification

The staff reviewed the applicant's information related to the QA Program for equipment qualification included under FSAR Subsection 3.10.1.4, which states the following:

> Section 17.5 defines the Quality Assurance Program requirements that are applied to equipment qualification files, including requirements for handling safety-related quality records, control of purchased material, equipment and services, test control, and other quality related processes.

The following portion of this technical evaluation section is reproduced from Subsection 3.10.4, "Technical Evaluation," of the North Anna Unit 3 SER (ADAMS Accession No. ML091730304):

> *The staff reviewed the conformance of Section 3.10 of the North Anna COL FSAR to the guidance in RG 1.206, Chapter 3, Sections C.I.3.10 and C.III.1.3.10, "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment." The staff's review of Section 3.10 of the North Anna COL FSAR found that the applicant has appropriately incorporated by reference Section 3.10 of the ESBWR DCD, Revision 5 except that the standard COL item described above is not acceptable in accordance with the guidance in Section C.I.3.10.4 of RG 1.206. RG 1.206 Sections C.I.3.10.4 and C.III.3.10.4 state that the applicant should provide the results of tests and analyses to demonstrate adequate seismic qualification of equipment. However, RG 1.206 acknowledges that this level of detail may not be available and provides an alternative provision for an implementation plan that includes milestones and completion dates.*
>
> *The staff reviewed the North Anna COL FSAR and found that it does not provide either the results of qualification or an implementation plan. This information is necessary for the staff to make a reasonable assurance safety finding for licensing (i.e., to find that the design is in accordance with the regulations). The information included with this plan should address those planning details not addressed in the DCD. Those details include, for example, a listing of the equipment to be qualified, the method of qualification, who will be performing the qualification, the timing, etc. The expectation is that all information for the phases would be completed before procurement would be available for review prior to licensing. For example, the list of equipment and qualification method can be provided now with wording for a license condition which will require provision of the name of the organization qualifying the equipment and details on timing post procurement six months before the qualification process is expected to be completed. It is expected that this information would be available to be audited by the NRC Staff prior to equipment installation. In **RAI 3.10-1**, the NRC requested the applicant to provide an implementation plan that includes the level of detail that will be completed prior to procurement and the plan for completing equipment qualification as called for in RG 1.206 and the example described above.*

As indicated above in Fermi 3 COL FSAR, Section 3.10, the applicant provides Commitments COM 3.10-001, COM 3.10-002, and COM 3.10-003 that meet the alternative provision for an implementation plan that includes milestones and completion dates as described in RG 1.206.

Therefore, RAI 3.10-1 is closed. Based on the above evaluation above, the staff finds the information in Supplemental Information Item STD SUP 3.10-1 acceptable.

3.10.5 Post Combined License Activities

The applicant identifies the following commitments:

- **Commitment (COM 3.10-003)** Detroit Edison shall submit to the NRC, no later than 1 year after issuance of the combined license or at the start of construction as defined in 10 CFR 50.10(a), whichever is later, its implementation schedules for completing of the following ITAACs. Detroit Edison shall submit updates to the ITAAC schedules every 6 months thereafter and, within 1 year of its scheduled date for initial loading of fuel, and shall submit updates to the ITAAC schedules every 30 days until the final notification is provided to the NRC under paragraph (c)(1) of this section [10 CFR 52.99].

- **Commitment (COM 3.10-001)** The Dynamic Qualification Report and documentation that describe the seismic and dynamic qualification methods will be made available for NRC staff review, inspection, and audit. Information that verifies the seismic and dynamic qualification will be made available to the NRC to facilitate reviews, inspections, and audits throughout the process.

- **Commitment (COM 3.10-002)** FSAR information will be revised, as necessary, as part of a subsequent FSAR update.

3.10.6 Conclusion

The staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E ,Section VI.B.1, all nuclear safety issues relating to the seismic and dynamic qualification of mechanical and electrical equipment that were incorporated by reference have been resolved.

In addition, the staff compared the additional COL information in the application to the relevant NRC regulations, the guidance in Section 3.10 of NUREG–0800, and other NRC RGs. The staff's review concluded that the applicant has adequately addressed COL Item STD COL 3.10.4-1-A and Supplemental Item STD SUP 3.10-1. Therefore, the staff finds that Fermi 3 COL FSAR, Revision 7, Section 3.10, is acceptable and meets the NRC regulatory requirements and acceptance criteria in Section 3.10 of NUREG-0800 and RG 1.206 including GDC 1, GDC 2, GDC 4, GDC 14 and GDC 30; Appendix S to 10 CFR Part 50, 10 CFR Part 50, Appendix B, Criterion III, and 10 CFR 52.80(a).

3.11 <u>Environmental Qualification of Mechanical and Electrical Equipment</u>

3.11.1 Introduction

This FSAR section describes the EQ Program to be used at Fermi 3 for the electrical and mechanical equipment important to safety. The objective of the EQ Program is to reduce the potential for common failures resulting from specified environmental events and to demonstrate that the equipment within the scope of the EQ Program is capable of performing its intended design function under all conditions, including environmental stresses resulting from design-basis events. During plant operation, the COL licensee implements the EQ Program, which specifies the replacement frequencies of affected safety-related equipment in harsh environments. The EQ Program also addresses nonsafety-related equipment failures under the postulated environmental conditions that could prevent the satisfactory performance of the safety functions of the safety-related equipment, and certain post-accident monitoring equipment.

The equipment important to safety must perform its safety functions under all normal environmental conditions, abnormal operational occurrences, design-basis events, post-design-basis events, and containment test conditions. This capability is demonstrated through qualification testing and analysis of similar equipment under the temperature, pressure, humidity, chemical effects, radiation, and submergence conditions in which the equipment will be expected to operate. The qualification information shall include identification of the equipment required to be environmentally qualified. Each component shall have onsite and in an auditable form, the designated functional requirements; the definition of the applicable environmental parameters; the periodic maintenance to support the qualified life; the accident that the component is required to mitigate; the required operation time; and the documentation of the qualification process employed to demonstrate the required environmental capability. This information shall be maintained and remain current.

3.11.2 Summary of Application

Section 3.11 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 3.11 of the ESBWR DCD, Revision 10. In addition, in FSAR Section 3.11 the applicant provides the following:

<u>*COL Items*</u>

- STD COL 3.11-1-A Environmental Qualification Documentation

In FSAR Subsection 3.11.4.4 the applicant provides additional information to address COL Item 3.11-1-A. The applicant states that a description of the EQ Program is in ESBWR DCD, Tier 2, Section 3.11. The Fermi 3 FSAR also specifies that the implementation of the EQ Program, including the development of the Environmental Qualification Document (EQD), will be in accordance with the milestone schedule in FSAR Section 13.4, “Operational Program Implementation.”

3.11.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is discussed in NUREG–1966.

The relevant requirements of the Commission regulations for the EQ operational program and EQD and the associated acceptance criteria are in Section 3.11 of NUREG-0800.

The applicable regulatory requirements for the EQD are as follows:

- 10 CFR 50.49, “Environmental qualification of electrical equipment important to safety for nuclear plants,” requires an applicant for a nuclear power plant license to establish a program that qualifies electrical equipment for environmental effects.

- GDC 1 requires components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed.

- GDC 2 requires components important to safety be designed to withstand the effects of natural phenomena without loss of capability to perform their safety function.

- GDC 4 requires components important to safety be designed to accommodate the effects of, and be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss of coolant accidents.

- GDC 23, “Protection system failure modes,” requires protection systems to be designed to fail in a safe state, or in a state demonstrated to be acceptable on some other defined basis, if conditions such as postulated adverse environments occur (e.g., extreme heat or cold, pressure, steam, water, or radiation).

- 10 CFR Part 50, Appendix B, Criterion III, “Design Control,” requires measures to be established to ensure that applicable regulatory requirements and the associated design bases are correctly translated into specifications, drawings, procedures, and instructions. These measures should include provisions to ensure that appropriate quality standards are included in design documents and deviations from established standards are controlled. A process should also be established to determine the suitability of equipment that is essential to safety-related functions and to identify, control, and coordinate design interfaces between participating design organizations. Where a testing program is used to verify the adequacy of a specific design feature, the test shall include suitable qualification testing of a prototype unit under the most adverse design conditions.

- 10 CFR Part 50, Appendix B, Criterion XI, “Test Control,” requires a test control plan to be established to ensure that all tests needed to demonstrate a component's performance capability are identified in accordance with required procedures and acceptance limits in the applicable design documents.

- 10 CFR Part 50, Appendix B, Criterion XVII, “Quality Assurance Records,” requires sufficient records to be maintained to furnish evidence of activities affecting quality. The records must include inspections, tests, audits, work performance monitoring, and materials analyses. Records must be identifiable and retrievable.

The related acceptance criteria are as follows:

- In accordance with SECY-05-0197, “Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria,” as accepted in the Commission’s SRM dated February 22, 2006, equipment qualification is an Operational Program that will be reviewed in the COL application. The staff reviews this program to make a reasonable assurance finding on the program. A COL applicant should fully describe the EQ and other Operational Programs as defined in SECY-05-0197 to avoid the need for ITAAC to implement those programs. The term “fully described” for an operational program should be understood to mean that the program is clearly and sufficiently described in terms for scope and level of detail to allow a reasonable assurance finding of acceptability. Further, Operational Programs should be described at a functional level and an increasing level of detail where implementation choices could materially and negatively affect the program effectiveness and acceptability. The Commission approved the use of a license condition for operational program implementation milestones that are fully described or referenced in the FSAR as discussed in the SRM for SECY-05-0197, dated February 22, 2006.

3.11.4 Technical Evaluation

As documented in NUREG–1966, NRC staff reviewed and approved Section 3.11 of the certified ESBWR DCD. The staff reviewed Section 3.11 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the ESBWR DCD and the information in the Fermi 3 COL FSAR, Revision 7, appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the relevant information related to this section.

The NRC staff reviewed the Fermi 3 COL application and the applicable sections in the ESBWR DCD incorporated by reference into the Fermi 3 FSAR for the description of the EQ Program for mechanical and electrical equipment to determine whether the Fermi 3 COL application meets the regulatory requirements to provide reasonable assurance that the applicable equipment at Fermi 3 will be capable of performing their intended functions. In letters dated February 16, 2009, July 19, 2010, and September 21, 2010, Detroit Edison notified the NRC that it had assumed the role of the referenced COL (R-COL) application for the ESBWR design. Detroit Edison also adopted the RAI responses related to FSAR Section 3.11 that Dominion Power had provided for the previous R-COL plant. The staff's review of the description of the EQ Program for Fermi 3 appears below in this SER section.

The staff reviewed the following information in the Fermi 3 COL FSAR as follows:

<u>*COL Items*</u>

- STD COL 3.11-1-A Environmental Qualification Documentation

NRC staff reviewed the additional information related to the environmental qualification documentation under Subsection 3.11.7 of the Fermi 3 COL FSAR, Revision 7, which states the following:

> This COL item is addressed in Subsection 3.11.4.4.

In ESBWR DCD, Tier 2, Subsection 3.11.7, COL Item 3.11-1-A states that the COL applicant will provide a full description and a milestone for implementing the EQ Program that will include completion of the plant-specific EQD per Subsection 3.11.4.4, "Environmental Qualification Documentation." In FSAR Subsection 3.11.4.4, the applicant states that a description of the EQ Program is provided in ESBWR DCD, Tier 2, Section 3.11. The applicant also states that the implementation of the EQ Program, including the development of the EQD will be in accordance with the milestone schedule in FSAR Section 13.4. The NRC staff reviewed the applicant's

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

resolution to ESBWR COL Item 3.11-1-A in FSAR Subsection 3.11.4.4. In addition to reviewing the Fermi 3 COL application, the staff reviewed the information in the ESBWR DCD. Provisions in the ESBWR DCD support the Fermi 3 COL application by fully describing the EQ Operational Program for Fermi 3.

Fermi 3 FSAR Section 3.11 incorporates by reference ESBWR DCD, Tier 2, Section 3.11 with supplemental information. In RAI 03.11-1 for the previous R-COL plant, the staff requested Dominion to provide or reference certain information related to the EQ Program for safety-related mechanical equipment - or indicate the status of and schedule for its availability. Detroit Edison adopted Dominion's RAI response dated September 11, 2008 (ADAMS Accession No. ML082730754), which noted that ESBWR DCD, Tier 2, Section 3.11 had been revised to provide substantial additional information. For example, ESBWR DCD, Tier 2, Table 3.11-1, "Electrical and Mechanical Equipment for Environmental Qualification," identifies the environment in which a component within the scope of the EQ Program will be located. The RAI response stated that no site-specific, safety-related equipment will be used beyond that described in the ESBWR DCD. Subsection 3.11.4.1, "Harsh Environment Qualification," in ESBWR DCD, Tier 2, indicates that the qualification of mechanical equipment includes materials that are sensitive to environmental effects (e.g., seals, gaskets, lubricants, and fluids for hydraulic systems). The RAI response stated that the completion of the plant-specific EQD will be accomplished as specified in FSAR Subsection 3.11.4.4. Furthermore, the RAI response indicated that the completion of the EQ Program for plant equipment will be confirmed by the close-out of the ITAAC, which is specified in ESBWR DCD, Tier 1, Table 3.8-1, "ITAAC for Environmental Qualification of Mechanical and Electrical Equipment." As noted in Section 3.9.4 of this SER, GEH is responsible for the design and qualification of mechanical equipment, and the GEH procurement specifications and processes were made available for NRC to review.

In July 2009, the staff conducted an audit of the design and procurement specifications for valves and the EQ (ADAMS Accession No. ML092390403) at the GEH office in Wilmington, North Carolina. The purpose of the audit was to confirm the implementation of the ESBWR DCD provisions for the design and qualification of applicable pumps, valves, and dynamic restraints; and to support the full description of the IST and EQ operational programs by COL applicants. As discussed in an NRC memorandum dated September 1, 2009 (ADAMS Accession No. ML092390403), the staff reviewed ESBWR DCD IST Table 3.9-8, and several design and purchase specifications. In the response to the audit follow-up items in a letter dated September 21, 2009 (ADAMS Accession No. ML092650083), GEH indicated that the ESBWR DCD IST table and component specifications would be revised to incorporate the necessary clarifications identified during the audit. On March 19, 2010, the staff conducted a follow-up audit at the GEH office in Washington, DC, to review the implementation of the actions specified by GEH in a letter dated September 21, 2009 (ADAMS Accession No. ML092650083). During the follow-up audit, the staff found that GEH had issued the design specification for the EQ of mechanical and electrical equipment. Based on the GEH letter dated September 21, 2009, and the NRC follow-up audit on March 19, 2010, the staff noted that GEH had resolved the audit follow-up actions related to the EQ of mechanical equipment in support of the ESBWR DCD (ADAMS Accession No. ML100890011). The staff finds that the ESBWR DCD provisions for the EQ of mechanical equipment are being implemented in the design specifications in an adequate manner to support the Fermi 3 COL application. Therefore, RAI 03.11-1 is resolved.

ESBWR DCD, Tier 2, Subsection 3.11.4.1 states that active EQ safety-related mechanical equipment will be qualified using the qualification methods of IEEE Standard (Std.) 323-1974, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations." ESBWR DCD, Tier 2, Subsection 3.11.4.2, states that the environmental design bases will be specified in the design and purchase specifications to assure that EQ safety-related equipment located in a mild environment meet their safety-related functional requirements during normal environmental conditions and anticipated operational occurrences. For EQ safety-related equipment (except for computer-based instrumentation and control systems), a Certificate of Conformance from the vendor of the safety-related equipment that will be located in a mild environment will certify performance to the environmental design basis for normal environmental conditions and anticipated operational occurrences, at the equipment location for the amount of time that the safety-related function will be required.

In RAI 03.11-2 for the previous R-COLA plant, the staff requested Dominion to discuss the implementation of the EQ approach. Detroit Edison adopted Dominion's RAI response dated September 11, 2008 (ADAMS Accession No. ML082730754), which referenced ESBWR DCD, Tier 2, Section 3.11 for more detailed provisions of the EQ Program. The RAI response also noted that the qualification of safety-related mechanical equipment will be performed by GEH, and the qualification processes will be available for NRC to audit.

As discussed above, the staff conducted an audit to determine the acceptability of specific aspects of the EQ program. The scope of the audit included the concerns expressed in RAI 03.11-2 as well as RAI 03.11-1 and noted above. The audit report (ADAMS Accession No. ML092390403) concludes that the GEH approach to EQ as documented in the ESBWR DCD is adequately being implemented in the design specifications to support the Fermi 3 COL application. Therefore, RAI 03.11-2 is resolved.

In RAI 03.11-3 for the previous R-COL plant, the staff requested Dominion to clarify whether the FSAR would be updated to include additional equipment not identified in ESBWR DCD, Tier 2, Table 3.11-1. Detroit Edison adopted Dominion's RAI response dated September 11, 2008, that there is no safety-related equipment or safe shutdown equipment outside the scope of the ESBWR design. As a result, there is no additional equipment covered by the EQ Program that is not identified in DCD Table 3.11-1. Therefore, RAI 03.11-3 is resolved.

ESBWR DCD, Tier 2, Section 3.11 references the NRC-approved proprietary licensing Topical Report NEDE-24326-1-P, "General Electric Environmental Qualification Program." In a letter dated November 19, 2007 (MFN 07-174, Supplement 2) (ADAMS Accession No. ML073380043), GEH stated that the staff's review of NEDE-24326-1-P was addressed in NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design." On page 3-90 of NUREG-1503, NRC staff found that the topical report conforms to 10 CFR 50.49 and its associated standards, except for the position on the time margin. In RAI 03.11-4 for the previous R-COL plant, the staff requested Dominion to describe the implementation of NEDE-24326-1-P for the EQ of safety-related mechanical equipment, including the exception to its acceptance indicated in NUREG-1503. Detroit Edison adopted Dominion's RAI response dated September 11, 2008, which stated that the ESBWR DCD had been revised to incorporate the provisions of NEDE-24326-1-P and to address the time margin issue. The staff reviewed ESBWR DCD, Revision 10 and found that the time margin issue was acceptably addressed and conformed to 10 CFR 50.49 requirements. Therefore, RAI 03.11-4 is resolved.

ESBWR DCD, Tier 2, Section 3.10, addresses the methods of testing and analysis employed to ensure the capability of mechanical and electrical equipment under the full range of normal and accidental loadings to ensure conformance with NRC regulations. Operating experience from nuclear power plants has revealed the potential for adverse flow effects during normal plant operation that can impact safety-related components (such as safety relief valves). As a result, EQ programs need to address these adverse flow effects to provide confidence that safety-related equipment will be capable of performing their safety functions.

In RAI 03.11-5 for the previous R-COL plant, the NRC staff requested Dominion to describe the consideration of FIV in the qualification of safety-related mechanical equipment, including acoustic resonance and hydraulic loading. Detroit Edison adopted Dominion's RAI response dated September 11, 2008, which stated that ESBWR DCD, Tier 2, Subsection 3.9.3.5 requires the ESBWR general valve requirement specification to include requirements related to the design and functional qualification of safety-related valves that incorporate lessons learned from nuclear power plant operations and research programs. ESBWR DCD, Tier 2, Section 3.10 addresses methods of testing and analysis employed to ensure the capability of mechanical and electrical equipment under the full range of normal and accident loadings. The RAI response indicated that testing, as described in ESBWR DCD, Tier 2, Section 3.9.2 and FSAR Section 14.2, will provide confidence in the capability of safety-related equipment to perform their safety functions. For example, ESBWR DCD, Tier 2, Section 3.9.2.1.1 discusses vibration and dynamic effects testing that will be performed during the ITP, as described in DCD Subsections 14.2.8.1.42 and 14.2.8.2.10. The objective of these tests will be to confirm that the piping, components, restraints, and supports of specified high and moderate-energy systems were designed to withstand the dynamic effects of steady-state FIV and anticipated operational transient conditions. The staff considers that the actions specified in the ESBWR DCD will address potential adverse flow effects on safety-related valves and dynamic restraints including the consideration of lessons learned from nuclear power plant operating experience. Therefore, RAI 03.11-5 is resolved.

Fermi 3 FSAR Section 13.4, "Operational Program Implementation," includes FSAR Table 13.4-201, "Operational Programs Required by NRC Regulations," which lists each Operational Program, the regulatory source for the program, the FSAR section where the Operational Program is described, and the associated implementation milestones. FSAR Table 13.4-201 specifies the implementation milestone for the EQ Program as "prior to fuel load." In RAI 03.11-6 for the previous R-COL plant, the staff requested Dominion to clarify the commencement of the EQ Program and its transition into an operating reactor program. Detroit Edison adopted Dominion's RAI response dated September 11, 2008, stating that the COL application will contain a license condition that will require the COL licensee to submit a schedule to the NRC 12 months after the issuance of the COL, which will support planning and conducting NRC inspections of Operational Programs including the EQ Program, with periodic updating of the schedule. This schedule will address additional program implementation details, such as commencement of the EQ Program. The transition of the EQ Program into an operating program will occur as part of the plant turnover process. The staff finds that the RAI response clarified plans for the implementation and turnover of the EQ Program during plant construction and startup. Therefore, RAI 03.11-6 is resolved.

ESBWR DCD, Tier 1, Revision 4, Section 3.8, "Environmental Qualification of Mechanical and Electrical Equipment," specifies the EQ ITAAC for safety-related mechanical and electrical equipment in Table 3.8-2. The inspections, tests, and analyses for safety-related or RTNSS mechanical equipment located in a harsh environment state that type tests, or a combination of type tests and analyses will be performed. In RAI 03.11-7 for the previous R-COL plant, the staff requested Dominion to describe the plan for the implementation of the ITAAC for safety-related mechanical equipment located in a harsh environment, as specified in ESBWR DCD, Tier 1. Detroit Edison adopted Dominion's RAI response dated September 11, 2008, stating that ESBWR DCD, Tier 1, Subsection 1.1.2.2 provides a general plan description of ITAAC implementation. Part 10 of the Fermi 3 COL application incorporates the DCD ITAAC by reference. With respect to specific ITAAC implementation, the NRC regulations in 10 CFR 52.99, “Inspection during construction,” require the licensee to submit a schedule for completing the inspections, tests, or analyses in the ITAAC, no later than 1 year after COL issuance or the start of construction as defined in 10 CFR 50.10(b) - whichever is later - with subsequent updates to the ITAAC schedule. The RAI response stated that plans and schedules for implementing the ITAAC will be provided in accordance with 10 CFR 52.99. The staff finds that these provisions for addressing the EQ ITAAC are consistent with the regulations and are thus acceptable. Therefore, RAI 03.11-7 is resolved.

ESBWR DCD, Tier 2, Section 3.11 describes the program for the initial EQ of electrical and mechanical equipment within the EQ Program for nuclear power plants applying the ESBWR reactor design. An NRC audit at the GEH office in Wilmington, NC, in July 2009, found that the ESBWR DCD does not address the transition from the initial EQ program to the operational aspects of the EQ Program. As discussed in RG 1.206 and Commission Paper SECY-05-0197, COL applicants must fully describe their operational programs to avoid the need for ITAAC regarding those programs. Therefore, the staff requested in RAI 03.11-8 for the previous R-COL plant that Dominion address the operational aspects of the EQ Program in the FSAR. Detroit Edison adopted Dominion’s RAI response dated February 4, 2010 (ADAMS Accession No. ML100470588), which provided a proposed revision to the FSAR to enhance the EQ Program description and to address the operational aspects of the program. The staff found that the planned revision to the COL FSAR would provide an acceptable description of the transition from the initial EQ Program to the operational aspects of the EQ Program. In the SER with open items, this issue was tracked as Confirmatory Item 03.11-8 for incorporation of the Fermi 3 FSAR changes. Subsequently, Revision 3 (and Revision 4) to Fermi 3 FSAR in Subsection 3.11.4.4 incorporates the provisions for the EQ Operational Program as specified in the RAI response. For example, the FSAR specifies that the documentation necessary to support the continued qualification of the equipment installed in the plant that is within the EQ Program scope will be available in accordance with 10 CFR Part 50, Appendix A. The FSAR also describes the EQ Master Equipment List (EQMEL) that identifies the electrical and mechanical equipment that must be environmentally qualified for use in a harsh environment. The FSAR describes the control of revisions to the EQ files and the EQMEL. The FSAR specifies that the operational aspect of the EQ Program will include: (1) evaluation of EQ results for design life to establish activities to support continued EQ; (2) determination of surveillance and preventive maintenance activities based on EQ results; (3) consideration of EQ maintenance recommendations from equipment vendors; (4) evaluation of operating experience in developing surveillance and preventive maintenance activities for specific equipment; (5) development of plant procedures that specify individual equipment identification, appropriate references, installation requirements, surveillance and maintenance requirements, post-maintenance testing requirements, condition monitoring requirements, replacement part identification, and applicable design changes and modifications; (6) development of plant procedures for reviewing equipment performance and EQ operational activities, and for trending the results to incorporate lessons learned through appropriate modifications to the EQ operational program; and (7) development of plant procedures for the control and maintenance of EQ records. Therefore, Confirmatory Item 03.11-8 is closed. Based on the above evaluation, the staff finds that the applicant has adequately addressed COL Item STD COL 3.11-1-A, and it is therefore acceptable.

Interfaces for Standard Design

ESBWR DCD, Tier 2, Section 1.8, “Interfaces with Standard Design,” identifies site-specific interfaces with the standard ESBWR design. DCD Table 1.8-1, “Matrix of NSSS Interfaces,” references Section 3.11 for the supporting interface area of the environmental design of mechanical and electrical equipment. The staff reviewed the Fermi 3 COL application for interfacing requirements with the ESBWR standard design regarding the EQ of mechanical and electrical equipment using the review procedures described in SRP Section 3.11. The NRC staff finds the applicant's consideration of design interface items to be acceptable based on compliance with 10 CFR 50.49 as discussed above.

License Conditions

- Part 10, License Condition 3.5

The applicant proposed a license condition providing the implementation milestone for the EQ Program.

- Part 10, License Condition 3.6

The applicant proposed a license condition to provide a schedule to support the NRC's inspection of operational programs, including the EQ Program.

These license conditions are consistent with the policy established in SECY-05-0197 and are, thus, acceptable.

3.11.5 Post Combined License Activities

The following items were identified as the responsibility of the COL licensee:

License Condition 3.5, "Operational Program Implementation," in Part 10 of the Fermi 3 COL application includes a Proposed License Condition in 3.5.7 related to the EQ Program. This license condition will require the EQ Program to be implemented prior to initial fuel load. License Condition 3.6, "Operational Program Readiness," in Part 10 of the Fermi COL application will require the licensee to develop a schedule that supports planning for and conduct of NRC inspection of the operational programs listed in Fermi 3 COL FSAR Table 13.4-201, "Operational Program Required by NRC Regulations." This schedule must be available to the NRC staff no later than 12 months after issuance of the COL. The condition will also require that the schedule be updated every 6 months until 12 months before scheduled fuel load, and every month thereafter until the operational programs listed in the Fermi 3 COL FSAR Table 13.4-201 have been fully implemented or the plant has been placed in commercial service, whichever comes first.

3.11.6 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG-1966. The staff reviewed the application and checked the referenced DCD. The NRC staff's review confirms that the applicant has addressed the required information and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the EQ of the mechanical and electrical equipment that were incorporated by reference have been resolved.

In addition, the staff compared the supplemental information in the COL application to the relevant NRC regulations, the guidance in Section 3.11 of NUREG-0800, and other NRC RGs.

The staff's review concluded that the applicant has provided sufficient information to satisfy the NRC requirements. Therefore, the staff concludes that the Fermi 3 COL FSAR, with the incorporation by reference of the ESBWR DCD, provides an acceptable description of the EQ of electrical and mechanical equipment to be used at Fermi 3, which provides reasonable assurance that the electrical and mechanical equipment within the scope of the Fermi 3 EQ Program will be capable of performing their safety functions in accordance with NRC regulations.

3.12 Piping Design Review

3.12.1 Introduction

This FSAR section covers the design of the metallic piping system and piping support for seismic Category I, Category II, and nonsafety systems. The discussion also includes the adequacy of the structural integrity, and the functional capability of the safety-related piping system, piping components, and their associated supports. The design of the piping systems should ensure that they perform their safety-related functions under all postulated combinations of normal operating conditions, system operating transients, postulated pipe breaks, and seismic events. This includes pressure retaining piping components and their supports, buried piping, instrumentation lines, and the interaction of NS Category I piping and associated supports with seismic Category I piping and associated supports. This section also covers the design transients and resulting loads and load combinations with appropriate specified design and service limits for seismic Category I piping and piping supports - including those designated as ASME Code Class 1, 2, and 3.

3.12.2 Summary of Application

Section 3.12 of the Fermi 3 COL FSAR, Revision 7, references the related sections of Chapter 3 and Chapter 5 of the ESBWR DCD, Revision 10 for the information on seismic Category I and II and NS piping analyses. In addition in FSAR Section 3.12, the applicant provides the following:

Supplemental Information

- STD SUP 3.12-1 Piping Design Review

In Section 3.12, the applicant states the following:

> Information on seismic Category I and II, and non-seismic piping analysis and their associated supports is presented in DCD Sections 3.7, 3.9, 3D, 3K, 5.2 and 5.4.

3.12.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1966.

In addition, the relevant requirements of the Commission regulations for the piping and support design, and the associated acceptance criteria, are in Section 3.12 of NUREG-0800.

3.12.4 Technical Evaluation

As documented in NUREG–1966, NRC staff reviewed and approved Chapters 3 and 5 of the ESBWR DCD. The staff reviewed Section 3.12 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the ESBWR DCD and the information in the Fermi 3 COL FSAR, Revision 7, appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the relevant information related to this section.

The staff reviewed the following information in the Fermi 3 COL FSAR:

Supplemental Information

- STD SUP 3.12-1 Piping Design Review

The staff reviewed Supplemental Information STD SUP 3.12-1. The ESBWR DCD does not have Section 3.12. Therefore, this supplemental information is being considered as an editorial change to provide a map for the piping design information. The staff finds this change acceptable.

The staff also reviewed COL application FSAR Section 3.7 to verify that the site-specific structural response spectra are enveloped by the response spectra of the ESBWR DCD. This evaluation is documented in Section 3.7.2 of this SER. On the basis that site-specific response spectra are enveloped by the ESBWR DCD response spectra, the staff finds the ESBWR standard plant design acceptable at the Fermi 3 site.

In addition to the piping DAC ITAAC in ESBWR DCD, Tier 1, the staff also reviewed COL Item STD COL 14.3A-1-1 which provides a schedule for completing the piping DAC ITAAC. On the basis that the applicant's proposed DAC are sufficient to provide reasonable assurance in meeting the requirements of 10 CFR 52.80(a), the staff finds this acceptable.

3.12.5 Post Combined License Activities

The following activities will be implemented following issuance of the COL:

- Piping DAC
  - The ASME Code piping and support design reports are completed on a system-by-system basis for applicable systems in order to support closure of the DAC ITACC.
  - Reconciliation of the as-built piping.

[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

3.12.6 Conclusion

NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the relevant information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional COL information in the application to the relevant NRC regulations and the guidance in Section 3.12 of NUREG-0800. The staff's review concludes that the applicant is in compliance with NRC regulations. The applicant has adequately addressed the COL information item involving the completion of the piping DAC ASME Design Reports. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR Part 52 requirements by providing reasonable assurance that the piping system will be designed and built in accordance with the certified ESBWR design.

3.13 Threaded Fasteners – ASME BPV Code Class 1, 2 and 3

3.13.1 Introduction

This FSAR section covers the selection of the materials and design, and the inspecting and testing for threaded fasteners before initial service and during service and is limited to threaded fasteners in the ASME Boiler and Pressure Vessel Code Class 1, 2 or 3 systems.

ESBWR DCD, Revision 10 does not contain Section 3.13 because the DCD application was submitted before the new SRP Section 3.13 was issued in March 2007. However, ESBWR DCD, Tier 2, Subsection 3.9.3.9, "Threaded Fasteners - ASME B&PV Code Class 1, 2 and 3," provides sufficient information for the staff to conclude that the selection of the materials and design, and inspecting and testing for threaded fasteners before initial service and during service are acceptable. Therefore, Fermi 3 FSAR, Revision 7, Section 3.13 provides supplemental information that references ESBWR DCD, Tier 2, Subsection 3.9.3.9.

3.13.2 Summary of Application

Section 3.13 of the Fermi 3 FSAR, Revision 7, references Subsection 3.9.3.9 of the ESBWR DCD, Revision 10. Section 3.9 of Fermi 3 FSAR, Revision 7, incorporates by reference Subsection 3.9.3.9 of the ESBWR DCD, Revision 10. In addition, in FSAR Section 3.13 the applicant provides the following:

Supplemental Information

- STD SUP 3.13-1 Threaded Fasteners – ASME Code Class 1, 2, and 3

In Section 3.13, the applicant states the following:

> Criteria applied to the selection of materials, design, inspection and testing of threaded fasteners (i.e., threaded bolts, studs, etc.) are presented in DCD Section 3.9.3.9, with supporting information in DCD Sections 4.5.1, 5.2.3, and 6.1.1.

3.13.3 Regulatory Basis

The relevant requirements of the Commission regulations for the piping and support design, and the associated acceptance criteria, are in Section 3.13 of NUREG–0800. Specific requirements include the following:

- 10 CFR Part 50, Appendix A, GDC 1 and 30, as they relate to the requirement that SSCs important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed.

- GDC 4, as it relates to the compatibility of components with environmental conditions.

- GDC 14, as it relates to the requirement that the RCPB be designed, fabricated, erected, and tested in a manner that provides assurance of an extremely low probability of abnormal leakage, rapidly propagating failure, or gross rupture.

- GDC 31, "Fracture prevention of reactor coolant pressure boundary," as it relates to the requirement that the RCPB be designed with a sufficient margin to ensure that when stressed under operating, maintenance, testing, and postulated accident conditions the boundary behaves in a non-brittle manner and the probability of rapidly propagating fracture is minimized.

- 10 CFR Part 50, Appendix B, as it relates to controlling the cleaning of material and equipment to prevent damage or deterioration.

- 10 CFR Part 50, Appendix G, "Fracture Toughness Requirements," as it relates to materials testing and acceptance criteria for fracture toughness of reactor pressure boundary components.

- 10 CFR 50.55a incorporates by reference the design criteria of ASME BPV Code, Section III, Class 1, 2, and 3 components. The selection of materials, design, testing, fabrication, installation and inspection of threaded fasteners and mechanical joints are acceptable if they meet the criteria of ASME BPV Code, Section III Class 1, 2, and 3 components. However, 10 CFR 50.55a(b)(4) permits the use of code cases that have been adopted by the staff in RG 1.84 in lieu of applicable criteria in ASME BPV Code, Section III, Class 1, 2, and 3 component.

- 10 CFR 52.47(b)(1), which requires a DC application to contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and NRC's regulations.

- 10 CFR 52.80(a), which requires that a COL application to contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the COL, the provisions of the Atomic Energy Act, and the NRC's regulations.

3.13.4 Technical Evaluation

As documented in NUREG–1966, NRC staff reviewed and approved Subsection 3.9.3.9 of the certified ESBWR DCD. The staff reviewed Section 3.13 of the Fermi 3 COL FSAR, Revision 7, which references ESBWR Subsection 3.9.3.9, and checked the referenced ESBWR DCD to ensure that the combination of the information in the ESBWR DCD and the information in the Fermi 3 COL FSAR, Revision 7, appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the relevant information related to this section.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on the standard content that were documented in the SER with open items issued for the North Anna Unit 3 application were equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna 3 COL FSAR, Revision 1, to the Fermi COL FSAR. In performing this comparison, the staff considered changes to the Fermi 3 COL FSAR (and other parts of the COL application, as applicable) resulting from (RAIs) and open and confirmatory items identified in the North Anna SER with open items.

- The staff confirmed that the applicant has endorsed all responses to the RAIs identified in the corresponding standard content (the North Anna SER) evaluation.

- The staff verified that the site-specific differences were not relevant to this section.

The staff has completed the review and found the evaluation performed for the North Anna standard content to be directly applicable to the Fermi COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting.

The staff reviewed the following information in the Fermi 3 COL FSAR:

Supplemental Information

- STD SUP 3.13-1 Threaded Fasteners – ASME Code Class 1, 2, and 3

The staff reviewed the applicant's information related to threaded fasteners and included under Section 3.13 of the Fermi 3 COL FSAR, which states the following:

> Criteria applied to the selection of materials, design, inspection and testing of threaded fasteners (i.e., threaded bolts, studs, etc.) are presented in DCD Section 3.9.3.9, with supporting information in DCD Sections 4.5.1, 5.2.3, and 6.1.1.

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

The following portion of this technical evaluation section is reproduced from Subsection 3.13.4, “Technical Evaluation,” of the North Anna Unit 3 SER (ADAMS Accession No. ML092010530):

> *NRC staff reviewed STD SUP 3.13-1 related to the criteria for the selection of materials, design, inspection, and testing of threaded fasteners included under Section 3.13 of the North Anna 3 COL FSAR. STD SUP 3.13-1 points to ESBWR DCD Tier 2, Sections 4.5.1, 5.2.3, and 6.1.1. Those sections provide additional and specific requirements concerning threaded fasteners used in reactor internals, the reactor coolant system, and other engineered safety features. The staff found that STD SUP 3.13-1 appropriately points out the DCD sections that identify the specific use of threaded fasteners in reactor internals, the reactor coolant system, and other engineered safety features.*
>
> *The staff reviewed the conformance of Section 3.13 of the North Anna 3 COL FSAR to the guidance of RG 1.206, Section C.III.1, Chapter 3, C.I.3.13, “Threaded Fasteners.” The staff’s review of Section 3.13 of the North Anna 3 COL FSAR found that the applicant has appropriately incorporated by reference Section 3.9.3.9 of ESBWR DCD, Revision 5.*

The staff considers the applicant’s Supplemental Information Item STD SUP 3.13-1 to adequately address threaded fasteners.

3.13.5 Post Combined License Activities

There are no post COL activities related to this section.

3.13.6 Conclusion

NRC staff reviewed the application and checked the referenced DCD. The staff’s review confirms that the applicant has addressed the relevant information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

In addition, the staff compared the additional COL information in the application to the relevant NRC regulations, the guidance in Section 3.12 of NUREG-0800, and other NRC RGs. The staff’s review concludes that the information in Fermi 3 COL FSAR, Section 3.13 is within the scope of the design certification and adequately incorporates by reference Subsection 3.9.3.9 of the ESBWR DCD, which addresses SRP Section 3.13. The information is thus acceptable and meets the NRC regulations.

4.0 REACTOR

4.1 Introduction

This chapter describes the mechanical components of the Economic Simplified Boiling-Water Reactor (ESBWR) and the reactor core including the reactor internals, control rod drive, and core support structural materials, fuel system design (fuel rods and assemblies), the nuclear design, and the thermal-hydraulic design. It provides an evaluation and the supporting information necessary to establish the capability of the reactor to perform its safety functions throughout its design lifetime under all normal operational modes and transient, steady-state, and accident conditions. This chapter also includes information to support the accident analyses.

4.2 Summary of Application

Chapter 4 of the Fermi 3 Combined License (COL) Final Safety Analysis Report (FSAR), Revision 7 incorporates by reference, with no departures, Chapter 4 of the certified ESBWR Design Control Document (DCD), Revision 10. In addition, in FSAR Chapter 4, the applicant provides the following:

COL items

- STD COL 4.3-1-A Variances from Certified Design

The applicant shall address changes to the reference design of the fuel, control rod, or core design.

- STD COL 4A-1-A Variances from Certified Design

The applicant shall address changes to the reference design of the fuel, control rod, or core design.

For both items, the applicant states that there are no changes to the fuel, control rod, or core design from the referenced certified design.

4.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG-1966, "Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling-Water Reactor." In addition, the relevant requirements of the Commission regulations for the reactor, and the associated acceptance criteria, are in Chapter 4 of NUREG–0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, (LWR Edition)," the Standard Review Plan (SRP).

4.4 Technical Evaluation

As documented in NUREG–1966, U.S. Nuclear Regulatory Commission (NRC) staff reviewed and approved Chapter 4 of the certified ESBWR DCD. The staff reviewed Chapter 4 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to this chapter.

Chapter 4 of the Fermi 3 COL FSAR contains the following sections:

4.1 Summary Description
4.2 Fuel System Design
4.3 Nuclear Design
4.4 Thermal and Hydraulic Design
4.5 Reactor Materials
4.6 Functional Design of Reactivity Control System

Appendix 4A Typical Control Rod Patterns and Associated Power Distribution for ESBWR
Appendix 4B Fuel Licensing Acceptance Criteria
Appendix 4C Control Rod Licensing Acceptance Criteria
Appendix 4D Stability Evaluation

The staff reviewed the following information in the COL FSAR:

COL items

- STD COL 4.3-1-A Variances from Certified Design
- STD COL 4A-1-A Variances from Certified Design

For COL Items STD COL 4.3-1-A and STD COL 4A-1-A, the applicant states that there are no changes to the fuel, control rod, or core design from the referenced certified design. The staff reviewed the information in the COL FSAR and concluded that the information provided to address these COL items is adequate and therefore acceptable.

4.5 Post Combined License Activities

There are no post COL activities related to this chapter.

4.6 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this chapter. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference are resolved. The staff's review confirms that the applicant adequately addressed COL Items STD COL 4.3-1-A and STD COL 4A-1-A.

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

5.0 REACTOR COOLANT SYSTEM AND CONNECTED SYSTEMS

The reactor coolant system (RCS) and connected systems include those systems and components that contain or transport fluids coming from or going to the reactor core. These systems form a major portion of the reactor coolant pressure boundary (RCPB). This chapter provides information regarding the RCS and pressure-containing appendages out to and including isolation valves. This grouping of components is defined as the RCPB and is defined in Title 10 of the *Code of Federal Regulations* (10 CFR) 50.2.

5.1 <u>Summary Description</u>

This section of the Fermi 3 combined license (COL) Final Safety Analysis Report (FSAR) incorporates by reference, with no departures or supplements, Section 5.1, "Summary Description," of the certified Economic Simplified Boiling-Water Reactor (ESBWR) design control document (DCD) Revision 10, referenced in 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Appendix E, "Design Certification Rule for the Economic Simplified Boiling-Water Reactor," with no departures or supplements. The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the application and checked the referenced DCD. The staff's review confirmed that no outstanding information is addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52 Appendix E, Section VI.B.1, all nuclear safety issues relating to the summary description are resolved.

5.2 <u>Integrity of Reactor Coolant Pressure Boundary</u>

This FSAR section discusses measures employed to provide and maintain the integrity of the RCPB.

5.2.1 Compliance with Codes and Code Cases

5.2.1.1 Compliance with 10 CFR 50.55a

5.2.1.1.1 *Introduction*

This subsection of the Fermi 3 COL FSAR, Revision 7, addresses the American Society of Mechanical Engineers (ASME) Code edition and addenda to be used at Fermi 3, in order to show compliance with NRC regulations in 10 CFR 50.55a.

5.2.1.1.2 *Summary of Application*

Section 5.2 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 5.2 of the certified ESBWR DCD, Revision 10. In addition, in FSAR Subsection 5.2.1.1, the applicant provides the following:

<u>*Supplemental Information*</u>

- STD SUP 5.2-2

In FSAR Subsection 5.2.1.1, the applicant provides supplemental information that the preservice inspection (PSI) and the inservice inspection (ISI) of the RCPB are conducted in accordance with the applicable edition and addenda of the ASME Boiler and Pressure Vessel (BPV) Code, Section XI, as required by 10 CFR 50.55a. FSAR Subsection 5.2.1.1 also states the following:

> As described in DCD Section 3.9.6 for pumps and valves, and in DCD Section 3.9.3.7.1 for dynamic restraints, preservice and inservice testing of RCPB components is in accordance with the edition and addenda of the ASME OM Code required by 10 CFR 50.55a.

5.2.1.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1966, “Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling-Water Reactor.” In addition, the related requirements of the Commission’s regulations for compliance with 10 CFR 50.55a, and the associated acceptance criteria, are described in Subsection 5.2.1.1 of NUREG–0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition),” (the Standard Review Plan [SRP]).

In particular, NRC regulations in 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” and Part 52 provide the regulatory basis for the NRC staff’s review of the information in the Fermi 3 COL application. For example, NRC regulations in 10 CFR Part 50, Appendix A, “General Design Criteria for Nuclear Power Plants,” General Design Criterion (GDC) 1, “Quality standards and records,” require that nuclear power plant structures, systems, and components (SSCs) important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed. Furthermore, NRC regulations in 10 CFR 50.55a, “Codes and standards,” as they relate to the establishment of the minimum quality standards for the design, fabrication, erection, construction, testing, and inspection of nuclear power plant components require conformance with appropriate editions of published industry codes and standards.

Also, NRC staff followed the guidance in Regulatory Guide (RG) 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition),” June 2007, in evaluating Fermi 3 COL FSAR Subsection 5.2.1.1 for compliance with NRC regulations.

5.2.1.1.4 *Technical Evaluation*

As documented in NUREG–1966, NRC staff reviewed and approved Section 5.2 of the certified ESBWR DCD. The staff reviewed Section 5.2 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff’s review confirms that the information in the application and the information incorporated by reference address the relevant information related to this section.

Section 1.2.3 of this safety evaluation report (SER) discusses the NRC’s strategy for performing one technical review for each standard issue outside the scope of the design certification (DC)

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[1] See “*Finality of Referenced NRC Approvals*” in SER Section 1.2.2 for a discussion on the staff’s review related to verification of the scope of information to be included in a COL application that references a design certification.

and to use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the North Anna application are equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna 3 COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes to the Fermi 3 COL FSAR (and other parts of the COL application, as applicable) resulting from requests for additional information (RAIs) and open and confirmatory items identified in the North Anna SER with open items.

- The staff confirmed that the applicant has endorsed all responses to the RAIs identified in the corresponding standard content (the North Anna SER) evaluation.

- The staff verified that the site-specific differences were not relevant to this section.

The staff completed the review and found the evaluation of the North Anna standard content to be directly applicable to the Fermi 3 COL application. This SER identifies the standard content material with italicized, double-indented formatting.

The staff reviewed the information in the Fermi 3 COL FSAR as follows:

Supplemental Information

- STD SUP 5.2-2

The following portion of this technical evaluation section is reproduced from Subsection 5.2.1.1.4 of the North Anna Unit 3 SER (Agencywide Documents Access and Management Systems (ADAMS) Accession No. ML091730304):

> - STD SUP 5.2-2
>
> *In request for additional information (RAI) 05.02.01.01-1, NRC staff requested that Dominion address the application of other sections of the ASME BPV Code and the ASME Code for Operation and Maintenance of Nuclear Power Plants (OM Code) in its implementation of the ESBWR reactor design. In response to this RAI, by letter dated September 11, 2008, the applicant stated that the FSAR would be revised to provide references to the appropriate sections that discuss compliance with the ASME BPV Code, Section XI, and the ASME OM Code. As a result, Revision 1 of FSAR Section 5.2.1.1 states that the* [PSI] *and ISI of the RCPB will be conducted in accordance with the applicable edition and addenda of the ASME BPV Code, Section XI, required by 10 CFR 50.55a as described in FSAR Section 5.2.4. FSAR Section 5.2.1.1 also states that preservice and inservice testing (IST) of the RCPB components will be in accordance with the edition and addenda of the ASME OM Code required by 10 CFR 50.55a as described in DCD Section 3.9.6, for pumps and valves and DCD Section 3.9.3.7.1, for dynamic restraints. NRC staff has verified these revisions and finds that the reference to the applicable sections of the ESBWR DCD for the application of appropriate ASME Code editions and addenda is consistent with NRC regulations, and therefore is acceptable. Therefore, this RAI is closed.*

Revision 7 of the Fermi 3 COL FSAR, Subsection 5.2.1.1 is consistent with these statements in the North Anna 3 FSAR. However, the quoted text above is missing the portion of the text that refers to the "PSI," which is now inserted in brackets. Therefore, NRC staff finds that the reference to the applicable sections of the ESBWR DCD for the application of appropriate ASME Code editions and addenda meets the 10 CFR 50.55a requirements and the guidance in NUREG–0800, and is therefore acceptable.

5.2.1.1.5 *Post Combined License Activities*

There are no post COL activities related to this section.

5.2.1.1.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

In addition, the staff compared the additional COL supplemental information in the application to the NRC regulations, the guidance in Subsection 5.2.1.1 of NUREG–0800, and other NRC regulatory guides. The staff's review concludes that the applicant has presented adequate information in the Fermi 3 COL FSAR to meet the requirements of the Codes and Standards Rule (10 CFR 50.55a).

5.2.1.2 Applicable Code Cases

5.2.1.2.1 *Introduction*

This subsection addresses the ASME BPV Code and ASME "Operation and Maintenance of Nuclear Power Plants" (OM Code) Code Cases that are applicable to the Fermi 3 COL FSAR, Revision 7. This section also addresses regulatory guides that indicate the acceptance of ASME Code Cases with or without conditions. In general, a Code Case is developed by ASME based on inquiries from the nuclear industry associated with Code clarification, modification or alternative to the Code. All Code Cases will remain valid and available for use until annulled by the ASME. ASME Code Cases acceptable to the NRC staff are published in RG 1.84, "Design and Fabrication Code Case Acceptability, ASME Section III, Division 1"; RG 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1"; and RG 1.192, "Operation and Maintenance Code Case Acceptability, ASME OM Code"; in accordance with requirements of 10 CFR 50.55a(b)(4), (5), and (6), respectively.

5.2.1.2.2 *Summary of Application*

Section 5.2 of the Fermi 3 COL FSAR Revision 7 incorporates by reference Subsection 5.2.1.2, "Applicable Code Cases," of the certified ESBWR DCD, Tier 2 Revision 10, without supplemental information or departures.

5.2.1.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1966. In addition, the requirements of the Commission regulations for the applicable code cases, and the associated acceptance criteria, are in Subsection 5.2.1.2 of NUREG–0800. NRC regulations in 10 CFR Parts 50 and 52 provide the regulatory basis for the NRC staff's review of the information in the Fermi 3 COL application. For example, in 10 CFR Part 50, Appendix A, GDC 1 requires that nuclear power plant SSCs important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed. Furthermore, NRC regulations in 10 CFR 50.55a that are related to the establishment of the minimum quality standards for the design, fabrication, erection, construction, testing, and inspection of nuclear power plant components require conformance with appropriate editions of published industry codes and standards.

As one acceptable means of meeting the applicable NRC regulations, RG 1.84 lists ASME BPV Code Section III—Code Cases related to design, fabrication, materials, and testing—that are acceptable with applicable conditions for implementation at nuclear power plants. RG 1.147 lists ASME BPV Code Section XI Code Cases as acceptable with applicable conditions for use in the ISI of nuclear power plant components and their supports. RG 1.192 lists Code Cases related to the ASME OM Code for the operation and maintenance of nuclear power plant components that are acceptable with applicable conditions for implementation at nuclear power plants.

The NRC staff followed the guidance in SRP Subsection 5.2.1.2, "Applicable Code Cases," and RG 1.206 to evaluate Fermi 3 COL FSAR Subsection 5.2.1.2, for compliance with NRC regulations.

5.2.1.2.4 *Technical Evaluation*

As documented in NUREG–1966, NRC staff reviewed and approved Subsection 5.2.1.2 of the certified ESBWR DCD. The staff reviewed Section 5.2 of the Fermi 3 COL FSAR, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the relevant information related to this section.

The applicant notified the NRC that it had assumed the role of the reference-COL (R-COL) applicant for the ESBWR design in letters dated February 16, 2009; July 19, 2010; and September 21, 2010. Detroit Edison stated that it had adopted the RAI responses relating to FSAR Subsection 5.2.1.2 provided by Dominion Power for the previous R-COL plant (North Anna Unit 3 ESBWR). The NRC staff's review of these RAIs as they relate to Fermi 3 COL FSAR Subsection 5.2.1.2 is provided below.

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Fermi 3 COL FSAR Section 5.2.1, “Compliance with Codes and Code Cases,” incorporates by reference ESBWR DCD, Tier 2, Subsection 5.2.1.2, without departures or supplemental information. In ESBWR DCD, Tier 2, Subsection 5.2.1.2 indicates that the various ASME Code Cases that may be applied to components in the ESBWR design are listed in ESBWR DCD, Tier 2, Table 5.2-1. ESBWR DCD, Tier 2, Subsection 5.2.1.2 also notes that RG 1.84 and RG 1.147 provide a list of ASME Code design, fabrication, and inspection Code Cases that the NRC has generically approved.

In RAI 05.02.01.02-1, which was issued for the previous R-COL plant, the staff requested Dominion to discuss the use of any Code Cases related to the ASME BPV and OM Codes that are not listed in ESBWR DCD, Tier 2, Table 5.2-1. The applicant adopted Dominion’s RAI response dated September 11, 2008. This response states that no ASME BPV Code Section III or Section XI Code Cases—other than those listed in ESBWR DCD, Tier 2, Table 5.2-1—are identified as necessary. This RAI response indicates that other Code Cases approved by the NRC in RG 1.147 might be used during the development and implementation of the PSI and ISI Programs. ESBWR DCD, Tier 2, Subsection 3.9.3.7.1b, “Inspection, Testing, Repair, and/or Replacement of Snubbers,” references RG 1.192 for the use of Code Cases applicable to inservice testing of dynamic restraints (such as Code Case OMN-13). ESBWR DCD, Tier 2, Subsection 3.9.6.6, “10 CFR 50.55a Relief Requests and Code Cases,” indicates that the IST Program for the ESBWR does not use any ASME Code Cases. The RAI response states that other Code Cases approved by the NRC in RG 1.192 might be used during the development and implementation of the preservice testing and IST programs. The RAI response also includes a planned FSAR revision to reference RG 1.192 in Subsection 5.2.1.2. Subsequently, Revision76 to ESBWR DCD, Tier 2 Subsection 5.2.1.2 included RG 1.192, in addition to RGs 1.84 and 1.147, for the use of ASME Code Cases. ESBWR DCD, Tier 2, Subsection 5.2.1.2 also states that the use of the ASME OM Code—including the application of any OM Code Cases—with the conditions and restrictions of RG 1.192 is described in DCD Tier 2, Section 3.9. Although the RAI response considered an FSAR revision, NRC staff finds the Fermi 3 COL FSAR Subsection 5.2.1.2 acceptable without a specific discussion of ASME OM Code Cases, because Revision 10 to the ESBWR DCD considers those code cases. Therefore, RAI 05.02.01.02-1 is resolved.

In the ESBWR DCD, Tier 2, Subsection 5.2.1.2 states that annulled cases are considered active for equipment that was contractually committed to fabrication before the annulment. In RAI 05.02.01.02-2 for the previous R-COL plant, North Anna Unit 3), NRC staff requested Dominion to discuss its compliance with the requirements regarding the use of annulled Code Cases specified in 10 CFR 50.55a(b)(4), (5), and (6). Detroit Edison adopted Dominion’s RAI response dated September 11, 2008. This response states that the design, fabrication, and construction of safety-related components were conducted in accordance with ASME Code requirements specified in ESBWR DCD, Tier 2, Table 3.2-1, “Classification Summary”; and Table 3.2-3, “Quality Group Designations—Codes and Industry Standards.” This RAI response also notes that in the ESBWR DCD, Tier 2, Subsection 5.2.1.1 specifies that the ESBWR complies with the requirements of 10 CFR 50.55a. In addition, this RAI response states that these requirements include the application of any limitations and modifications to the applicable Code edition and addenda that may be specified in 10 CFR 50.55a, including any limitations regarding the use of annulled Code Cases. With respect to preservice and inservice inspections and the testing of safety-related components, the RAI response indicates that the applicable edition and addenda of the ASME Code identified in 10 CFR 50.55a are used subject to the limitations and modifications specified in 10 CFR 50.55a—including those limitations specified in 10 CFR 50.55a(b)(4), (5), and (6) regarding the use of Code Cases. The plans to use the ASME Code Cases are described in the RAI response. The staff finds that the plans meet the applicable NRC regulations. Therefore, RAI 05.02.01.02-2 is resolved.

Based on the above information, the staff finds it acceptable for the applicant to incorporate by reference the ESBWR DCD.

5.2.1.2.5 *Post Combined License Activities*

There are no post COL activities related to this section.

5.2.1.2.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

5.2.2 Overpressure Protection

This FSAR section addresses the safety and relief valves (SRVs) and the portion of the reactor protection system that ensures overpressure protection for the RCPB during operation at power.

Section 5.2.2, "Overpressure Protection," of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 5.2.2, "Overpressure Protection," of the certified ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this subsection remains for review.[1] The staff's review confirmed that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the overpressure protection have been resolved.

5.2.3 Reactor Coolant Pressure Boundary Materials

This FSAR subsection addresses information related to the materials selection, fabrication, and processing of RCPB piping and components, as well as the compatibility of RCPB materials with the reactor coolant.

Section 5.2.3, "Reactor Coolant Pressure Boundary Materials," of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 5.2.3, "Reactor Coolant Pressure Boundary Materials," of the certified ESBWR DCD, Revision 10, which is referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remains for review.[1] The staff's review confirmed that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52,

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Appendix E, Section VI.B.1, all nuclear safety issues relating to the RCPB materials have been resolved.

5.2.4 Preservice and Inservice Inspection and Testing of Reactor Coolant Pressure Boundary

5.2.4.1 *Introduction*

This FSAR section discusses components that are part of the RCPB, which must be designed to permit periodic inspection and testing of important areas and features to assess their structural and leak-tight integrity. ISI programs are based on the requirements of 10 CFR 50.55a, "Codes and Standards," in that Code Class 1 components, as defined in Section III of the ASME BPV Code meet the applicable inspection requirements set forth in Section XI of the ASME Code, "Rules for Inservice Inspection of Nuclear Power Plant Components."

5.2.4.2 *Summary of Application*

Section 5.2.4 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 5.2.4 of the certified ESBWR DCD, Revision 10, without departures. In addition, in FSAR Section 5.2.4, the applicant provides the following information:

COL Items

- STD COL 5.2-1-A — Preservice and In-service Inspection Program Description

The applicant provided additional information in FSAR Sections 5.2.4, 5.2.4.3.4, 5.2.4.6, and 5.2.4.11 in order to fully describe the PSI and ISI program including the applicable ASME Code Edition and Addenda, the certification of nondestructive examination (NDE) personnel as amended by 10 CFR 50.55a, system leakage tests as amended by 10 CFR 50.55a, and the PSI and ISI program implementation milestones.

- STD COL 5.2-3-A — Preservice and In-service Inspection Non-Destructive Examination Accessibility Plan Description

The applicant provided additional information in FSAR Sections 5.2.4 and 5.2.4.2 to address Class 1 austenitic or dissimilar metal welds and the preservation of accessibility during construction to enable the performance of ISI examinations during the operational phase.

Supplemental Information

- STD SUP 5.2-1

The applicant provided supplemental information in FSAR Section 5.2.4.6 to describe the relevant Technical Specification (TS) sections that address system pressure tests and RCS pressure and temperature (P-T) limits.

5.2.4.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1966. In addition, the requirements of the Commission regulations for the inservice inspections and testing of ASME Code Class 1 components, and the associated acceptance criteria, are in Section 5.2.4 of NUREG–0800.

The regulatory basis for accepting the COL information items (STD COL 5.2-1-A, STD COL 5.2-3-A) and supplemental information is GDC 32, "Inspection of reactor coolant pressure boundary," as it relates to the periodic inspection and testing of the RCPB; and 10 CFR 50.55a, as it relates to the requirements for testing and inspecting the Code Class 1 components as specified in Section XI of the ASME BPV Code. In addition, SECY-05-0197, "Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria," provides the Commission policy for fully describing an operational program.

5.2.4.4 *Technical Evaluation*

As documented in NUREG–1966, NRC staff reviewed and approved Section 5.2.4 of the certified ESBWR DCD. The staff reviewed Section 5.2.4 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the combination of information in the application and the information incorporated by reference addresses the relevant information related to this section.

The staff reviewed the information in the Fermi 3 COL FSAR as follows:

<u>*COL Items*</u>

- STD COL 5.2-1-A — Preservice and In-service Inspection Program Description

ESBWR DCD COL Item 5.2-1-A states that the COL applicant is responsible for providing a full description of the preservice and inservice inspection programs and augmented inspection programs by supplementing, as necessary, the information in FSAR Subsection 5.2.4 and to provide the milestones for their implementation. To address this COL Item, the applicant provided additional information in FSAR Sections 5.2.4, 5.2.4.3.4, 5.2.4.6, and 5.2.4.11 in order to provide a full description of the Fermi 3 preservice and inservice inspection program.

In Section 5.2.4, the applicant stated that "the initial inservice inspection program incorporates the latest edition and addenda of the ASME BPV Code approved in 10 CFR 50.55a(b) on the date 12 months before initial fuel load." 10 CFR 50.55a(g)(4)(i) requires that inservice examinations and pressure tests conducted during the initial 120-month inspection interval must comply with the requirements in the latest edition and addenda of the Code (or Code Cases) incorporated by reference in paragraph (b) of this section (10 CFR 50.55a) on the date 12

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

months before the date scheduled for initial loading of fuel under a COL under 10 CFR Part 52 of this chapter subject to the limitations and modifications listed in paragraph (b) of this section. The staff finds that the information provided by the applicant in FSAR Section 5.2.4 is acceptable because it is in compliance with the requirements of 10 CFR 50.55a(g)(4) and 10 CFR 50.55a(b).

In Section 5.2.4.3.4, the applicant stated that "certification of NDE personnel shall be in accordance with ASME Section XI, IWA-2300, as modified by 10 CFR 50.55a(b)(2)(xviii)." 10 CFR 50.55a(b)(2)(xviii) imposes a modification on the use of the latest edition and addenda of the Code incorporated by reference into 10 CFR 50.55a by requiring that Level I and Level II NDE personnel be recertified on a 3-year interval in lieu of the 5-year interval specified in Section XI, IWA-2314. Given that the initial ISI program will be in accordance with the latest edition and addenda of the ASME Code incorporated by reference in 10 CFR 50.55a, the information provided in the FSAR Section 5.2.4.3.4 is acceptable because it is in compliance with 10 CFR 50.55a(b).

In Section 5.2.4.6 the applicant stated that "system leakage and hydrostatic pressure tests will meet all the requirements of ASME Code, Section XI, IWA-5000 and IWB-5000 for Class 1 components, including the limitation of 10 CFR 50.55a(b)(2)(xxvi)." 10 CFR 50.55a(b)(2)(xxvi) imposes a limitation on the use of the 2001 Edition through the latest edition and addenda of the ASME Code incorporated by reference in 10 CFR 50.55a by requiring that the provisions of IWA-4540(c) from the 1998 Edition of Section XI for pressure testing Class 1, 2, and 3 mechanical joints be applied. Given that the initial ISI program will be in accordance with the latest edition and addenda of the ASME Code incorporated by reference in 10 CFR 50.55a, the information provided in the FSAR Section 5.2.4.6 is acceptable because it is in compliance with 10 CFR 50.55a(b).

In Section 5.2.4.11, the applicant stated that DCD Section 5.2.4 "fully describes the Preservice and Inservice Inspection and Testing Programs for the RCPB and that the implementation milestones for the Preservice and Inservice Inspection and Testing Programs are provided in FSAR Section 13.4." Since the PSI program uses essentially the same elements of the ISI program and the PSI program requirements are stated under ASME Section XI, the staff concurs with the statement that the PSI/ISI programs are fully described. The staff reviewed Table 13.4-201 and found that the implementation milestones for the PSI/ISI operational programs are listed.

Also, in the Fermi 3 COL application, Part 10, Section 3.6, the applicant has also provided the following proposed license condition related to the PSI/ISI operational program:

- The licensee shall submit to the appropriate Director of the NRC, a schedule, no later than 12 months after issuance of the COL, for implementation of the operational programs listed in FSAR Table 13.4-201. The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until the operational programs in the FSAR table have been fully implemented.

The staff finds implementation milestones are acceptable because they are in accordance with the requirements of ASME Section XI and 10 CFR 50.55a. The staff also finds that the proposed license condition is acceptable because it is in accordance with SECY 05-0197. As discussed in SECY-05-0197, a COL applicant should provide schedules for the implementation of operational programs in order to support the planning for and conducting of NRC inspections. Therefore, the staff will include such license condition in the Fermi 3 COL.

Based on the evaluation described above, STD COL 5.2-1-A is acceptable

- STD COL 5.2-3-A Preservice and Inservice Inspection NDE Accessibility Plan Description

ESBWR DCD COL Item 5.2-3-A states that the COL applicant is responsible for developing a plan and providing a full description of its use during construction, preservice inspection, inservice inspection, and during design activities for components that are not included in the referenced certified design, to preserve accessibility to piping systems to enable NDE of ASME Code Class 1 austenitic and dissimilar metal welds during inservice inspection. To address this COL item, the applicant provided additional information in FSAR Sections 5.2.4 and 5.2.4.2.

In FSAR Section 5.2.4, the applicant stated that all Class 1 austenitic or dissimilar metal welds are included in the referenced certified design. The applicant described in FSAR Section 5.2.4.2 how anomalies and construction issues are addressed using change control procedures during the construction phase of the project. Procedures require that changes to approved design documents, including field changes and modifications, are subject to the same review and approval process as the original design. Control of accessibility for inspect ability and testing during licensee design activities affecting Class 1 components is provided via procedures for design control and plant modifications. The applicant explained that ultrasonic techniques (UT) will be the preferred NDE method for all PSI and ISI volumetric examinations; radiographic techniques (RT) will be used as a last resort only if UT cannot achieve the necessary coverage. The same NDE method used during PSI will be used for ISI to the extent possible to assure a baseline point of reference. If a different NDE method is used for ISI than was used for PSI, equivalent coverage will be achieved as required by the ASME Code.

During normal plant operation, ultrasonic examination is the desired NDE method for austenitic and dissimilar metal welds due to ease in obtaining examination coverage of piping that is filled with water and as low as reasonably achievable personnel radiation exposure considerations. The use of RT is an acceptable replacement for UT and is allowed under ASME Section XI, Table IWB-2500, since the examination technique specified for these welds is volumetric. The information provided by the applicant meets the requirements under 10 CFR 50.55a(g)(3), which requires that plants be designed to enable the performance of inservice examinations. The use of RT as a supplemental examination technique with 100 percent coverage meets the requirements of ASME Section XI, Table IWB-2500. The information provided by the applicant provides reasonable assurance that during construction, controls exist to maintain the accessibility to enable the performance of inservice examinations for austenitic and dissimilar metal welds. The information provided by the applicant meets 10 CFR 50.55a(g)(3) and ASME Section XI. Based on the evaluation described above, STD COL 5.2-3-A is acceptable.

Supplemental Information

- STD SUP 5.2-1

In FSAR Section 5.2.4.6, the applicant stated that system pressure tests and correlated technical specification requirements are provided in the plant TSs 3.4.4, “RCS P-T Limits,” and 3.10.1, “Inservice Leak and Hydrostatic Testing Operation.” The proposed change provides additional information with respect to system pressure testing that is located within the TS.

Since the location of additional information regarding pressure testing is at the discretion of the licensee, and, the proposed change under STD COL 5.2-1-A (discussed above) meets the ASME Code and the limitations under 10 CFR 50.55a(b)(2)(xxvi), the staff concludes that the supplemental information as it pertains to pressure testing is acceptable.

5.2.4.5 *Post Combined License Activities*

In FSAR Table 13.4-201, the applicant provided the implementation milestones for the Preservice Inspection and Inservice Inspection programs.

As discussed above, the staff plans to impose the following license condition below:

- License Condition 05.04.04-1 – The licensee shall submit to the appropriate Director of the NRO, a schedule, no later than 12 months after issuance of the COL, for implementation of the operational programs listed in FSAR Table 13.4-201. The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until the operational programs in the FSAR table have been fully implemented.

5.2.4.6 *Conclusions*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52 Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

In addition, the staff concludes that the information in Fermi 3 COL FSAR Section 5.2.4 meets the relevant guidelines in SRP Section 5.2.4; and RG 1.206; and is therefore acceptable. The staff further concludes that the Fermi 3 COL FSAR PSI/ISI programs and implementation milestones are consistent with the policy established in SECY-05-0197. Conformance with these guidelines and the policy provides an acceptable basis for satisfying in part the requirements of GDC 32 and 10 CFR 50.55a.

5.2.5 Reactor Coolant Pressure Boundary Leakage Detection

5.2.5.1 *Introduction*

This section of the Fermi 3 COL FSAR, Revision 7, discusses the RCPB leakage detection systems that are designed to detect and, to the extent practical, identify the source of reactor coolant leakage.

5.2.5.2 *Summary of Application*

Section 5.2.5 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 5.2.5 of the certified ESBWR DCD, Revision 10. In addition, in FSAR Section 5.2.5, the applicant provides the following:

COL Item

- STD COL 5.2-2-A Leak Detection Monitoring

The applicant provided additional information to address STD COL 5.2-2-A. The applicant replaced Subsection 5.2.5.9, "Leak Detection Monitoring," of the ESBWR DCD with a paragraph stating that operators are provided with procedures and information for detecting, monitoring, recording, trending, and determining the sources of the RCPB leakage. The applicant added that FSAR Section 13.5, "Plant Procedures," describes the plant procedures program and implementation milestones.

5.2.5.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1966. In addition, the requirements of the Commission regulations for RCPB leakage detection, and the associated acceptance criteria, are in Section 5.2.5 of NUREG-0800.

The staff's acceptance of the leakage detection design is based on meeting the requirements of the following criteria:

- GDC 2, "Design basis for protection against natural phenomena," as it relates to the capability of the design to maintain and perform its safety function following an earthquake.

- GDC 30, "Quality of reactor coolant pressure boundary," as it relates to the detection, identification, and monitoring of the source of the reactor coolant leakage.

Also, the NRC staff followed the guidance in RG 1.206 for evaluating the compliance of Fermi 3 COL FSAR Section 5.2.5 with NRC regulations.

5.2.5.4 *Technical Evaluation*

As documented in NUREG–1966, NRC staff reviewed and approved Section 5.2.5 of the certified ESBWR DCD. The staff reviewed Section 5.2.5 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the relevant information related to this section.

Section 1.2.3 of this SER discusses the NRC's strategy for performing one technical review for each standard issue outside the scope of the DCD and to use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the North Anna application are equally applicable to the Fermi COL application, the staff undertook the following reviews:

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

- The staff compared the North Anna 3 COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes to the Fermi COL 3 FSAR (and other parts of the COL application, as applicable) resulting from requests for RAIs and open and confirmatory items identified in the North Anna 3 SER with open items.

- The staff confirmed that the applicant has endorsed all responses to the RAIs identified in the corresponding standard content (the North Anna SER) evaluation.

- The staff verified that the site-specific differences were not relevant to this section.

The staff completed the review and found the evaluation of the North Anna standard content to be directly applicable to the Fermi 3 COL application. This SER identifies the standard content material with italicized, double-indented formatting.

The staff reviewed the information in the Fermi 3 COL FSAR as follows:

COL Item

- STD COL 5.2-2-A Leak Detection Monitoring

In the ESBWR DCD, Revision 9, STD COL Item 5.2-2-H becomes STD COL 5.2-2-A.

The following portion of this technical evaluation section is reproduced from Subsection 5.2.5.4 of the North Anna Unit 3 SER (ADAMS Accession No. ML091730304):

> - STD COL 5.2-2-H Leak Detection Monitoring
>
> *NRC staff identified that the substitution of Section 5.2.5.9 of the ESBWR DCD with STD COL 5.2-2-H text appears to inappropriately limit the intended scope of the procedures contained in Section 5.2.5.9 of the ESBWR DCD. In addition, inclusion in FSAR, Revision 0 of the STD COL 5.2-2-H text of the examples "sump pump run time, sump level, and condensate transfer rate" without inclusion of "radioactivity," also appears to inappropriately limit the scope of the procedures. In RAI 05.02.05-1, the staff requested the applicant to clarify the following:*
>
> *(a) Revise the FSAR to clarify the scope of procedures relative to TSs. In addition to establishing the leakage rates for the limits in the TS, the operators should be able to use the procedures to identify and monitor the unidentified leakage at a level much lower than the TS limit so that the operator can monitor leakage, evaluate trends, determine the source of leakage, and evaluate potential corrective actions. This level to provide operators an early alert to initiate actions prior to the TS limit should be established as an alarm. The alarm level being established in an approved revision of the ESBWR DCD, Section 5.2.5 is acceptable for the COL application.*
>
> *(b) Confirm the procedure scope addresses the conversion of different parameter indications to include all three detection instrumentation in TS Limiting Condition for Operation 3.3.4.1, and clarify STD COL 5.2.2-H accordingly. The procedures should include indications from 1) the drywell floor drain high conductivity water sump monitoring system, 2)*

drywell air coolers condensate flow monitoring system, and 3) drywell fission product monitoring system.

In the letter, dated August 8, 2008, the applicant responded to RAI 05.02.05-1. In the response, the applicant revised FSAR Section 5.2.5.9 and STD COL 5.2.2-H to clarify that the procedures will fully address the topics described in Items (a) and (b) of the RAI and will be consistent with Section 5.2.5 of the ESBWR DCD, Revision 5. The revised FSAR Section 5.2.5.9 and STD COL 5.2.2-H states as follows:

"Operators are provided with procedures for detecting, monitoring, recording, trending, and determining the sources of RCPB leakage. Examples of parameters that are monitored are sump pump run time, sump level, condensate transfer rate, and process chemistry/radioactivity.

The procedures are used for converting different parameter indications for identified and unidentified leakage into common leak rate equivalents (volumetric or mass flow) and leak rate rate-of-change values, including indications from: 1)the drywell floor drain high conductivity water sump monitoring system, 2) the drywell air coolers condensate flow monitoring system, and 3) the drywell fission product monitoring system.

The procedures are used to monitor leakage at levels well below Technical Specifications limits and provide guidance for evaluating potential corrective action plans to prevent the plant from exceeding a Technical Specifications limit.

An unidentified leakage rate-of-change alarm provides an early alert to the operators to initiate corrective actions prior to reaching a Technical Specifications limit."

NRC staff reviewed the applicant's response to the above RAI. The staff found that the response addresses all the concerns identified in the RAI, and that the applicant committed to be consistent with ESBWR DCD, Tier 2, Revision 5, Section 5.2.5. DCD Revision 5, Section 5.2.5 includes an alarm that annunciates if a step increase in the unidentified leak rate occurs ("reference DCD Section 5.2.5.4, Limits for Reactor Coolant Leakage Rates within the Drywell.") The standard design and procedures will enable the operators to monitor leakage at levels well below TS limits, and initiate actions to prevent the plant from exceeding a TS limit. Based on the above, the staff finds RAI 05.02.05-1 resolved and the staff confirmed the appropriate information is provided in FSAR Revision 1.

The applicant identified the following commitment to track the implementation of the operating and emergency operating procedures:

> Operating procedures are developed at least six months prior to fuel load to allow sufficient time for plant staff familiarization and to allow NRC staff adequate time to review the procedures and to develop operator licensing examinations. (COM 13.5-002)

The staff concludes that the above information meets the relevant guidelines in SRP Section 5.2.5, RG 1.206, and Regulatory Positions C.III.1 and C.I.5.2.5 and is thus acceptable. Conformance with these guidelines, GDC 2, and GDC 30 provide an acceptable basis for satisfying the requirements.

5.2.5.5 *Post Combined License Activities*

The applicant identifies the following commitment to track the implementation of the operating and emergency operating procedures:

- Commitment (COM 13.5-002)–Develop operating procedures at least six months before fuel load to allow sufficient time for plant staff familiarization and to allow NRC staff adequate time to review the procedures and to develop operator licensing examinations.

5.2.5.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

In addition, the staff compared the additional Fermi 3 COL supplemental information in the application to the NRC regulations, the guidance in Section 5.2.5 of NUREG–0800, and other NRC regulatory guides. The staff's review concluded that the applicant has presented adequate information in the Fermi 3 COL FSAR to meet the requirements of GDC 2 and GDC 30.

5.3 Reactor Vessel

5.3.1 Reactor Vessel Materials

5.3.1.1 *Introduction*

This section of the Fermi 3 COL FSAR addresses the reactor vessel material specifications including weld materials, special processes used to manufacture and fabricate components, special methods for NDE, special controls and special processes used for ferritic steels and austenitic stainless steels, fracture toughness, the reactor vessel materials surveillance program (RVSP), and reactor vessel fasteners.

5.3.1.2 *Summary of Application*

Section 5.3.1 of the Fermi 3 COLA FSAR incorporates by reference Section 5.3.1 of the certified ESBWR DCD, Revision 10. In addition, in FSAR Section 5.3.1, the applicant provides the following:

COL Items

- STD COL 5.3-2-A — Materials and Surveillance Capsule

The applicant provided additional information in FSAR Section 5.3.1.8 in order to fully describe the Fermi 3 RVSP and its implementation.

- STD COL 16.0-1-A 5.6.4-1 — Reactor Coolant System (RCS) PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)

This COL Item is discussed in SER Section 5.3.2, "Pressure-Temperature Limits".

5.3.1.3 *Regulatory Basis*

The regulatory basis for the information incorporated by reference is in NUREG–1966. In addition, the requirements of the Commission regulations for reactor vessel materials, and the associated acceptance criteria, are in Section 5.3.1 of NUREG–0800.

In particular, the regulatory basis for the acceptance of the RVSP Information (STD COL 5.3.2-A) is established in:

- 10 CFR Part 50, Appendix A, GDC 32, as it relates to the RVSP
- 10 CFR 50.60, "Acceptance criteria for fracture prevention measures for light-water nuclear power reactors for normal operation," as it relates to compliance with the requirements of 10 CFR Part 50, Appendix G
- 10 CFR Part 50, Appendix G, "Fracture Toughness Requirements," as it relates to materials testing and acceptance criteria for fracture toughness
- 10 CFR Part 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements," as it relates to the RVSP
- SECY-05-0197, as it relates to fully describing an operational program

Also, the NRC staff followed the guidance in RG 1.206 for evaluating the compliance of Fermi 3 COL FSAR Section 5.3.1 with NRC regulations.

5.3.1.4 *Technical Evaluation*

As documented in NUREG–1966, NRC staff reviewed and approved Section 5.3.1 of the certified ESBWR DCD. The staff reviewed Section 5.3.1 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

combination of the information in the application and the information incorporated by reference addresses the relevant information related to this section.

The staff reviewed the information in the Fermi 3 COL FSAR as follows:

<u>COL Item</u>

- STD COL 5.3-2-A Materials and Surveillance Capsule

ESBWR DCD COL Item 5.3.2-A states that the COL applicant will develop a description of the reactor vessel materials surveillance program and milestones per DCD Section 5.3.1.8. To address this COL item, the applicant provided STD COL 5.3-2-A in order to fully describe the Fermi 3 RVSP and its implementation.

In FSAR Subsection 5.3.1.8, the applicant has described, in detail, the preparation of the surveillance capsule specimens, the number and type of specimens, and the location of the specimen capsules in the core beltline region. In addition, the applicant identified in FSAR Section 13.4, Table 13.4-201, that the RVSP is to be implemented prior to fuel load and required by a license condition. In Fermi 3 COL, Part 10, the applicant has provided the following proposed license conditions related to the RVSP:

- The licensee shall implement the Reactor Vessel Materials Surveillance Program prior to fuel load. (Fermi 3 COL, Part 10, Section 3.5.7)

- The licensee shall submit to the appropriate Director of the NRC, a schedule, no later than 12 months after issuance of the COL, that supports planning for and conduct of NRC inspections of operational programs listed in the operational program FSAR Table 13.4-201. The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until either the operational programs in the FSAR table have been fully implemented or the plant has been placed in commercial service, whichever comes first. (Fermi 3 COL, Part 10, Section 3.6)

Based on the review of the information described above, the staff finds it acceptable to require the RVSP by a license condition because it is in accordance with SECY 05-0197. The staff also finds that the applicant's proposed license conditions are acceptable because they are in accordance with SECY 05-0197 and provide a reasonable assurance that the operational program will be implemented at the identified milestone. Therefore, the staff will include such license condition in the Fermi COL. The staff finds that the COL applicant has met the minimum guidelines provided in RG 1.206 regarding the description of the RVSP and its implementation and that the applicant has provided a sufficient level of detail to "fully describe" its RVSP as an operational program in accordance with SECY 05-0197. On this basis, STD COL 5.3-2-A is acceptable.

5.3.1.5 *Post Combined License Activities*

In FSAR Table 13.4-201, the applicant describes the implementation milestone for the Reactor Vessel Materials Surveillance Program.

As discussed above, the staff plans to impose the following license conditions below:

- License Condition 05.03.01-1– The licensee shall implement the Reactor Vessel Materials Surveillance Program prior to fuel load.

- License Condition 05.03.01-2– No later than 12 months after issuance of the COL, the licensee shall submit to the Director of NRO a schedule that supports planning for, and the conducting of, NRC inspections of the preservice inspection and ISI programs. The schedule shall be updated every 6 months until 12 months before schedule fuel loading, and every month thereafter until either the PSI or ISI programs have been fully implemented.

5.3.1.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

The staff concludes that the applicant's proposed resolution to COL Item STD COL 5.3-2-A meet the relevant acceptance criteria of SRP Section 5.3.1 and the guidance in RG 1.206, and are thus acceptable. Conformance with GDC 32 provides an acceptable basis for satisfying the requirements of Appendices G and H to 10 CFR Part 50.

5.3.2 Pressure-Temperature Limits

5.3.2.1 *Introduction*

This section of the Fermi 3 COL FSAR, discusses the P-T limits that are required as a means of protecting the reactor vessel during startup and shutdown to minimize the possibility of fast fracture. The methods outlined in Appendix G of Section XI of the ASME Code are employed in the analysis of protection against non-ductile failure. Beltline material properties degrade with radiation exposure, and this degradation is measured in terms of the adjusted reference temperature which includes a reference nil ductility temperature (NDT) shift, initial RT_{NDT}, and margin.

5.3.2.2 *Summary of Application*

Section 5.3.2 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 5.3.2 of ESBWR DCD Revision 10, without any departures. In addition, in FSAR Subsection 5.3.1.5, the applicant provides the following:

COL Item

- STD COL 16.0-1-A 5.6.4-1 Pressure-Temperature Limit Curves

In FSAR Section 5.3, the applicant provides supplemental information related to Subsection 5.3.1.5 "Fracture Toughness Compliance with 10 CFR Part 50, Appendix G", that requires:

> The pressure-temperature limit curves are developed in accordance with the Pressure and Temperature Limits Report, as discussed in the Technical Specifications Subsection 5.6.4. Prior to fuel load, the pressure-temperature limit curves will be updated to reflect plant-specific material properties, if required.

In addition, the applicant has provided technical report NEDC-33441P, "GE Hitachi Nuclear Energy Methodology for the Development of Economic Simplified Boiling Water Reactor (ESBWR) Reactor Pressure Vessel Pressure-Temperature Curves," Revision 5. This report is referenced in Fermi 3 Technical Specification Subsection 5.6.4 as providing the analytical methods used to determine the RCS pressure and temperature limits.

5.3.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1966. In addition, the regulatory basis for the acceptance of STD COL 16.0-1-A 5.6.4-1 is 10 CFR Part 50, Appendix G, which provides the requirements for pressure-temperature limits.

5.3.2.4 *Technical Evaluation*

As documented in NUREG–1966, NRC staff reviewed and approved Section 5.3.2 of the certified ESBWR DCD. The staff reviewed Section 5.3.2 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the combination of the information in the application and the information incorporated by reference addresses the relevant information related to this section.

The staff reviewed the following information in the COL FSAR as follows:

COL Item

- STD COL 16.0-1-A 5.6.4-1 Pressure-Temperature Limit Curves

ESBWR DCD, Section 5.3.1.5, states that the COL applicant, in accordance with the ESBWR TS (Chapter 16, Section 5.6.4), will furnish bounding P-T curves either as part of the TS or as part of a PTLR submittal for NRC review. To address this COL item, the applicant submitted technical report NEDC-33441P, "GE Hitachi Nuclear Energy Methodology for the Development of Economic Simplified Boiling Water Reactor (ESBWR) Reactor Pressure Vessel Pressure-

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Temperature Curves," Revision 5, by a letter dated March 3, 2011 (ADAMS Accession No. ML1106700900). This report was prepared by GE-Hitachi (GEH) in support of the Fermi 3 R-COL application to address an ESBWR DCD COL item described above. As such, the purpose of this report is to provide the bounding P-T limits and the associated methodology for the development of the PTLR using the criteria of Generic Letter (GL) 96-03, "Relocation of Pressure Temperature Limit Curves and Low Temperature Overpressure Protection System Limits."

The first part of the staff's review was to ensure that the information in the proposed PTLR and the revised TS pages are in accordance with the guidance in GL 96-03. The second part of the staff's review was to verify that the proposed P-T limits have been developed appropriately using the methodology in NEDC–33441P, Revision 5 (hereafter referred to as the ESBWR PTLR).

5.3.2.4.1 Summary of Regulatory Requirements for the submittal of a PTLR

The NRC established requirements in 10 CFR Part 50 to protect the integrity of the RCPB in nuclear power plants. The staff evaluated the acceptability of a facility's proposed PTLR based on the NRC regulations and guidance in Appendix G to 10 CFR Part 50; Appendix H to 10 CFR Part 50; RG 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials"; GL 92-01 Revision 1, "Reactor Vessel Structural Integrity, 10 CFR 50.54(f)"; GL 92-01; Revision 1 Supplement 1,"Reactor Vessel Structural Integrity"; NUREG–0800 Section 5.3.2; and GL 96-03. Appendix G to 10 CFR Part 50 requires that facility P-T limits for the RPV be at least as conservative as those obtained by applying the linear elastic fracture mechanics methodology of Appendix G to Section XI of the ASME Code. Appendix H to 10 CFR Part 50 establishes requirements related to facility RPV material surveillance programs. RG 1.99, Revision 2 contains methodologies for determining the increase in the transition temperature and the decrease in upper-shelf energy resulting from neutron radiation. GL 92-01, Revision 1 requested the licensees to submit the RPV data for their plants to the staff for review. In GL 92-01 Revision 1, Supplement 1, the staff requested the licensees to provide and assess data from other licensees that could affect their RPV integrity evaluations. SRP Section 5.3.2 provides an acceptable method for determining the P-T limits for ferritic materials in the beltline of the RPV based on the methodology provided in ASME Code Section XI, Appendix G.

The most recent version of Appendix G to Section XI of the ASME Code which has been mandated in 10 CFR 50.55a, and therefore, by reference in 10 CFR Part 50, Appendix G, is the 2007 Edition through the 2008 Addenda of the ASME Code. The P-T limit methodology based on this edition of Appendix G to Section XI of the ASME Code (the ASME Code, Section XI, Appendix G methodology) incorporates the provisions of ASME Code Cases N-588, "Alternative to Reference Flaw Orientation of Appendix G for Circumferential Welds in Reactor Vessels Section XI, Division 1," and N-640, "Alternative Reference Fracture Toughness for Development of P-T Limit Curves Section XI, Division 1". Additionally, Appendix G to 10 CFR Part 50 imposes minimum head flange temperatures when the system pressure is at or above 20 percent of the preservice hydrostatic test pressure.

GL 96-03 addresses the technical information necessary for a licensee to implement a PTLR. GL 96-03 establishes the information that must be included in (1) an acceptable PTLR methodology (with the P-T limit methodology as its subset), and (2) the PTLR itself. Technical specification task force (TSTF)-419 provides additional guidance, which includes an alternative format for documenting the implementation of a PTLR in the "Administrative Controls" section of a facility's TS.

5.3.2.4.2 Evaluation of the Fermi 3 R-COL Technical Specification (TS) Requirements for Implementation and Control of a PTLR

The Fermi 3 COL TSs contains all of the necessary provisions required for the implementation and control of a PTLR. The Fermi 3 TSs are in Part 4 of the R-COL application. The relevant TS requirements include the TS definition of the PTLR (TS Section 1.1); the TS limiting conditions of operation (LCO) for the reactor coolant system P-T limits (LCO 3.4.4), including LCO Action Statements, Surveillance Requirements, and related applicability criteria; and the necessary administrative controls governing the PTLR content and reporting requirements (TS 5.6.4). All of the TS pages related to the implementation and control of a PTLR are acceptable to the staff.

5.3.2.4.3 Evaluation of the ESBWR Generic PTLR Contents and Methodology against the Seven Criteria for PTLR Contents in Attachment 1 of GL 96-03

As discussed in Section 1.0 of the ESBWR PTLR, this report describes the methodology used to develop the P-T limits and provides specific P-T curves for the reactor vessel (RV). Accordingly, the PTLR utilizes generic inputs for the RV beltline material chemistry, initial nil-ductility reference temperature (RT_{NDT}) values, and a projected neutron fluence to determine the P-T limit curves. These generic inputs are intended to be bounding for the design and represent the maximum allowable limits on the input parameters. Therefore, these generic inputs will be substantiated for use in the Fermi 3 COL PTLR in order to verify that actual plant-specific RV beltline properties remain bounded by the generic inputs provided in the PTLR.

Attachment 1 of GL 96-03 contains seven technical criteria (PTLR Criteria) that the contents of PTLRs should conform to if P-T limits are to be located in a PTLR. The staff's evaluations of the contents of the ESBWR PTLR against the seven criteria in Attachment 1 of GL 96-03 are in the subsections that follow.

5.3.2.4.3.1 PTLR Criterion 1

PTLR Criterion 1 states that the PTLR contents should include the neutron fluence values that are used in the calculations of the adjusted reference temperature (ART) values for the P-T limit calculations. Accurate and reliable neutron fluence values are required in order to satisfy the provisions in GDC 14, 30, and 31 of 10 CFR Part 50 ,Appendix A; as well as the specific fracture toughness requirements of 10 CFR Part 50, Appendix G. ESBWR PTLR Section 3.3, "Predicted Fluence," states that the fluence analysis for the ESBWR is based on the NRC-approved methodology provided in GE Licensing Topical Report NEDC-32983P-A, "General Electric Methodology for Reactor Pressure Vessel Fast Neutron Flux Evaluations." In addition, the applicant provides the peak RV neutron fluence values for each beltline material projected to 60 years of facility operation in Section 3.3 of the ESBWR PTLR. The staff determined that these 60-year neutron fluence values were calculated using an NRC-approved methodology that is consistent with the guidelines in RG 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence." The inclusion of valid peak RV neutron fluence values calculated using a neutron fluence methodology that is in conformance with RG 1.190 fulfills the provisions of PTLR Criterion 1. Therefore, the staff determined that PTLR Criterion 1 is satisfied.

5.3.2.4.3.2 PTLR Criterion 2

10 CFR Part 50, Appendix H provides the staff's requirements for designing and implementing RV material surveillance programs. The rule requires that RV material surveillance programs for operating reactors comply with the specifications of American Society for Testing and Materials (ASTM) Standard Procedure E 185, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels." The rule requires that the program design and the surveillance capsule withdrawal schedules for the programs must meet the edition of ASTM E 185 that is current on the issue date of the ASME Code to which the RV was purchased, although the rule permits more recent versions up through the 1982 version of ASTM E 185 to be used.

To ensure conformance with these requirements, PTLR Criterion 2 states that the PTLR should either provide the RV surveillance capsule withdrawal schedule or provide references by title and number, for the documents containing the RV surveillance capsule withdrawal schedule. The criterion also states that the PTLR should reference, by title and number, any applicable surveillance capsule reports placed on the docket by the licensee requesting approval of the PTLR for its units. This criterion assures that the adjusted reference temperature (ART) calculations will appropriately follow the RV material surveillance program requirements of 10 CFR Part 50, Appendix H. A discussion of the RV material surveillance program is in Section 7.0 of the PTLR, which states that the material surveillance program complies with Appendix H to 10 CFR Part 50 and ASTM E 185-82. The surveillance program description states that four capsules are provided to consider the 60-year design life of the vessel. This number exceeds the three capsules specified in ASTM E 185-82, since the predicted transition temperature shift is less than 55.6 degrees Celsius (°C) (100 degrees Fahrenheit [°F]) at the inside of the vessel. The capsule withdrawal schedule is also included in this section, which states that each surveillance capsule will be withdrawn and tested according to 10 CFR Part 50, Appendix H. The applicant also states that the results of the material surveillance program will be used to verify the ΔRT_{NDT} values in accordance with RG 1.99, Revision 2, and the P-T limits will be adjusted as necessary based on these results. The staff reviewed the recommended surveillance capsule withdrawal schedule and determined that it is in accordance with the specifications of ASTM E 185-82. On this basis, the staff determined that the provisions of PTLR Criterion 2 are satisfied.

5.3.2.4.3.3 PTLR Criterion 3

PTLR Criterion 3 states that the Low Temperature Overpressure Protection (LTOP) System lift setting limits for the Power Operated Relief Valves (PORVs) developed using NRC-approved methodologies may be included in the PTLR. This criterion is not applicable to the ESBWR design and is therefore not applicable to the Fermi 3 R-COL.

5.3.2.4.3.4 PTLR Criterion 4

10 CFR Part 50, Appendix G requires that the P-T limits for operating reactors be generated using a method that accounts for the effects of neutron embrittlement on the fracture toughness of RV beltline materials. For P-T limits, the effects of neutron embrittlement on the fracture toughness of RV beltline materials is defined in terms of the shift in the RT_{NDT} values resulting from neutron irradiation over a given period of facility operation. The final ART value for a material resulting from neutron embrittlement over a certain period of facility operation is defined as the sum of the initial (unirradiated) reference temperature (initial RT_{NDT}), the mean value of the shift in the reference temperature caused by irradiation (ΔRT_{NDT}), and a margin term.

RG 1.99, Revision 2 provides the staff's recommended methodologies for calculating ART values used for P-T limit calculations. ΔRT_{NDT} is a product of a chemistry factor (CF) and a fluence factor. The CF is dependent upon the amount of copper and nickel in the material and may be determined from tables in RG 1.99, Revision 2, or from surveillance data. The fluence factor is dependent upon the neutron fluence at the maximum postulated flaw depth. The margin term is dependent upon whether the initial RT_{NDT} is a plant-specific or a generic value and whether the CF was determined using the tables in RG 1.99, Revision 2, or surveillance data. The margin term is used to account for uncertainties in the values of the initial RT_{NDT}, the copper and nickel contents, the fluence, and the calculation procedures. Appendix G to Section XI of the ASME Code requires the licensees to determine the ART at the 1/4T and 3/4T locations, (T is the vessel beltline thickness).

To ensure compliance with the requirements of 10 CFR Part 50, Appendix G, PTLR Criterion 4 states that the PTLR contents should identify the limiting materials and limiting ART values at the 1/4T and 3/4T locations in the wall of the RV. The ART values and all inputs for the ART calculations including RV beltline material chemistry values, initial RT_{NDT} values (Table 3-1), and peak RV beltline neutron fluence projections at 60-years are in Section 3 of the PTLR. In PTLR Section 3.4, the applicant describes how the procedures outlined in RG 1.99, Revision 2 were applied to determine the ΔRT_{NDT} and ART values. In this section, the applicant states that the nominal irradiation temperature in the beltline region is less than 274.9 °C (525 °F). The staff notes that for the procedures of this RG to be valid for nominal irradiation temperatures less than 274.9 °C (525 °F), a correction factor shall be used to compensate for greater embrittlement. To address this issue, the applicant proposed to utilize a correction factor equal to a 0.56 °C (1 °F) increase in the ΔRT_{NDT} for each 0.56 °C (1 °F) decrease in irradiation temperatures below 287.8 °C (550 °F). This method will be validated for Fermi 3 using the results of the reactor vessel surveillance program. The staff determined that this approach is acceptable because (1) it provides a conservative estimate of the additional effects of irradiation on the beltline region at lower temperatures, and (2) the applicant will verify the applicability of the assumption upon receipt of the surveillance capsule data.

The ART calculations and margin term values for the RV beltline materials are in Section 3.5. These values are determined for a 60-year design life. Based on the ART calculations, the applicant has identified the shell forging as limiting material to be used for the derivation of the P-T limits. To evaluate the proposed P-T limits for the RV, the staff confirmed the applicant's selection of the shell forging as the limiting beltline material and performed an independent calculation of the ART values provided in the report using the RG 1.99, Revision 2, methodology. The staff noted that the applicant had not calculated the ART value at the 3/4T location, which is relevant to the heatup P-T limit calculation; because the ART value at 1/4T is assumed to be bounding for heatup and cooldown. The staff verified that the applicant's assumption is valid.

Based on the evaluation described above, the staff finds that the procedure used to calculate the ART values is consistent with the guidance of RG 1.99, Revision 2, and is therefore acceptable. Also, the PTLR clearly identifies the limiting materials and limiting ART values at the 1/4T location. Therefore, the staff determined that the provisions of PTLR Criterion 4 are satisfied.

5.3.2.4.3.5 PTLR Criterion 5

Section IV.A.2 of 10 CFR Part 50, Appendix G requires that the P-T limits for operating reactors and the minimum temperatures established for the stressed regions of RVs (i.e., for the RV flange and stud assemblies) be met for all conditions. The rule also requires that the P-T limits for operating reactors must be at least as conservative as those that would be generated if the methods of analysis in ASME Code Section XI, Appendix G were used to generate the P-T limit curves. Table 1 of 10 CFR Part 50, Appendix G provides a summary of the required criteria for generating the P-T limits for operating reactors.

To ensure that PTLRs are in compliance with the above requirements, PTLR Criterion 5 states that the PTLR contents should provide the P-T limit curves for heatup and cooldown operations; core critical operations; and pressure testing conditions for operating light-water reactors. Table 4-2 of the PTLR includes P-T limit data for heatup and cooldown operations, core critical operations, and hydrostatic and pressure testing. The P-T limit curves corresponding to these data points are in Figure 4-1 of the PTLR. In Section 5.0, the applicant also provides P-T limit data and the corresponding curves for several non-beltline components including the closure head flanges and the main steam, feedwater, standby liquid control, and core differential pressure (DP) nozzles. This information meets the provisions of PTLR Criterion 5, which specifies that the PTLR should include the P-T limit curves for reactor heatup, cooldown, critical operations, and pressure testing conditions.

The staff also performed independent analyses to verify the P-T limit curves for heatup and cooldown operations, core critical operations, and hydrostatic pressure and leak testing provided in the PTLR. Based on this independent verification, the staff determined that the applicant's proposed P-T limits were developed in accordance with ASME Code Section XI, Appendix G and therefore satisfy the requirements of 10 CFR Part 50, Appendix G. Hence, the applicant's proposed P-T limit curves are acceptable for RV operation.

5.3.2.4.3.6 PTLR Criterion 6

Section IV.A.2 of 10 CFR Part 50, Appendix G requires that the P-T limits for operating reactors and the minimum temperature requirements for the highly stressed regions of the RVs (i.e., for the RV flange and stud assemblies) be met for all conditions. Table 1 of 10 CFR Part 50, Appendix G identifies the required criteria for meeting the minimum temperature requirements for the highly stressed regions of the RV.

PTLR Criterion 6 states that the minimum temperature requirements of 10 CFR Part 50, Appendix G shall be incorporated into the P-T limit curves, and the PTLR shall identify minimum temperatures on the P-T limit curves such as the minimum boltup temperature and the hydrotest temperature. The staff determined that the curves are in compliance with the minimum temperature requirements of 10 CFR Part 50, Appendix G. Furthermore, the PTLR clearly identifies the minimum boltup temperature and hydrotest temperature in Section 6.0. Therefore, the staff determined that the provisions of PTLR Criterion 6 are satisfied.

5.3.2.4.3.7 PTLR Criterion 7

RG 1.99, Revision 2 provides the staff's recommended methods for calculating the ART values for RV beltline materials. These ART values are calculated for the 1/4T and 3/4T locations in the vessel wall. ASME Code Section XI, Appendix G and 10 CFR Part 50, Appendix G require these values to be used for the calculations of P-T limit curves for reactors. 10 CFR Part 50, Appendix G also requires the ART values to include the applicable results of the RV material surveillance program of 10 CFR Part 50, Appendix H. ART values for ferritic RV base metal and weld materials increase as a function of accumulated neutron fluence and the quantity of alloying elements in the materials, copper and nickel in particular. The procedures of the regulatory guide specify the use of a CF as a means for quantifying the effect of the alloying elements on the ART values. Furthermore, the RG specifies that a CF be calculated and input into the calculation of the final ART value for each beltline material. The regulatory guide cites two possible methods for determining the CF values for the RV beltline base metal and weld materials: (1) Regulatory Position 1.1 in the RG allows the licensee to determine the CF values from applicable tables in the regulatory guide as a function of copper and nickel content; or (2) Regulatory Position 2.1 allows the use of applicable RV surveillance data to determine the CF values if the base metal or weld materials are represented in a licensee's RV material surveillance program and if two or more credible surveillance data sets become available for the material in question. The regulatory guide defines the criteria for determining the credibility of the RV surveillance data sets. In accordance with the requirements of 10 CFR Part 50, Appendix G, the RG states that if the procedure of Regulatory Position 2.1 results in a higher ART value than that obtained by using the procedure of Regulatory Position 1.1, the surveillance data should be used to determine the CF and ART. If the procedure of Regulatory Position 2.1 results in a lower value for the ART, either procedure may be used for determining the CF and ART.

To ensure that PTLRs are in compliance with the above regulatory requirements and guidelines, PTLR Criterion 7 states that if surveillance data are used in the calculations of the ART values, the PTLR contents should include the surveillance data and calculations of the CF values for the RV base metal and weld materials, as well as an evaluation of the credibility of the surveillance data against the credibility criteria of RG 1.99, Revision 2. However, the PTLR is generic for the design and is based on bounding embrittlement correlations for which surveillance data are not yet available. Therefore, the incorporation of surveillance data and related calculations is currently not applicable to the PTLR. As previously discussed, the CF and ART values in the PTLR were determined using the procedures of Regulatory Position 1.1 in RG 1.99, Revision 2. Therefore, the staff determined that the provisions of PTLR Criterion 7 are satisfied.

5.3.2.4.4 Staff Findings on the Acceptability of the PTLR

Based on the evaluation, described above, the NRC staff has determined that the contents of the PTLR conform to the staff's technical criteria for PTLRs, as defined in Attachment 1 of GL 96-03. The staff also determined that the PTLR satisfies the requirements of 10 CFR Part 50, Appendix G. Furthermore, the staff determined that the PTLR is compatible with the TSs and the PTLR-related TS provisions meet the technical criteria of GL 96-03. The staff noted that the PTLR provides generic, not plant-specific, heatup and cooldown P-T curves based on bounding material properties and the projected fluence. To address the submittal of plant-specific P-T limits, the COL applicant has provided the following commitment:

- Prior to fuel load, the pressure-temperature limit curves will be updated to reflect plant-specific material properties, if required.(COM 05.03-002)

The staff finds that this approach is consistent with the guidelines of GL 96-03 and is therefore acceptable. Based on this evaluation, the staff finds that STD COL 16.0-1-A 5.6.4-1 is acceptable. The staff also finds that the PTLR methodology (NEDC-33441P, Revision 5) is acceptable for use by the Fermi 3 R-COL for establishing P-T limit curves and related input parameters. The staff notes that, per GL 96-03, any subsequent changes in the methodology used to develop the P-T limits must be approved by the NRC. Pursuant to Fermi 3 TS requirement 5.6.4c, the PTLR shall be provided to the Nuclear Regulatory Commission (NRC) upon issuance for each reactor vessel neutron fluence period, and for any PTLR revision or supplement thereto.

5.3.2.5 *Post Combined License Activities*

The applicant identifies the following commitment:

- Commitment (COM 05.03-002) – Prior to fuel load, the pressure-temperature limit curves will be updated to reflect plant-specific material properties, if required.

5.3.2.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52 Appendix E Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

In addition, the staff concluded that the ESBWR PTLR methodology (NEDC-33441P, Revision 5) is acceptable for use by the Fermi 3 COL for establishing limiting P-T limit curves and related input parameters. Per GL 96-03, any subsequent changes in the methodology used to develop the P-T must be approved by the NRC. Finally, pursuant to Fermi 3 TS requirement 5.6.4c, the PTLR shall be provided to the NRC upon issuance for each reactor vessel neutron fluence period, and for any PTLR revision or supplement thereto.

The staff also concludes that the information provided in STD COL 16.0-1-A 5.6.4-1 meets the relevant acceptance criteria of NUREG-0800, Section 5.3.2, and the guidance of RG 1.206. Conformance with these guidelines provides an acceptable basis for satisfying the requirements of 10 CFR Part 50, Appendix G.

5.3.3 *Reactor Vessel Integrity*

5.3.3.1 *Introduction*

This section of the Fermi 3 COL FSAR discusses all factors related to reactor vessel integrity.

5.3.3.2 *Summary of Application*

Section 5.3 of the Fermi 3 COL FSAR incorporates by reference Section 5.3.3 of the ESBWR DCD, Revision 10.

In addition, in the Fermi 3 COL FSAR Section 5.3.3, the applicant provided the following:

<u>*Supplemental Information:*</u>

- STD SUP 5.3-1

In FSAR Revision 3, the applicant provides supplemental information in Subsection 5.3.3.6, "Operating Conditions," which states the following:

> Development of plant operating procedures is addressed in Section 13.5. These procedures require compliance with the Technical Specifications. The Technical Specifications (which are developed by the methodology also identified in the

Technical Specifications) are intended to ensure that the P-T limits identified in DCD Section 5.3.2 are not exceeded during normal operating conditions and anticipated plant transients.

5.3.3.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference will be addressed within the FSER related to the DCD.

5.3.3.4 *Technical Evaluation*

The NRC staff reviewed Section 5.3.3 of the Fermi 3 COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COL represent the complete scope of information relating to the review topic.[1] The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the relevant information related to Reactor Vessel Integrity.

The staff reviewed the information in the COL FSAR as follows:

<u>*Supplemental Information*</u>

- STD SUP 5.3-1

In STD SUP 5.3-1, the COL applicant added information to FSAR Subsection 5.3.3.6, Operating Conditions," to state that the development of plant operating procedures is addressed in Section 13.5. The applicant also states, in FSAR Section 5.3.3.6, that these procedures require compliance with the technical specifications which are intended to ensure that the pressure and temperature (P-T) limits identified in DCD Section 5.3.2 are not exceeded during normal operating conditions and anticipated plant transients. The staff finds STD SUP 5.3-1 acceptable because it is in accordance with the recommendations of Regulatory Position C.I.5.3.2.2 in RG 1.206, which states that the FSAR should include a commitment stating that plant operating procedures will ensure that the P-T limits will not be exceeded during any foreseeable upset condition.

5.3.3.5 *Post Combined License Activities*

There are no post COL activities related to this section.

5.3.3.6 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

The staff also concluded that the information in STD SUP 5.3-1 meets the guidance of RG 1.206 and is therefore acceptable. Conformance with this guidance provides an acceptable basis for satisfying, in part, the requirements of 10 CFR Part 50, Appendix G.

5.4 Reactor Coolant System Component and Subsystem Design

5.4.1 Introduction

NRC staff reviewed Section 5.4 of the Fermi 3 COL FSAR, Revision 7, including the corresponding sections in the referenced DCD. Specifically, the staff verified that the following sections of the DCD contain information appropriate for incorporation by reference and that any supplemental information to be provided by the COL applicant is addressed in the COL application:

5.4.1 Reactor Recirculation System
5.4.2 Steam Generators (not applicable to the ESBWR)
5.4.3 Reactor Coolant Piping
5.4.4 Main Steamline Flow Restrictors
5.4.5 Nuclear Boiler System Isolation
5.4.6 Isolation Condenser System
5.4.7 Residual Heat Removal System
5.4.8 Reactor Water Cleanup/Shutdown Cooling System
5.4.9 Main Steamlines and Feedwater Piping
5.4.10 Pressurizer (not applicable to the ESBWR)
5.4.11 Pressurizer Relief Discharge System (not applicable to the ESBWR)
5.4.12 Reactor Coolant System High Point Vents
5.4.13 Safety and Relief Valves and Depressurization Valves
5.4.14 Component Supports
5.4.15 COL Information
5.4.16 References

5.4.2 Summary of Application

Section 5.4 of the Fermi 3 COL FSER, Revision 7 incorporates by reference Section 5.4 of the certified ESBWR DCD, Revision 10. In addition, the applicant provides the following:

Supplemental Information:

- STD SUP 5.4-1

In FSAR Section 5.4.8, the applicant states that operating procedures will provide guidance to prevent severe water hammer caused by mechanisms such as voided lines.

- STD SUP 5.4-2

In FSAR Section 5.4.12, the applicant states that the human factors analysis of control room displays and controls for the RCS vents is included as part of the overall human factors analysis of the control room displays and controls described in ESBWR DCD, Chapter 18.

- STD SUP 5.4-3

In FSAR Section 5.4.12, the applicant states that operating procedures for the reactor vent system address considerations regarding when venting is and is not needed, including a variety of initial conditions that may require venting. Section 13.5 of the Fermi 3 COL FSAR addresses the development of operating procedures.

5.4.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1966. In addition, the relevant requirements of the Commission regulations for reactor coolant system component and subsystem design, and the associated acceptance criteria, are in Section 5.4 of NUREG–0800.

5.4.4 *Technical Evaluation*

As documented in NUREG–1966, NRC staff reviewed and approved Section 5.4 of the certified ESBWR DCD. The staff reviewed Section 5.4 of the Fermi 3 COL FSAR Revision 7 and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the relevant information related to this section.

Section 1.2.3 of this SER discusses the NRC's strategy for performing one technical review for each standard issue outside the scope of the DC and to use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the North Anna application are equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna 3 COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes to the Fermi 3 COL FSAR (and other parts of the COL application, as applicable) resulting from requests for RAIs and open and confirmatory items identified in the North Anna SER with open items.

- The staff confirmed that the applicant has endorsed all responses to the RAIs identified in the corresponding standard content (the North Anna SER) evaluation.

- The staff verified that the site-specific differences were not relevant.

The staff completed the review and found the evaluation of the North Anna standard content to be directly applicable to the Fermi 3 COL application. This SER identifies the standard content material with italicized, double-indented formatting.

The staff reviewed the information in the COL FSAR as follows:

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[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Supplemental Information

The following portion of this technical evaluation section is reproduced from Section 5.4 of the North Anna Unit 3 SER (ADAMS Accession No. ML091730304):

- *STD SUP 5.4-1*

In FSAR Subsection 5.4.8, the applicant stated that operating procedures will provide guidance to prevent severe water hammer caused by mechanisms such as voided lines.

The NRC staff finds that supplement STD SUP 5.4-1 is acceptable because water hammer is to be addressed in the plant operating procedures.

- *STD SUP 5.4-2*

In FSAR section 5.4.12, the applicant stated that human factors analysis of the control room displays and controls for the RCS vents is included as part of the overall human factors analysis of the control room displays and controls described in ESBWR DCD Chapter 18.

The staff found that this information is wholly incorporated in Section 18 of the Fermi 3 COL FSAR, and is thus, the staff concludes that STD SUP 5.4-2 is acceptable.

- *STD SUP 5.4-3*

In FSAR Section 5.4.12, the applicant stated that operating procedures for the reactor vent system address considerations regarding when venting is needed and when it is not needed, including a variety of initial conditions for which venting may be required. The development of operating procedures is addressed in Section 13.5 of the Fermi 3 COL FSAR.

The NRC staff finds that supplement STD SUP 5.4-3 is acceptable because system venting is to be addressed in the plant operating procedures.

5.4.5 *Post Combined License Activities*

There are no post COL activities related to this section.

5.4.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

In addition, the staff compared the supplemental information in the application to the guidance in Section 5.4 of NUREG-0800 and finds it acceptable.

6.0 ENGINEERED SAFETY FEATURES

The design and functional requirements of engineered safety features (ESF) of the plant are provided to mitigate the consequences of postulated accidents. The ESF consist of containment systems, core cooling systems, habitability systems, and fission product removal and control systems. The containment systems include the primary containment system, the passive containment cooling system (PCCS), the containment isolation system, and the hydrogen control system. The passive containment cooling system provides emergency core cooling following postulated design-basis events and is designed to operate without the use of active equipment such as pumps and ac power sources. Similarly, the PCCS removes heat from the containment without the use of active equipment or ac power sources. The control room habitability system is designed so that the main control room remains habitable following a postulated design basis event. Control of fission products following a postulated design basis event is provided by natural removal processes inside containment, the containment boundary, and the containment isolation system.

6.1 Design Basis Accident Engineered Safety Feature Materials

Section 6.1, "Design Basis Accident Engineered Safety Feature Materials" of the Fermi 3 Combined License (COL) Application incorporates by reference, with no departures or supplements, Economic Simplified Boiling-Water Reactor (ESBWR) Design Control Document (DCD) Revision 10, Section 6.1, "Engineered Safety Feature Materials," which contains Section 6.1.1, "Metallic Materials," and Section 6.1.2, "Organic Materials." Materials used in the ESF components have been evaluated to ensure that material interactions do not occur that can potentially impair operation of the ESF. Materials have been selected to withstand the environmental conditions encountered during normal operation and during any postulated loss-of-coolant accident (LOCA). Their compatibility with core and containment spray solutions has been considered, and the effects of radiolytic decomposition products have been evaluated.

As documented in NUREG-1966 "Final Safety Evaluation Report related to the Certification of the Economic Simplified Boiling-Water Reactor (ESBWR) Standard Design," the U.S. Nuclear Regulatory Commission (NRC) staff reviewed and approved Section 6.1 of the certified ESBWR DCD. The staff reviewed Section 6.1 "Design Basis Accident Engineered Safety Feature Materials" of the Fermi 3 COL FSAR, Revision 7, and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 52.63(a)(5) and Section VI.B.1 of Appendix E to 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," all nuclear safety issues relating to the "Design Basis Accident Engineered Safety Feature Materials" that were incorporated by reference have been resolved.

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

6.2 Containment Systems

The containment and its associated systems provide the final barrier against the release of significant amounts of radioactive fission products in the event of an accident. The containment structure must be capable of withstanding, without loss of function, the pressure and temperature conditions resulting from postulated loss-of-coolant, steamline, or feedwater line break accidents. The containment structure must also maintain functional integrity in the long term following a postulated accident (i.e., the structure must remain a low-leakage barrier against the release of fission products for as long as postulated accident conditions require).

GE-Hitachi Nuclear Energy (GEH), used the TRACG computer program to evaluate the containment performance. Appendix 6A – "TRACG Application for Containment Analysis"; Appendix 6B – "Evaluation of the TRACG Nodalization for the ESBWR Licensing Analysis"; Appendix 6C – "Evaluation of Impact of Containment Back Pressure on the ECCS Performance"; Appendix 6D – "Containment Passive Heat Sink Details"; Appendix 6E – "TRACG LOCA Containment Response Analysis"; Appendix 6F – "Break Spectrums of Break Sizes and Break Elevations"; Appendix 6 G – "TRACG LOCA SER Confirmation Items"; Appendix 6H – "Additional TRACG Outputs and Parametrics Cases"; and Appendix 6I – "Results of Containment Design Basis Calculations with Suppression Pool Bypass Leakage Assumption of 1 cm^2 (1.08E-03 ft^2)," of the certified ESBWR DCD, Revision 10 are incorporated by reference in the Fermi 3 COL FSAR with no departures or supplements.

As documented in NUREG-1966, the NRC staff reviewed and approved Section 6.2 of the certified ESBWR DCD. The staff reviewed Section 6.2 "Containment Systems" and the Appendices listed above of the Fermi 3 COL FSAR, Revision 7, and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the "Containment Systems" that were incorporated by reference have been resolved.

6.3 Emergency Core Cooling Systems

As documented in NUREG-1966, the NRC staff reviewed and approved Section 6.3 of the certified ESBWR DCD. The staff reviewed Section 6.3 "Emergency Core Cooling Systems" of the Fermi 3 COL FSAR, Revision 7, and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the "Emergency Core Cooling Systems" that were incorporated by reference have been resolved.

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

6.4 Control Room Habitability Systems

6.4.1 Introduction

The control room habitability area provides protection for the plant operators and suitable environmental conditions for the necessary equipment to monitor and control the plant during normal operation, and maintain the plant in a safe condition during accident conditions. The control room ventilation system and control building layout and structures ensure that plant operators are adequately protected against the effects of accidental releases of toxic chemicals and radioactive material.

6.4.2 Summary of Application

Section 6.4 "Control Room Habitability Systems" of the Fermi 3 COL FSAR incorporates by reference Section 6.4 of the ESBWR DCD, Revision 10.

In addition, in FSAR Section 6.4, the applicant provides the following:

COL Items

- STD COL 6.4-1-A — Control Room Habitability Area (CRHA) Procedures and Training

This COL item directs the applicant to address procedures for training on control room habitability. The applicant states that the operators are provided with training and procedures for control room habitability that address the applicable aspects of NRC Generic Letter (GL) 2003-01 and are consistent with the intent of Generic Issue (GI) 83. The implementation milestones for training and procedures are discussed in sections 13.4 and 13.5 of the application respectively.

- EF3 COL 6.4-1-A — CRHA Procedures and Training

The applicant addressed CRHA Procedures and Training under COL Item STD COL 6.4-1-A.

- EF3 COL 6.4-2-A — Toxic Gas Analysis

This COL item directs the applicant to address potential toxic gas sources to confirm that an external release of hazardous chemicals does not impact control room habitability.

Supplemental Information

- EF3 SUP 6.4-1

The applicant provides this supplemental information to address the impact of a postulated DBA in Fermi Unit 2 on the Fermi Unit 3 control room.

6.4.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG-1966, the Final Safety Evaluation Report (FSER) related to the certified ESBWR DCD. In addition, the relevant requirements of the Commission regulations for habitability systems, and the associated acceptance criteria, are in Section 6.4 of NUREG–0800. The applicable regulatory guidance for control room habitability is as follows:

- Three Mile Island (TMI) Action Plan, Item III.D.3.4.
- Regulatory Guide (RG) 1.78, Revision 1, “Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release.”
- RG 1.52, Revision 3, “Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Post Accident Engineered Safety Feature Atmosphere Cleanup Systems in Light Water Cooled Nuclear Power Plants,” June 2001.
- RG 1.206, “Combined License Applications for Nuclear Power Plants,” June 2007.
- RG 1.196, “Control Room Habitability at Light Water Nuclear Power Reactors,” May 2003.
- General Design Criteria (GDC) 4, “Environmental and dynamic effects design bases,” as it relates to SSCs important to safety being designed to accommodate the effects of and to be compatible with environmental conditions associated with postulated accidents.
- GDC 5, “Sharing of structures, systems and components,” as it relates to ensuring that sharing among nuclear power units of SSCs important to safety will not significantly impair the ability to perform safety functions, including in the event of an accident in one unit and an orderly shutdown and cooldown of the remaining unit(s).
- GDC 19, “Control room,” as it relates to maintaining the nuclear power unit in a safe condition under accident conditions and providing adequate radiation protection.
- 10 CFR 50.34(f)(2)(xxviii) “Contents of application; technical information”, as it relates to evaluations and design provisions to preclude certain control room habitability problems.
- 10 CFR 52.80(a) “Contents of application; additional technical information” which requires a COL application to address the proposed inspections, tests, and analyses (including those applicable to emergency planning) that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that if the inspections, tests, and analyses are performed and the acceptance criteria are met, the facility has been constructed and will operate in conformity with the COL, the provisions of the Atomic Energy Act, and NRC regulations.

6.4.4 Technical Evaluation

As documented in NUREG-1966, the NRC staff reviewed and approved Section 6.4 of the certified ESBWR DCD. The staff reviewed Section 6.4 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1] The staff's review confirms that information in the application and information incorporated by reference address the required information related to the control room habitability systems.

Section 1.2.3 of this safety evaluation report (SER) provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the North Anna application were equally applicable to the Fermi COL application, the staff undertook the following reviews:

- The staff compared the North Anna COL FSAR, Revision 1, to the Fermi COL FSAR. In performing this comparison, the staff considered changes made to the Fermi COL FSAR (and other parts of the COL application, as applicable) resulting from requests for additional information (RAIs) and open and confirmatory items identified in the North Anna SER with open items.

- The staff confirmed that the applicant endorsed all responses to RAIs identified in the corresponding standard content (the North Anna SER) evaluation.

- The staff verified that the site-specific differences are not relevant.

The staff has completed its review and finds the evaluation performed for the North Anna standard content to be directly applicable to the Fermi COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting.

The NRC staff reviewed the conformance of Section 6.4 of the Fermi 3 COL FSAR to the guidance in RG 1.206, Section C.III.1, Chapter 6, C.I.6.4 "Habitability Systems." Compliance with the control room habitability dose requirements of GDC 19 requires the applicant to show that for a plant located at the site, the control room provides adequate radiation protection to ensure that radiation exposures shall not exceed 0.05 sievert (Sv) (5 rem), a total effective dose equivalent (TEDE) to permit access and occupancy of the control room under accident conditions for the duration of the accident.

The applicant does not provide site-specific doses in the control room for the DBAs. Instead, the applicant incorporates by reference the analysis of the radiological control room habitability from ESBWR DCD Revision 10, Section 6.4.4, "System Safety Evaluation."

ESBWR DCD, Revision 10, Chapter 6.4, provides the results of the analysis of control room radiological consequences for the DBAs analyzed in Chapter 15, Section 15.4, "Analysis of Accidents." DCD Section 15.4 describes the details and assumptions used to model the radiological consequences to control room operators.

The DBA analyses of control room radiological consequences in the DCD uses design reference values for the atmospheric dispersion factors (χ/Qs), in place of site-specific values. The χ/Qs are the only input to the DBA radiological consequences analyses that are impacted

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

by the site characteristics. The applicant provides and discusses the Fermi site-specific control room χ/Qs and comparison to the site parameter χ/Q values used in the ESBWR DCD in the resolution of Fermi EF3 COL 2.0-10-A, "Short-Term (Accident) Diffusion Estimates," EF3 COL 2A.2-1-A, "Confirmation of the ESBWR χ/Q Values," and EF3 COL 2A.2-2-A, "Confirmation of the Reactor Building χ/Q Values." The Fermi site-specific control room χ/Qs are in Fermi 3 COL FSAR Tables 2.3-301 and 2.3-378 and are also listed as site characteristics in Fermi 3 COL FSAR Table 2.0-201. In Section 2.3 "Meteorology" of this SER, the staff discusses its review of the resolution to Fermi EF3 COL 2.0-10-A, EF3 COL 2A.2-1-A and EF3 COL 2A.2-2-A, which are related to the Fermi site-specific χ/Qs for the control room.

The estimated DBA dose in the control room is calculated for a particular site that is affected by the site characteristics through the site-specific control room χ/Q input to the analysis. The resulting dose is different from the dose calculated generically for the ESBWR design. All other inputs and assumptions in the analyses of radiological consequences remain the same as those in the DCD. Smaller χ/Q values are associated with a greater dilution capability, thus resulting in lower radiological doses. When comparing a DCD site parameter χ/Q value and a site characteristic χ/Q value, the site is acceptable for the design if the site characteristic χ/Q value is smaller than the DCD site parameter χ/Q value. Such a comparison shows that the site has better dispersion characteristics than those required by the reactor design.

For each time-averaging period, the Fermi site-specific control room χ/Q values are less than the design reference control room χ/Q values used in the ESBWR DCD, Revision 10, for the radiological consequence analyses for each of the DBAs. The Fermi site-specific control room dose for each DBA is less than the ESBWR DCD Revision 10 referenced control room dose for each DBA because (1) the result of the radiological consequence analysis for a DBA during any time period of radioactive material release from the plant is directly proportional to the atmospheric dispersion factor for that time period; and (2) the Fermi site-specific control room χ/Q values are less than the comparable design reference control room χ/Q values in the ESBWR DCD, Revision 10, for all time periods for each accident.

The applicant has sufficiently shown that the DBA control room radiological consequences meet the requirements of GDC 19 because (1) the ESBWR DCD analyses show that the radiological consequences in the control room meet the regulatory dose requirements of GDC 19 by resulting in a TEDE of less than 0.05 Sv (5 rem); and (2) using the logic in the above discussion, the Fermi site-specific DBA control room radiological consequences are less than those for the ESBWR DCD, Revision 10. The staff reviewed the following information in the COL FSAR:

<u>*COL Items*</u>

The following portion of this technical evaluation section is reproduced from Section 6.4.4 of the North Anna SER (ADAMS Accession No. ML091380480):

- *STD COL 6.4-1-A CRHA Procedures and Training*

NRC staff reviewed NAPS COL 6.4-1-A related to the procedures and training included under Section 6.4 of the FSAR. The applicant provided additional information that states:

> *The COL applicant committed to develop and implement procedures and training for control room habitability that address the applicable*

> *aspects of NRC Generic Letter 2003-01 and are consistent with the intent of Generic Issue 83.*
>
> *NRC staff evaluated STD COL 6.4-1-A related to providing operators with training and procedures for control room habitability that address the applicable aspects of NRC Generic Letter 2003-01 and are consistent with the intent of Generic Issue 83 included under Section 6.4 of the North Anna 3 COL Application.*

The applicant stated, "Operators are provided with training and procedures for control room habitability that address the applicable aspects of NRC Generic Letter 2003-01 and are consistent with the intent of Generic Issue 83. Training and procedures are developed and implemented in accordance with Sections 13.2 and 13.5, respectively."

The staff determined that the applicant has provided adequate information regarding the development of operator training and procedures for control room habitability to address the applicable aspects of NRC GL 2003-01, as well as the intent of Generic Issue 83.

The applicant identified the following commitments to track implementation milestones for operator training and procedures for control room habitability as discussed in Sections 13.4 and 13.5 of this SER:

(1) Non Licensed Plant Staff Training Program – 18 months prior to scheduled fuel load. [COM 13.4-028]

(2) Reactor Operator Training Program - 18 months prior to scheduled fuel load. [COM 13.4-016]

(3) Operating procedures are developed at least six months prior to fuel load to allow sufficient time for plant staff familiarization and to allow NRC staff adequate time to review the procedures and to develop operator licensing examinations. [COM 13.5-002]

- EF3 COL 6.4-1-A CRHA Procedures and Training

The staff's technical evaluation is discussed above under STD COL 6.4-1-A "CRHA Procedures and Training".

- EF3 COL 6.4-2-A Toxic Gas Analysis

This item addresses potential toxic gas sources to confirm that an external release of hazardous chemicals does not impact control room habitability. This COL item states, in part that "The COL Applicant will identify potential site specific toxic or hazardous materials that may affect control room habitability in order to meet the requirements of TMI Action Plan III.D.3.4 and GDC 19."

The NRC staff evaluated EF3 COL 6.4-2-A, which relates to potential toxic gas sources, to confirm that an external release of hazardous chemicals does not impact control room habitability included in Section 6.4 of the Fermi 3 COL application.

The applicant provides additional information in FSAR Section 6.4.5 to identify potential site-specific toxic or hazardous materials that may affect control room habitability. The potential sources of hazardous chemicals include offsite industrial facilities, transportation routes, and onsite sources from Fermi 2 and Fermi 3. The applicant evaluates potentially hazardous offsite chemicals in Section 2.2 "Nearby Industrial, Transportation, and Military Facilities" and concludes that there are no significant control room habitability impacts due to potential sources within 8 km (5 miles) of the plant. The applicant also performs a toxic gas analysis for potentially hazardous chemicals stored on the site, in accordance with the guidelines of RG 1.78. The applicant concludes that concentrations of toxic gas in the control room will not exceed the toxicity limits in RG 1.78.

The applicant also analyzes the onsite hydrogen and oxygen storage facilities. Based on the hazards of a postulated instantaneous release followed by a vapor cloud explosion or the intake of a flammable vapor concentration into a safety-related intake, the applicant found the locations of the onsite hydrogen and oxygen storage facilities to be acceptable in accordance with RG 1.78. The applicant concludes that seismic Category I safety-related toxic gas monitoring instrumentation is not required.

The staff reviewed the information submitted by the applicant in Section 2.2 of the COL FSAR and confirms that there are no significant control room habitability impacts from chemicals stored offsite or transported along offsite routes within 8 km (5 miles) of the plant. In response to RAI 02.02.03-5 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML092750405) dated September 30, 2009, as part of the Section 2.2 review, the applicant provided a list of all toxic chemicals considered and the methods used to evaluate toxicity. Tables 2.2-202, 2.2-203, and 2.2-205 documents these chemicals, and related information. The staff reviewed the applicant's screening methodology and finds it to be consistent with RG 1.78. The applicant's conclusions are therefore acceptable.

The applicant identifies two gases, nitrogen and carbon dioxide, which are not toxic but could be an asphyxiant in some circumstances. Nitrogen is stored onsite as liquid nitrogen in a tank and is associated with Fermi 2. The carbon dioxide tank is associated with Fermi 3. Although the applicant's evaluation shows that the allowable air concentration limits for nitrogen and carbon dioxide will be exceeded by the maximum concentration at the CRHA intakes, the concentration inside the CRHA will be significantly less than the allowable limits. This finding is due primarily to the short amount of time that the chemical cloud will be at its maximum at the intake. As such, the rupture or leakage of a nitrogen or carbon dioxide tank poses no threat to control room operators. The staff finds that COL Item EF3 COL 6.4-2-A conforms to the requirements of TMI Action Plan, Item III.D.3.4 and GDC 19 and is consistent with RG 1.78.

Supplemental Information

- EF3 SUP 6.4-1

The applicant provides additional information in FSAR Section 6.4.5 to address the impact of a postulated DBA in Fermi 2 on the Fermi 3 control room.

The applicant provides conservatively calculated dispersion factors at the Fermi 3 CRHA intakes along with the distance and height of the Fermi 2 release. The calculations consider meteorological data and include a safety factor.

The applicant's review of the Fermi 2 LOCA, as described in Fermi 2 UFSAR Section 15.6.5, determined that the resultant dose to the Fermi 3 control room operator is within regulatory limits.

The NRC staff evaluated the applicant's supplemental information in FSAR Section 6.4.5 related to the impact of a postulated DBA in Fermi 2 on the Fermi 3 control room operators. The staff concurs that the information is sufficient to assure that the dose to a Fermi 3 control room operator from an accident at Fermi 2 is bounded by the dose to the control room operator from a postulated Fermi 3 DBA, which is less than the GDC 19 dose limit.

6.4.5 Post Combined License Activities

The applicant identified the following commitments to track implementation milestones for operator training and procedures for control room habitability as discussed in Sections 13.4 and 13.5 of this SER:

(1) Non Licensed Plant Staff Training Program – 18 months prior to scheduled fuel load. [COM 13.4-028]

(2) Reactor Operator Training Program - 18 months prior to scheduled fuel load. [COM 13.4-016]

(3) Operating procedures are developed at least six months prior to fuel load to allow sufficient time for plant staff familiarization and to allow NRC staff adequate time to review the procedures and to develop operator licensing examinations. [COM 13.5-002]

6.4.6 Conclusion

The NRC staff's findings related to information incorporated by reference are in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to control room habitability, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the control room habitability systems that were incorporated by reference have been resolved.

Based on the information in the technical review section above, the staff concludes that the information in the COL application is acceptable and meets the requirements of 10 CFR 50.34(f)(2)(xxviii) and GDC 19.

In addition, the staff concludes that the information presented in the COL FSAR is acceptable and meets the requirements of GDC 4 and 19 of Appendix A to 10 CFR Part 50 "Domestic Licensing of Production and Utilization Facilities", 10 CFR 50.34(f)(2)(xxviii),10 CFR 50.34(a)(6) and (10), and 10 CFR 50.34(b)(6)(iv) and (v). This conclusion is based on the following:

- STD COL 6.4-1-A is acceptable because the applicant has provided adequate information regarding the development and implementation of operator training and procedures for control room habitability to address the applicable aspects of NRC GL 2003-01 as well as the intent of GI 83. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR 50.34(a)(6) and (10) and 10 CFR 50.34(b)(6)(iv) and (v).

- EF3 COL 6.4-2-A is acceptable because the staff evaluated the technical adequacy of the toxic gas hazards analysis provided by the applicant in Section 2.2. The staff finds that the onsite storage locations of nitrogen and carbon dioxide present no toxic gas concerns with regards to control room habitability, in accordance with RG 1.78.

- EF3 SUP 6.4-1 is acceptable because the staff finds that supplemental information in COL FSAR Section 6.4.5 demonstrates that the dose to a Fermi 3 control room operator from an accident at Fermi 2 is bounded by the dose to the control room operator from a postulated Fermi 3 DBA, which is less than the maximum dose allowed by GDC 19.

6.5 Atmospheric Cleanup Systems

As documented in NUREG-1966, the NRC staff reviewed and approved Section 6.5 of the certified ESBWR DCD. The staff reviewed Section 6.5 "Atmospheric Cleanup Systems" of the Fermi 3 COL FSAR, Revision 7, and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the applicant has addressed the required information, and there is no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the "Atmospheric Cleanup Systems" have been resolved.

6.6 Preservice and Inservice Inspection and Testing of Class 2 and 3 Components and Piping

6.6.1 Introduction

Inservice inspection (ISI) Programs are based on the requirements of 10 CFR 50.55a, "Codes and Standards," in that Code Class 2 and 3 components, as defined in Section III of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC), meet the applicable inspection requirements set forth in Section XI of the ASME Code, "Rules for Inservice Inspection (ISI) of Nuclear Power Plant Components." ISI includes preservice examinations before the initial plant startup, as required by IWC-2200 and IWD-2200 of Section XI of the ASME Code.

6.6.2 Summary of Application

Section 6.6, "Preservice and Inservice Inspection and Testing of Class 2 and 3 Components and Piping" of the Fermi 3 COL FSAR incorporates by reference Section 6.6 of the ESBWR DCD, Tier 2, Revision 10. In addition, in FSAR Section 6.6, the applicant provides the following supplements:

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

COL Items

- STD COL 5.2-1-A System Pressure Tests

In FSAR Section 6.6.6, the applicant provides additional information in STD COL 5.2-1-A to address pressure testing information for Class 2 and 3 components. The applicant states that system leakage and hydrostatic tests will meet all applicable requirements of ASME Code Section XI, IWA-5000, IWC-5000, and IWD-5000 for Class 2 and 3 components, including the limitations of 10 CFR 50.55a(b)(2)(xx) and 10 CFR 50.55a(b)(2)(xxvi).

- STD COL 6.6-1-A Augmented Inservice Inspection

The applicant provides additional information in STD COL 6.6-1-A to address COL Item 6.6-1-A. The applicant states that: (a) the Pre-service Inspection (PSI)/ISI Program description for Class 2 and 3 components and piping is in DCD Section 6.6; (b) no relief requests have been identified; (c) the initial ISI Program is to be based on the latest edition and addenda of the ASME Code, incorporated by reference in 10 CFR 50.55a(b) on the date 12 months before fuel loading; and (d) the milestones for implementing the PSI/ISI Program are in FSAR Section 13.4, "Operational Programs Implementation."

In addition, in FSAR Section 6.6.7, the applicant supplements the ESBWR DCD with a new Subsection 6.6.7.1, "Flow Accelerated Corrosion Program Description," describing the Flow Acceleration Corrosion (FAC) Monitoring Program. The applicant adds that this program will be based on the Electric Power Research Institute "Recommendations for an Effective Flow-Accelerated Corrosion Program," Nuclear Safety Analysis Center 202L-R2. The applicant states that before startup, a comprehensive FAC susceptibility screening will be performed to identify any plant systems that may be susceptible to FAC degradation. Should any plant systems remain susceptible, a FAC Program will be implemented with PSI baseline nondestructive examinations (NDEs), and the material constituency will be identified for each as-fabricated piping component in the susceptible systems.

- STD COL 6.6-2-A PSI/ISI NDE Accessibility Plant Description

In FSAR Section 6.6.2, the applicant provides additional information to address accessibility and the NDEs of Class 1, 2, and 3 austenitic or dissimilar metal welds. The applicant states that procedures for design control and plant modifications will include provisions to assure accessibility for inspecting and testing during licensee design activities affecting Class 2 and 3 components. The applicant adds that the ISI NDE method will be similar to that of the PSI to ensure a baseline point of reference.

6.6.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG-1966, FSER related to the certified ESBWR DCD. In addition, the relevant requirements of the Commission regulations for the PSI/ISI for Class 2 and 3 components, and the associated acceptance criteria, are in Section 6.6 of NUREG–0800.

The applicable regulatory requirement for the PSI/ISI Program for Class 2 and 3 components is as follows:

- 10 CFR 50.55a

The related acceptance criteria are as follows:

> ASME BPVC Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components."

The basis for accepting the COL information item and supplementary information on the ISI of Class 2 and 3 components is established in 10 CFR 50.55a, as it pertains to specifying the PSI/ISI, and testing requirements of the ASME Code for Class 2 and 3 components. Acceptance of the description of the FAC program is also based on addressing the concerns in Generic Letter (GL) 89-08 as they pertain to establishing an erosion-corrosion monitoring program. Standard Review Plan (SRP) Section 10.3.6 discusses the need for a FAC program and identifies acceptance criteria.

6.6.4 Technical Evaluation

As documented in NUREG–1966, the NRC staff reviewed and approved Section 6.6 of the certified ESBWR DCD. The staff reviewed Section 6.6 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1] The staff's review confirms that information in the application and information incorporated by reference address the required information related to the PSI/ISI, and testing of Class 2 and 3 components.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure the staff's findings on standard content that were documented in the SER with open items issued for the North Anna application were equally applicable to the Fermi COL application, the staff undertook the following reviews:

- The staff compared the North Anna COL FSAR, Revision 1, to the Fermi COL FSAR, Revision 7. In performing this comparison, the staff considered changes made to the Fermi COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the North Anna SER with open items.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content (the North Anna SER) evaluation were endorsed.

- The staff verified that the site-specific differences are not relevant.

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

The staff has completed its review and finds the evaluation performed for the standard content to be directly applicable to the Fermi COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting.

The staff reviewed the conformance of FSAR Section 6.6 to the guidance in RG 1.206, Section C.III.1, Chapter 6, C.I.6.6, "Inservice Inspection of Class 2 and 3 Components." The staff's review of FSAR Section 6.6 found that it incorporates by reference Section 6.6 of the ESBWR DCD. The staff's review of DCD Section 6.6 has determined that the ESBWR ISI Program for Code Class 2 and 3 components is acceptable and meets the requirements of 10 CFR 50.55a, with regard to the preservice and inservice inspectability of these components. The specific version of ASME Code Section XI, which is used as the baseline Code in the ESBWR certified design, is the 2001 Edition up to and including the 2003 Addenda. It should also be noted that the staff did not identify any portions of the ESBWR ISI Program for Class 1, 2, and 3 components that were excluded from the scope of the staff's review of the ESBWR design. Fermi COL FSAR Section 6.6 states that the PSI/ISI Program description for Class 2 and 3 components and piping is in ESBWR DCD Tier 2, Section 6.6. Therefore, the staff's conclusions remain unchanged regarding the acceptability of the ESBWR ISI Program based on the 2001 Edition, up to and including the 2003 Addenda, of ASME Code Section XI, with regard to preservice and inservice inspectability of Class 2 and 3 components. The staff's evaluation of the operational program aspects of the ASME Code Class 2 and 3 ISI Program and the Augmented Inspection Programs is addressed with the Class 1 ISI in Section 5.2.4 of this SER. The adequacy of the ISI Program for metal containment (Class MC) components is discussed in Section 3.8.2 of this SER. Accordingly, the staff's evaluation of this section focuses on the acceptability of the FSAR COL applicant's supplemental information and responses to COL items as they relate to the ISI of ASME Code Class 2 and 3 components.

<u>*COL Items*</u>

The following portion of this technical evaluation section is reproduced from Section 6.6.4 of the North Anna SER (ADAMS Accession No. ML091380480):

- *STD COL 5.2- 1-A* *Plant Specific Pressure Testing*

In FSAR Section 6.6, the applicant provided additional information in STD COL 5.2-1-A to address pressure testing information for Class 2 and 3 components. This information also addresses the staff's RAI under Section 5.2.4 pertaining to the limitations under 10 CFR 50.55a. The applicant states that system leakage and hydrostatic tests will meet all applicable requirements of ASME Code, Section XI , IWA-5000 , IWC-5000, and IWD-5000 for Class 2 and 3 components, including the limitations of 10 CFR 50.55a(b)(2)(xx) and 10 CFR 50.55a (b)(2)(xxvi).

Revision 1 to the North Anna 3 COL FSAR agrees with the limitations for pressure testing of Class 1, 2, and 3 components in 10 CFR 50.55a, and is therefore acceptable to the staff.

- *STD COL 6.6-1-A* *Plant Specific PSI/ISI Program Information*

The COL applicant provided a full description of the PSI/ISI programs and augmented inspection programs for Class 2 and 3 components by supplementing the information in DCD Section 6.6. The COL applicant also provided milestones for program implementation (FSAR Section 13.4).

The COL item is addressed in the FSAR, in part, by replacing the last sentence and the parenthetical statement of the third paragraph of DCD Section 6.6 with the following:

> *The PSI/ISI program description for Class 2 and 3 components and piping is provided in DCD Section 6.6*

A PSI/ISI program encompasses Class 1, 2, and 3 components and is being evaluated under Section 5.2.4 of the staff SER of ESBWR DCD on Docket No. 52-010. Though Section 6.6 applies to Class 2 and 3 components, the augmented ISI programs, which protect against postulated piping failures, contain portions of the PSI/ISI program and include Class 1 components. This topic is discussed under Section 5.2.4 of this SER.

The applicant also provided Section 6.6.7.1, Flow Accelerated Corrosion Program Description, to describe the general attributes of the applicant's program for monitoring and managing degradation (i.e., thinning) of piping and components susceptible to flow accelerated corrosion. The staff's evaluation of FSAR Section 6.6.7.1 is addressed in Section 10.3 of this SER.

Since the PSI/ISI program for Class 1, 2, and 3 components and the implementation milestones are discussed under Section 5.2.4 of this SER, the staff concludes that STD COL 6.6-1-A is acceptable for Section 6.6 of this SER.

As stated above, the staff evaluated the North Anna FAC program description in Section 10.3 of the SER. That was based on the NRC SRP, which addresses FAC in Section 10.3.6, "Steam and Feedwater Materials." In reviewing the Fermi Unit 3 COLA, the staff concludes it would be more appropriate to include the FAC program evaluation in Section 6.6 of the SER in order to be consistent with the FSAR. The staff's evaluation of the North Anna FAC program is complete and applicable to the Fermi review since the FAC program description is part of the standard COL information under STD COL 6.6-1-A. Therefore, the following portion of this technical evaluation is reproduced from Section 10.3 of the North Anna SER (ADAMS Accession No. ML091520434):

The staff reviewed the information provided by the applicant in Section 6.6.7.1 of the COL FSAR, which describes the FAC program. FSAR Section 6.6.7.1 also refers to FSAR Section 13.4 for program implementation milestones. Therefore, the staff also reviewed the *information provided in FSAR Table 13.4-201, "Operational Programs Required by NRC Regulations."*

As part of the review, the staff requested in RAI 10.03.06-1 that the applicant discuss an implementation schedule for the detailed FAC program, (e.g., FAC program activities that will be conducted during the plant construction phase and the schedule for those activities). RAI 10.03.06-2 requested the applicant to confirm (1) that the FAC program will include pre-service thickness measurements of the as-built components considered susceptible to FAC, and (2) that these measurements will use the grid locations and measurement methods most likely to be used for inservice inspection (ISI) according to industry guidelines.

In a response dated July 14, 2008 (ML082050559), the applicant stated that the FAC program is considered an Operational Program under the ISI program listed in Table 13.4-201, "Operational Programs Required by NRC Regulations." The letter included a revised Table 13.4-201 that explicitly lists the FAC program under the ISI program in the FSAR with an implementation milestone of "prior to commercial service." The response also stated that during the construction phase, a comprehensive FAC susceptibility screening and preservice inspection of susceptible systems will be performed.

The applicant's response provided portions of a FAC program description the applicant had developed to address the requirement in ESBWR DCD Revision 5, under COL Item 6.6-1-A. The proposed description of the FAC program included a statement that the North Anna 3 FAC program will be based on EPRI NSAC 202-L, "Recommendations for an Effective Flow-Accelerated Corrosion Program." The response also stated that preservice, baseline, and non-destructive examinations will be performed on as-fabricated components in susceptible systems and that these preservice inspections will use grid locations and measurement methods most likely to be used for ISIs.

The changes proposed in the applicant's response addressed the staff concerns about the implementation activities and schedule by making the FAC program an explicit part of the operational programs. The proposed revision also addressed the staff concerns about preservice inspections by adding a description of the preservice inspection plan to the FSAR, including the affirmation that locations and measurement methods will be those most likely to be used in subsequent inspections. The staff reviewed the FAC program information provided in Section 6.6.7.1 of Revision 1 of the FSAR and confirmed that the FAC program is included in Chapter 13 as an operational program and that it addresses the concerns discussed above regarding preservice inspection requirements. Therefore, the staff finds the information on the FAC program acceptable.

Based on the information above, the staff finds that the FAC program is acceptable because it meets the requirements of 10 CFR 50.55a and addresses the concerns in GL 89-08 as they pertain to establishing an erosion-corrosion monitoring program.

The applicant identified the following commitments to track implementation of the PSI/ISI programs:

(1) ISI - Implemented prior to commercial service (COM 13.4-024)
(2) PSI – Completion prior to initial plant startup (COM 13.4-026)

- *STD COL 6.6-2-A* PSI/ISI NDE Accessibility Plant Description

The following portion of this technical evaluation section is reproduced from Section 6.6.4 of the North Anna SER (ADAMS Accession No. ML091380480):

> *The applicant replaced the last sentence in the second paragraph of the ESBWR DCD, Revision 5, with the following:*
>
> > *During the construction phase of the project, anomalies and construction issues are addressed using change control procedures. Procedures require that changes to approved design documents, including field changes and modifications, are subject to the same review and approval process as the original design. Accessibility and inspectability are key components of the design process. Control of accessibility for inspectability and testing during licensee design activities affecting Class 2 and 3 components is provided via procedures for design control and plant modifications. Ultrasonic techniques (UT) will be the preferred NDE method for all PSI and ISI volumetric examinations; radiographic techniques (RT) will be used as a last resort only if UT cannot achieve the necessary coverage. The same NDE method used during PSI will be used for ISI to the extent possible to assure a baseline point of reference. If a different NDE method is used for ISI than was used for PSI, equivalent coverage will be achieved as required by the Code.*
>
> *Accessibility of Class 1, 2, and 3 components, and the use of alternative NDE methods are discussed under Section 5.2.4 of this FSER and was deemed acceptable to the staff. Based on the above discussion, STD COL 6.6-2-A is acceptable.*

6.6.5 Post Combined License Activities

The applicant identified the following commitments to track implementation of the PSI/ISI programs:

(1) ISI - Implemented prior to commercial service (COM 13.4-024)
(2) PSI - Completion prior to initial plant startup (COM 13.4-026)

6.6.6 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the PSI/ISI of Class 2 and 3 components and piping, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to "Preservice and Inservice Inspection and Testing of Class 2 and 3 Components and Piping" that were incorporated by reference have been resolved.

In addition, the staff's review concludes that the applicant information to address STD COL Items 5.2-1-A, 6.6-1-A, and 6.6-2-A as provided in Section 6.6 of the Fermi COL FSAR meets the relevant guidelines in SRP Section 6.6 of NUREG-0800, and other NRC RGs, and are therefore acceptable. Conformance with these guidelines provides an acceptable basis for satisfying the requirements of GDC 32 and 10 CFR 50.55a. The staff concludes that the FAC program described in FSAR Section 6.6.7.1 is consistent with industry practices for addressing the concerns related to FAC and for monitoring the piping wall degradation caused by FAC during plant operations. The establishment of an FAC monitoring program adequately addresses the concerns identified in GL 89-08.

7.0 INSTRUMENTATION AND CONTROL SYSTEMS

This chapter presents specific detailed design and performance information for the instrumentation and control (I&C) systems. These systems help assure the integrity of the reactor coolant pressure boundary, the capability to shut down the reactor and maintain it in a safe shutdown condition, and the capability to prevent or mitigate the consequences of anticipated operational occurrences and postulated accidents. These systems are also significant for plant operation and are used throughout the plant. This chapter provides information on the systems and components that sense various reactor parameters and transmit signals to the control systems during normal operations and to the reactor trip and engineered safety feature systems during abnormal and accident conditions. The I&C system for the Economic Simplified Boiling-Water Reactor (ESBWR) design is an I&C distributed control and information system (DCIS). The DCIS is designated as either a safety-related DCIS (Q-DCIS) or nonsafety-related DCIS (N-DCIS). The Q-DCIS and N-DCIS functions include diverse power and sensors and diverse hardware and software architectures to significantly reduce the consequences of a potential software common cause failure in the primary I&C protection system.

The Q-DCIS includes the reactor protection system, the neutron monitoring system, the independent control platform, and the safety system logic and control for the emergency safety feature actuation system. The N-DCIS includes the diverse protection system, the balance of plant systems, the plant investment protection systems, the plant computer functions and workstations, and the severe accident mitigation system (the deluge system).

Chapter 7 of the Fermi 3 combined license (COL) Final Safety Analysis Report (FSAR), Revision 7 incorporates by reference Chapter 7, “Instrumentation and Control Systems,” of the certified ESBWR design control document (DCD) Revision 10, referenced in Title 10 of the *Code of Federal Regulations (*10 CFR) Part 52, Appendix E, “Design Certification Rule for the Economic Simplified Boiling-Water Reactor,” with no departures or supplements. U.S. Nuclear Regulatory Commission (NRC) staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this chapter remains for review.[1] The staff’s review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this chapter. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the I&C system are resolved.

[1] See *“Finality of Referenced NRC Approvals”* in SER Section 1.2.2 for a discussion on the staff’s review related to verification of the scope of information to be included in a COL application that references a design certification.

8.0 ELECTRIC POWER

The electric power system is the source of power for station auxiliaries during normal operation and for the reactor protection system and engineered safety features during abnormal and accident conditions. This chapter provides information on the functional adequacy of offsite power systems and safety-related onsite electric power systems, as applicable to the Economic Simplified Boiling-Water Reactors (ESBWR) design, and ensures that these systems have adequate redundancy, independence, and testability in conformance with the current criteria established by the U.S. Nuclear Regulatory Commission (NRC).

8.1 <u>Introduction</u>

8.1.1 Introduction

This section of the combined license (COL) Final Safety Analysis Report (FSAR) describes the transmission grid and its interconnection to the nuclear unit and other grid interconnections. This discussion also describes those onsite alternating and direct current (ac and dc) loads that are added to the certified ESBWR design and the function provided by these loads.

The section also includes a regulatory requirements applicability matrix that lists the design bases, criteria, regulatory guides (RGs), standards, and other documents to be implemented in the design of the electrical systems that are beyond the scope of the design certification (i.e., site-specific). The review under this section is coordinated closely with the reviews described in Sections 8.2, 8.3.1, 8.3.2, and 8.4 below.

8.1.2 Summary of Application

Section 8.1 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 8.1 of the ESBWR Design Control Document (DCD), Revision 10. In addition, in FSAR Section 8.1, the applicant provides the following:

<u>Supplemental Information</u>

- EF3 SUP 8.1-1 Utility Power Grid Description

This supplemental information relates to a general overview of the output from the Enrico Fermi 3 (EF3) main generator, the system connections of the International Transmission Company transmission (ITC Transmission) to the EF3 switchyard from the Milan Substation, and the configuration of the normal preferred and the alternate preferred transmission lines.

8.1.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1966, “Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling-Water Reactor.” In addition, the relevant requirements of the Commission regulations for the “Electric Power – Introduction,” and the associated acceptance criteria, are in Section 8.1 of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, (LWR Edition),” the Standard Review Plan (SRP).

The regulatory basis for accepting the COL supplemental information is established in General Design Criterion (GDC) 17, “Electric power systems,” of Appendix A, “General Design Criteria for Nuclear Power Plants,” to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, “Domestic Licensing of Production and Utilization Facilities.”

8.1.4 Technical Evaluation

As documented in NUREG–1966, NRC staff reviewed and approved Section 8.1 of the certified ESBWR DCD. The staff reviewed Section 8.1 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to the review topic.[1] The staff’s review confirmed that the information in the application and the information incorporated by reference address the required information related to this section.

The staff reviewed the following information in the COL FSAR:

Supplemental Information

- EF3 SUP 8.1-1 Utility Power Grid Description

The staff reviewed the applicant’s supplemental information modifying Subsection 8.1.2.1, “Utility Power Grid Description.” In Subsection 8.1.2.1, the applicant provides the following supplemental information:

> The output of Fermi 3 is delivered to a 345 kV switchyard through the unit main step-up transformers. Fermi 3 is connected to the switchyard by a 345 kV normal preferred transmission line that supplies power to the two unit auxiliary transformers and a 345 kV alternate preferred transmission line that supplies power to the two reserve auxiliary transformers. The switchyard for Fermi 3 serves three 345 kV transmission lines which connect this switchyard to the Milan substation.

The staff found that the applicant has adequately described the Fermi 3 electrical connection to the utility grid and that the connection conforms to the requirements of GDC 17.

8.1.5 Post Combined License Activities

There are no post COL activities related to this section.

8.1.6 Conclusion

The NRC staff’s finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff’s review finds that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, “Design Certification Rule for the Economic Simplified Boiling-Water Reactor,” Section VI.B.1, all nuclear safety issues relating to “Electric Power - Introduction” that were incorporated by reference are resolved.

[1] See *“Finality of Referenced NRC Approvals”* in SER Section 1.2.2 for a discussion on the staff’s review related to verification of the scope of information to be included in a COL application that references a design certification.

In addition, the staff compared the additional COL supplemental information in the application to the relevant NRC regulations, the guidance in Section 8.1 of NUREG–0800, and other NRC RGs. The staff's review concluded that the applicant has provided sufficient information to satisfy the requirements of GDC 17 for this section.

8.2 Offsite Power System

8.2.1 Introduction

This section of the FSAR describes analyses and referenced documents that include electrical single-line diagrams, electrical schematics, logic diagrams, tables, and physical arrangement drawings for the offsite power system. Industry standards and RGs refer to the offsite power system as the "preferred power system." This system includes two or more physically independent circuits capable of operating independently of the onsite standby power sources and encompasses the grid, transmission lines (overhead or underground), transmission line towers, transformers, switchyard components and control systems and switchyard battery systems, in addition to the main generator and generator circuit breakers, disconnect switches, and other switchyard equipment such as the capacitor banks and volt amperes reactive compensators, which supply electric power to safety-related and other equipment.

By not requiring ac power sources for design-basis events for 72 hours, the ESBWR passive reactor design used at Fermi 3 minimizes the potential risk contribution of a station blackout (SBO) (the loss of all ac power). The plant's safety-related passive systems automatically establish and maintain safe-shutdown conditions for the plant following design-basis events, including the extended loss of ac power sources. The passive systems can maintain these safe-shutdown conditions after design-basis events for 72 hours without operator action, following the loss of both onsite and offsite ac power sources.

8.2.2 Summary of Application

Section 8.2 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 8.2 of the ESBWR DCD, Revision 10.

In addition, in FSAR Section 8.2, the applicant provided site-specific supplemental information to resolve COL Items 8.2.4-1-A through 8.2.4-10-A. The applicant adds the following site-specific supplemental information:

COL Items

- EF3 COL 8.2-1 Bulletin 2012-01

[COM 8.2 -001] Plant operating procedures, including off-normal operating procedures, associated with the monitoring system will be developed in accordance with FSAR Subsection 13.5.2.1 at least six months prior to fuel load.

[COM 8.2-002] Maintenance and testing procedures, including calibration, set point determination and troubleshooting procedures, associated with the monitoring system will be developed in accordance with FSAR Subsection 13.5.2.2.6.1 prior to fuel loading.

[COM 8.2-003] Control room operator and maintenance technician training associated with the operation and maintenance of the monitoring system will be developed in accordance with FSAR Section 13.2.1 for Reactor Operators and FSAR Section 13.2.2 for Non Licensed Plant Staff. Training will be completed prior to fuel loading.

- EF3 COL 8.2.4-1-A Transmission System Description

In FSAR Subsection 8.2.1.1, the applicant provided detailed information on the plant site designs for the 345-kilovolt (kV) switchyard; the three 345-kV transmission lines connecting the plant switchyard to the Milan substation and to the ITC transmission system; and the interface of the switchyard with the transmission grid. The applicant also provided Figures 8.2-201 through 8.2-203. These figures show a one-line diagram of the Fermi 3 switchyard with transmission lines to the Milan substation and to the onsite electrical system, a physical arrangement of the 345-kV switchyard, and a map of the offsite transmission lines, respectively.

- EF3 COL 8.2.4-3-A Normal Preferred Power
- EF3 COL 8.2.4-4-A Alternate Preferred Power

In FSAR Subsection 8.2.1.2, the applicant provided additional information describing details of normal and alternate preferred power.

- EF3 COL 8.2.4-2-A Switchyard Description
- EF3 COL 8.2.4-6-A Switchyard Direct Current (DC) Power
- EF3 COL 8.2.4-7-A Switchyard AC Power
- EF3 COL 8.2.4-8-A Switchyard Transformer Protection

In FSAR Subsection 8.2.1.2.1, the applicant provided additional information describing details of the switchyard, the switchyard DC and AC power, and switchyard transformer protection.

- EF3 COL 8.2.4-5-A Protective Relaying

The applicant provided new information in Subsection 8.2.1.2.2 that specifically addresses the monitoring of the UAT and RAT transformers for open circuit conditions as addressed in NRC Bulletin 2012-01, "Design Vulnerability in Electric Power System," (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12074A115). Subsection 8.2.1.2.3 describes the existing relay schemes that protect the 345-kV transmission lines, switchyard buses, generating unit tie-line, and auxiliary transformers. [NOTE: The applicant inserted information concerning Bulletin 2012-01 into Subsection 8.2.1.2.2 in COL Revision 6 and renumbered the Subsections 8.2.1.2.2 and 8.2.1.2.3 as 8.2.1.2.3 and 8.2.1.2.4, respectively.]

- EF3 COL 8.2.4-9-A Stability and Reliability of the Offsite Transmission Power System

- EF3 COL 8.2.4-10-A Interface Requirements

In FSAR Subsection 8.2.2.1, the applicant provided additional information describing the transmission system study that was performed to verify grid stability, switchyard voltage, and frequency. This section also discusses the formal agreement between the control room and the transmission operator.

Supplemental Information

- EF3 SUP 8.2-2 Testing and Inspection

The applicant provided, in FSAR Subsection 8.2.1.2.4, “Testing and Inspection,” the details for testing and inspecting the switchyard components.

- EF3 SUP 8.2-3 Failure Mode and Effects Analysis

The applicant provided, in FSAR Subsection 8.2.2.3, “Failure Modes and Effects Analysis,” the details of the failure modes and effect analysis of transmission system and switchyard components.

8.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1966, the FSER related to the ESBWR DCD and NUREG–1966, Supplement 1,FSER related to the Certification of the ESBWR Standard Design, Supplement 1. In addition, the relevant requirements of the Commission regulations for the “Electric Power – Introduction,” and the associated acceptance criteria, are in Section 8.2 of NUREG–0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition),” the Standard Review Plan (SRP).

The regulatory basis for accepting the COL supplemental information is established in General Design Criterion (GDC) 17, “Electric power systems,” of Appendix A, “General Design Criteria for Nuclear Power Plants,” to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, “Domestic Licensing of Production and Utilization Facilities.” and specifically, as follows;

- For EF3 COL 8.2-1, the requirements of GDC 17.

- For EF3 COL 8.2.4-1-A, the requirements of GDC 17.

- For EF3 COL 8.2.4-3-A and 8.2.4-4-A, the requirements of GDC 17.

- For EF3 COL 8.2.4-2-A, 8.2.4-6-A, 8.2.4-7-A, and 8.2.4-8-A, the requirements of GDC 17 and GDC 5, “Sharing of structures, systems, and components,” recommendations of GL 2007-01, “Inaccessible or Underground Power Cable failures that Disabled Accident Mitigation Systems or cause Plant Transients,” and guidance of NUREG/CR 7000, “Essential Elements of an Electric Cable Condition Monitoring Program” and SRP Section 8.2, Review Procedure 1.L.

- For EF3 COL 8.2.4-5-A the requirements of GDC 17.

- For EF3 COL 8.2.4-9-A and 8.2.4-10-A, the requirements of GDC 17 and the guidelines of RG 1.32, “Criteria for Power Systems for Nuclear Power Plants”; RG 1.206 (2007), “Combined License Applications for Nuclear Power Plants (LWR Edition)”; Branch Technical Position (BTP) 8-3 (2007), “Stability of Offsite Power Systems”; BTP 8-6 (2007), “Adequacy of Station Electric Distribution System Voltages”; RG 1.160 (1997), “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants”; and RG 1.182 (2000), “Assessing and Monitoring Risk Before Maintenance Activities at Nuclear Power Plants.”

- For EF3 SUP 8.2-2, the requirements of GDC 18, "Inspection and testing of electric power and protective systems," and the guidelines of RG 1.118 (1995), "Periodic Testing of Electric Power and Protection Systems."

- For EF3 SUP 8.2-3, the guidance of RG 1.206.

8.2.4 Technical Evaluation

As documented in NUREG–1966 and NUREG-1966, Supplement 1, NRC staff reviewed and approved Section 8.2 of the ESBWR DCD. The staff reviewed Section 8.2 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1]

The staff's review confirmed that the information in the application and the information incorporated by reference address the required information related to the offsite power system.

The staff reviewed the following information in the COL FSAR:

COL Items

- EF3 COL 8.2.4-1-A Transmission System Description

The applicant provided in FSAR Subsection 8.2.1.1 the details to address COL Item 8.2.4-1-A. In this subsection, the applicant states the following:

> Fermi 3, is connected to the ITC Transmission system by three 345 kV lines. These lines are designed and located to minimize the likelihood of simultaneous failure.
>
> The Fermi 3 main generator feeds electric power through a 27 kV isolated-phase bus to a bank of three single-phase transformers, stepping the generator voltage up to the transmission voltage of 345 kV.
>
> The three 345 kV lines for Fermi 3 run in a common corridor. Transmission tower and steel pole separation, line installation, and clearances are consistent with applicable regulatory standards, typically the National Electrical Safety Code, and ITC Transmission line standards. Design standards and parameters, including number of wires, structure heights, materials and finish are consistent with ITC Transmission line design standards.

The staff's review of FSAR Subsection 8.2.1.1 and applicable Figures 8.2-201, 8.2-202, and 8.2-203 observed that all three lines between Fermi 3 and the Milan substation are routed though the same transmission corridor. In view of the common corridor for all transmission lines, the staff issued RAI 08.02-04 requesting the applicant to discuss why the phenomenon of galloping conductors will not be accentuated in the corridor under the required environmental

[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

conditions, such as wind and ice loading, which result in flashovers and structural damage to multiple transmission line conductors and hardware. The applicant's response to this RAI dated August 26, 2009 (ADAMS Accession No. 092450483), cited the Electric Power Research Institute (EPRI) Technical Report No.1010223, "Updating the EPRI Transmission Line Reference Book: "Wind-Induced Conductor Motion ("The Orange Book")." The applicant stated that the frequency with which galloping occurs is closely related to environmental conditions, such as the frequency of icing, smooth countered terrain with few large obstacles, and localized areas near lakes and rivers. The applicant also stated that a search of industry operating experience found no identifiable relationship with the number of transmission lines in a transmission corridor.

Because all three transmission lines are routed through a common corridor and are therefore exposed to the same environmental conditions, the staff issued RAI 08.02-14 requesting the applicant to indicate whether any of the EPRI-evaluated environmental conditions could result in the galloping conductor phenomenon impacting multiple lines at the same time, thus causing a complete loss of offsite power. The staff also requested the applicant to discuss any direct experiences with this phenomenon at Fermi Units 1 and 2.

The applicant's response to this RAI dated January 29, 2010 (ADAMS Accession No. ML100331450), clarified that regional galloping conductors could occur in a common transmission corridor or independent corridors exposed to similar situational weather conditions. The applicant also stated that there are no reported occurrences of galloping conductors or of any related outages on the existing lines that would be sharing the Fermi 3 to Milan transmission corridor in the ITC Transmission operating history, which began in February 2003. Further, the applicant added that ITC Transmission design practices to space the towers to preclude contact with an adjacent tower's conductors if any galloping phenomenon occurs. The staff reviewed the applicant's responses to RAI 08.02-04. Based on the ITC Transmission design practices, the installation of transmission line towers, and the lack of galloping conductor occurrences or outages due to such phenomena, the staff finds that the Fermi 3 offsite power transmission line system meets the requirements of GDC 17 and, hence, the applicant's response is acceptable. Therefore, RAI 08.02-04 and RAI 08.02-14 are resolved.

The staff finds that COL Item 8.2-4-1-A conforms to the requirements of GDC 17.

- EF3 COL 8.2.4-3-A — Normal Preferred Power
- EF3 COL 8.2.4-4-A — Alternate Preferred Power

The applicant provided additional information on the normal and alternate preferred power to address COL Items 8.2.4-3-A and 8.2.4-4-A. The applicant replaced the first paragraph of DCD Subsection 8.2.1.2 with the following:

> The offsite power system is a nonsafety-related system. Power is supplied to Fermi 3 from three independent and physically separate offsite power sources. The normal preferred power source is any one of the three 345 kV lines and the alternate preferred power source is any other one of the three 345 kV lines.

In addition, the applicant deleted the last paragraph of this subsection and replaced it with the following paragraph:

> Normal and alternate preferred power to the UATs and RATs, respectively, is via overhead conductors. To maintain their independence from each other, the conductors are routed such that they are physically and electrically separate from each other.

The staff finds that the applicant has adequately resolved COL Items 8.2.4-3-A and 8.2.4-4-A. The staff finds that the applicant's description of the offsite normal and alternate preferred power is reasonable and conforms to the requirements of GDC 17. The staff bases this conclusion on the fact that the three 345 kV lines from the Milan substation to the Fermi 3 switchyard are physically separated within the common right-of-way such that a transmission tower failure could only impact a single adjacent line and can be electrically isolated from each other by the breaker-and-one-half scheme in the Fermi 3 switchyard. The breaker-and-one-half scheme allows for uninterrupted operation of the switchyard given a single bus, single line or single circuit breaker failure.

- EF3 COL 8.2.4-2-A — Switchyard Description
- EF3 COL 8.2.4-6-A — Switchyard DC Power
- EF3 COL 8.2.4-7-A — Switchyard AC Power
- EF3 COL 8.2.4-8-A — Switchyard Transformer Protection

The applicant provided additional information in FSAR Subsection 8.2.1.2.1 to address COL Items 8.2.4-2-A, 8.2.4-6-A, 8.2.4-7-A, and 8.2.4-8-A. The applicant replaced the last paragraph of DCD Subsection 8.2.1.2.1 with new supplemental information that, in part, states the following:

> The Fermi 3 switchyard is a 345 kV, air-insulated, breaker-and-a-half bus arrangement. The 345 kV switchyard for Fermi 3 receives two sources of AC auxiliary power from the 6.9 kV Plant Investment Protection (PIP) buses for the normal and alternate preferred switchyard power centers. The switchyard auxiliary power system is designed with adequate equipment, standby power, and protection to provide maximum continuity of service for operation of the essential switchyard equipment during both normal and abnormal conditions. There are two independent sets of 125 V DC batteries, chargers, and DC panels for the switchyard relay and control systems DC supply requirements. Each charger is powered from a separate AC source with an automatic switchover to the alternate source, in the event the preferred source is lost. The distribution systems for the two battery systems are physically separated.
>
> Control and relay protection systems are provided. Support systems, such as grounding, raceway, lighting, AC/DC station service, and switchyard lightning protection, are also provided.

The staff's review of FSAR Subsection 8.2.1.2.1 noted that the subsection includes a resolution for COL Item 8.2.4-8-A, "Switchyard Transformer Protection," but does not include a discussion of transformer protection. Therefore, the staff issued RAI 08.02-13 requesting the applicant to modify the subsection accordingly. The applicant's response to this RAI dated August 26, 2009, emphasized a description already in FSAR Subsection 8.2.1.2.2 stating that the 345 kV for Fermi 3 does not require any transformers. Therefore, transformer protection is not required. To address the omission, the applicant proposed to include in FSAR Subsection 8.2.1.2.1 a discussion of switchyard transformer protection similar to that in FSAR Subsection 8.2.1.2.2. The staff's review of the applicant's response finds that the proposed FSAR revision is reasonable and adequately addresses the staff's issue. Therefore, RAI 08.02-13 is resolved. The staff confirmed that the applicant has included the proposed change in Revision 3 of the COL application. [NOTE: The applicant inserted information concerning Bulletin 2012-01 into Subsection 8.2.1.2.2 in COL Revision 6 and renumbered the Subsections 8.2.1.2.2 and 8.2.1.2.3 as 8.2.1.2.3 and 8.2.1.2.4, respectively.]

As stated in FSAR Subsection 8.2.1.2.1 and in DCD Figure 8.1-1, the switchyard receives two sources of ac auxiliary power from the 6.9-kV PIP buses for both the normal and alternate preferred switchyard power centers. Additionally, the design utilizes two 125 VDC power to meet the requirements of the switchyard relay and control systems. In RAI 08.02-07, the staff asked the applicant to describe how medium-voltage power and low-voltage power control and instrumentation cables that are expected to be partially or continuously submerged in manholes, trenches, and duct banks are specified and qualified. The staff also asked the applicant to provide the design features and/or in situ monitoring programs that will be implemented to avoid or arrest the degradation of cable insulation from the effects of moisture. In addition, the staff requested the applicant to include the cables that traverse the switchyard as well as those that extend from the switchyard to the Fermi 3 unit.

The applicant's response to this RAI dated August 26, 2009 (ADAMS Accession No. ML092450483), stated that periodic monitoring of cable insulation for underground medium-voltage cable will be conducted to detect potential cable insulation degradation from moisture intrusion. Such monitoring of medium-voltage cables will be conducted in a manner similar to that described in the Fermi 2 Electrical Cable Monitoring Program based on the recommendations of the EPRI Cable Task Force. Additionally, the applicant stated that "Detroit Edison does not believe that a testing program is necessary for low-voltage power, control, or instrumentation cables in underground circuits."

The staff's review of Detroit Edison's response to GL 2007-01 found that the three failed cables they identified at Fermi 2 were low-voltage (480 VAC and 260 VDC) cables. Additionally, the staff noted that for Fermi 2, Detroit Edison had committed to inspecting, testing, and monitoring all power cables—not only the medium-voltage cables. Based on the Fermi 2 operating experience with low voltage underground cables and the scope of the program described in the Fermi 2 response to GL 2007-01, the staff issued RAI 08.02-17 requesting the applicant to indicate why a program for inspecting, testing, and monitoring low-voltage underground power cables is not required for Fermi 3.

The applicant's response to RAI 08.02-17, dated January 29, 2010 (ADAMS Accession No. ML100331450), reiterated that the response provided by Detroit Edison to GL 2007-01 for Fermi 2 clarified that Detroit Edison had not made a commitment to inspect, test, and monitor all Fermi 2 power cables in the response to GL 2007-01. The applicant added that Fermi 2 currently has an electrical cable monitoring program with the purpose "to detect and trend the degradation of significant cables and connections located in challenged environments." The applicant pointed out that by monitoring those cables, the program helps to protect the safe-shutdown capability of the plant; increases equipment reliability; and ensures compliance with the appropriate equipment qualification maintenance and surveillance for cables. The scope of the program regarding cables in a wet environment (such as an underground raceway) includes inspecting significant medium-voltage cables in those areas, as well as monitoring underground raceway manholes for cable submergence and for overall condition, such as the condition of supporting and dewatering the equipment. Additionally, the applicant clarified that the periodic monitoring of underground medium-voltage cable insulation to detect potential cable degradation from moisture intrusion, which the applicant proposed in the original response, is consistent with the monitoring approach currently followed at Fermi 2. Therefore, the applicant does not believe that a monitoring program for Fermi 3 that extends beyond the Fermi 2 program described above is necessary.

As described in GL 2007-01, various regulations including GDC 4, 17, and 18 require monitoring for those cables that are important to safety to assure that they can perform their intended safety functions. GL 2007-01 discusses all cables within the scope of 10 CFR 50.65 and does not differentiate between low voltage and medium-voltage cables or between ac and dc cables. 10 CFR 50.65(a)(1) states that "Each holder of a license to operate a nuclear plant…shall monitor the performance or condition of structures, systems, or components…in a manner sufficient to provide reasonable assurance that such structures, systems, and components are capable of fulfilling their intended functions." Additionally, NUREG–0800, Section 8.2, Review Procedure 1.L states that "Operating experience has shown that undetected degradation of underground…could result in multiple equipment failures. Underground or inaccessible power and control cable runs that are susceptible to protracted exposure to wetted environments or submergence" should be reviewed. Further, guidance on the selection of electric cable condition monitoring can be found in Sections 3 and 4.5 of NUREG/CR–7000. RG 1.160 which states that the electrical distribution equipment out of the first inter-tie with the offsite distribution system (i.e., equipment in the switchyard) should be considered for inclusion, as defined in 10 CFR 50.65(b).

As indicated previously, the staff's review of the applicant's response to GL 2007-01 for Fermi 2 did not conclude that the scope of the cable monitoring program was intended for medium-voltage cables only, particularly in consideration of the Fermi 2 operating experience with three low-voltage cable failures. In addition, the applicant's description of the Fermi 2 electrical cable monitoring program in the response to RAI 08.02-17 is also not exclusive of low-voltage cables (i.e., the staff understands that for "significant cables" the applicant intends to encompass all cables within the scope of 10 CFR 50.65). Therefore, the staff requested the applicant to describe the Fermi 3 cable monitoring program for all medium and low voltage power and control cables that will be implemented to avoid or arrest the degradation of cable insulation from the effects of moisture. The proposed cable monitoring program must include cable testing and inspections of manholes. The frequency of the testing and inspections and any corrective action to be implemented should be mentioned. The applicant should either provide the details of an appropriate condition monitoring program for detecting incipient degradation in cables based on industry standards (EPRI, Institute of Electrical and Electronic Engineers [IEEE], and nuclear entities including regulatory bodies) and recommended practices, or the applicant should justify and support the stated position in the RAI response.

In the supplemental responses to RAI 08.02-17, dated July 9, 2010 (ADAMS Accession No. ML101930518), and August 4, 2010 (ADAMS Accession No. ML102180176), the applicant stated that the underground cable monitoring program will be based on guidance from the appropriate industry operating experience, regardless of the voltage (e.g., NRC GL 2007-01, NUREG/CR–7000, and the recently released Draft Regulatory Guide DG–1240 [replaced by RG 1.218]). This program will be considered part of the 10 CFR 50.65 Maintenance Rule (MR) program, which will be implemented in accordance with FSAR Section 13.4, FSAR Table 13.4-201 which provides the milestones for implementation of the inservice inspection program (prior to commercial service) and for the inservice testing program (after the generator is online on nuclear heat). A review of detailed design and procurement information will determine the appropriate inspections, tests, and monitoring frequency to support implementation. The following description of the MR Program was added to FSAR Section 17.6.4 to address DCD COL Item 8.3.4-2-A:

> Condition monitoring of underground or inaccessible cables is incorporated into the MR program. The cable condition monitoring program incorporates lesson learned from industry operating experience (e.g., GL 2007-01, NUREG/CR-7000), address regulatory guidance, and utilizes information from detailed design and procurement documents to determine the appropriate inspections, tests, and monitoring criteria for underground and inaccessible cables within the scope of the MR (10 CFR 50.65).

The applicant's responses also included proposed revisions to COL application Part 2, Tier 2, FSAR, Table 1.10-201, FSAR Subsection 8.2.1.2.1, Section 8.3, and Section 17.6.4.

Based on the above information, the staff finds that the applicant's condition monitoring program for underground or inaccessible cables satisfies the recommendations of GL 2007-01; the guidance of NUREG/CR–7000; and the guidance of SRP Section 8.2, Review Procedure 1.L. Therefore, RAI 08.02-07 and RAI 08.02-17 are resolved. Hence, COL Item 8.3.4-2-A is resolved. The staff confirmed that the applicant has included the proposed changes in Revision 6 of the COL application.

Fermi 3 is a single-unit plant with a switchyard that is not shared with any other units. Therefore, the requirement of GDC 5 is not applicable to Fermi 3.

Based on the above information, the staff finds that the applicant has adequately addressed COL Items 8.2.4-2-A, 8.2.4-6-A, 8.2.4-7-A, and 8.2.4-8-A, which are all in conformance with the requirements of GDC 17, recommendations of GL 2007-01, guidance of NUREG/CR 7000, and SRP Section 8.2, Review Procedure 1.L.

- EF3 COL 8.2.4-5-A Protective Relaying

In Subsection 8.2.1.2.3, the applicant provided additional information to address COL Item 8.2.4-5-A as follows:

> The 345 kV transmission lines are protected with redundant high-speed communications-assisted relay schemes and include automatic breaker reclosing. The 345 kV switchyard buses have redundant differential protection using separate and independent current and control circuits. Normal and alternate preferred power conductors between the Fermi 3 [Unit Auxiliary Transformers (UATs)] and [Reserve Auxiliary Transformers (RATs)] and the 345 kV switchyard buses are protected by dual high-speed current differential schemes.
>
> The 345 kV switchyard circuit breakers are equipped with breaker failure protection and have dual trip coils. There are two independent DC supply systems, each with a 125 V battery and battery charger. Each redundant

protection scheme that supplies a trip signal is powered from its redundant DC power supply and connected to a separate trip coil.

The 345 kV switchyard for Fermi 3 does not require any transformers for Fermi 3. Therefore, Fermi 3 switchyard transformer protection is not required.

In Revision 0 of the COL FSAR, the applicant designated Subsection 8.2.1.2.2 as Supplemental Information Item EF3 SUP 8.2-1 and indicated that Subsection 8.2.2.1 addresses COL Item EF3 COL 8.2.4-5-A. Because protective relaying is discussed in Subsection 8.2.1.2.2 and not in Subsection 8.2.2.1, the staff issued RAI 08.02-12 requesting the applicant to identify the correct FSAR subsections and to make the appropriate modifications. The applicant's response to this RAI dated August 26, 2009 (ADAMS Accession No. ML092450483), stated that Detroit Edison had submitted Revision 1 of the COL application indicating that Fermi 3 COL Information Item 8.2.4-5A is addressed in Subsection 8.2.1.2.2. The staff confirmed that, in Revision 1 of the FSAR, the applicant had deleted EF3 SUP 8.2-1 in Subsection 8.2.2.1 and had revised the two subsections appropriately. On the basis of this review, the staff finds that the applicant has adequately addressed the staff's issue. Therefore, RAI 08.02-12 is resolved. [NOTE: The applicant inserted information concerning Bulletin 2012-01 into Subsection 8.2.1.2.2 in COL Revision 6 and renumbered the Subsections 8.2.1.2.2 and 8.2.1.2.3 as 8.2.1.2.3 and 8.2.1.2.4, respectively.]

EF3 COL 8.2.4-5-A describes the protective relaying associated with the Fermi 3 switchyard and the connecting power lines. The 345 kV lines are protected with redundant high-speed relay schemes, the 345 kV buses have redundant differential relay schemes and the normal and alternate preferred power conductors have redundant high-speed current differential relay schemes. These redundant relay schemes are powered from redundant 125 V batteries and battery chargers. Based upon these fully redundant protection schemes, the staff finds that COL Item 8.2.4-5-A is in conformance with the requirements of GDC 17.

- EF3 COL 8.2.4-9-A — Stability and Reliability of the Offsite Transmission Power Systems

- EF3 COL 8.2.4-10-A — Interface Requirements

The applicant provided site-specific information in Subsection 8.2.2.1 to address COL Items 8.2.4-9-A and 8.2.4-10-A. The applicant provided information to replace DCD Subsection 8.2.2.1 that, in part, states the following:

> A system impact study performed by [International Transmission Company] (ITC) analyzed load flow, transient stability, and fault analysis for the addition of Fermi 3. Stability analysis was performed on both the 2017 summer peak base model and the 2017 eighty percent model with Fermi 3 and projected network upgrades included.
>
> The ITC Transmission system was analyzed for thermal and voltage limitations for normal and post contingency conditions. The analysis examined potential constraints such as thermal equipment overloads, voltage criteria violations, breakers that exceed their rated capabilities as well as constraints related to maintaining system stability and the sudden loss of single critical generation.

Normal operating and abnormal procedures exist to maintain the switchyard voltage schedule and address challenges to the maximum and minimum limits. Upon approaching or exceeding a limit, these procedures verify the availability of required and contingency equipment and materials, direct notifications to outside agencies, and address unit Technical Specifications actions until the normal voltage schedule can be maintained. Detroit Edison will establish a Generator Interconnection and Operation Agreement with ITC Transmission and protocols for maintenance, communications, switchyard control, and system analysis sufficient to safely operate and maintain the power station interconnection to the transmission system.

ITC Transmission in conjunction with the Midwest [Independent System operator] (ISO) provides analysis capabilities for both Long Term Planning and Real Time Operations. A Real Time State Estimator is used to assist in the evaluation of actual system conditions.

The study concluded that with the additional generating capacity of Fermi 3, the transmission system remains stable under the analyzed conditions, preserving the grid connection and supporting the normal and shutdown power requirements of Fermi 3.

The reliability of the overall system design is indicated by the fact that there have been no widespread system interruptions. Failure rates of individual facilities are low. Most lightning-caused outages are momentary, with few instances of line damage.

Grid availability in the region over the past 20 years has been highly reliable with minimal outages due to equipment failures.

Grid stability is evaluated on an ongoing basis based on load growth, the addition of new transmission lines, or new generation capacity.

In accordance with Regulatory Position C.I.8.2.2 of RG 1.206, the FSAR should discuss grid availability—including frequency, duration, and causes of outages over the past 20 years—for both the transmission system accepting the unit's output and the transmission system providing the preferred power to the unit's loads. In RAI 08.02-03, the staff asked the applicant to discuss historical outages of the 345-kV transmission lines and substation and to provide failure data for the ITC Transmission network for the past 20 years. The applicant's response to this RAI dated August 26, 2009 (ADAMS Accession No. ML092450483), provides the results of a review of equipment failures related to the Milan substation that occurred between 1988 and 2008. This review, which was limited to major equipment at the 345-kV voltage level that could affect the reliability of Fermi 3, determined that such equipment had experienced relatively few outages. Regarding transmission lines, the applicant reported that the Lemoyne-Majestic Line had experienced two momentary outages and two sustained outages. The two sustained outages were caused by a breaker failure and a stray radio frequency signal, respectively. Additionally, a Majestic breaker experienced a sustained outage due to an SF6 differential operation. The applicant also states that the local transmission system experienced only one complete loss of power due to a grid disturbance on August 14, 2003. During that event, some power became available within 6.5 hours and was fully restored after 21.5 hours. The staff reviewed the applicant's response and finds it consistent with the requirements of GDC 17, the guidance of BTP 8-3, "Stability of Offsite Power Systems", and the guidance in IEEE Std 765-2006, "IEEE Standard for Preferred Power Supply (PPS) for Nuclear Power Generating Stations." Therefore, RAI 08.02-03 is resolved.

In RAI 08.02-05, the staff asked the applicant to identify how the lightning protection mentioned in FSAR Subsection 8.2.2.1 and in DCD Section 8.2.3 would be implemented for the transmission system and the switchyard. The staff also requested the applicant to indicate how the lightning protection system would be periodically maintained and tested to assure functionality and effectiveness throughout the life of Fermi 3. The applicant's response to this RAI dated August 26, 2009 (ADAMS Accession No. ML092450483), stated that the Fermi 3 lightning protection system will be designed in accordance with IEEE Std 998–1996 (reaffirmed in 2002), "IEEE Guide for Direct Lightning Stroke Shielding of Substations," using the Rolling Sphere Method provided by the transmission operator. The applicant added that periodic monitoring, maintenance, and testing of the switchyard lightning protection system will include an annual thermal scanning of the lightning surge arresters using infrared technology. There will also be a power factor testing of the same arresters on a 10-year cycle. The applicant also noted that Subsection 8.2.1.2.1 will be revised accordingly. The staff confirmed that the applicant has revised Subsection 8.2.1.2.1 to address switchyard lightning protection system.

The staff's review of Section 8.1 of the DCD observed that the DCD endorses RG 1.204, "Guidelines for Lightning Protection of Nuclear Power Plants." Additionally, Table 1.9-202, "Conformance with Regulatory Guides," of the FSAR shows that Fermi 3 conforms to the guidance of RG 1.204. Because the applicant's reply failed to indicate conformance with the guidance of RG 1.204, the staff issued RAI 08.02-15. This RAI asked the applicant to explain why the following are not applicable to Fermi 3 and to justify not using such guidance: RG 1.204 and IEEE Std 665–1995 (reaffirmed in 2001), "IEEE Guide for Generating Station Grounding"; IEEE Std 666–1991 (reaffirmed in 1996), "IEEE Design Guide for Electric Power Service Systems for Generating Stations"; IEEE Std 1050–1996, "IEEE Guide for Instrumentation and Control Equipment Grounding in Generating Stations"; and IEEE Std C62-23–1995 (reaffirmed in 2001), and "IEEE Application Guide for Surge Protection of Electric Generating Plants," endorsed by RG 1.204. The applicant's response to RAI 08.02-15, dated January 29, 2010 (ADAMS Accession No. ML100331450), clarified that IEEE Std 998 1996 (reaffirmed in 2002) deals with physical and spatial relationships of equipment, masts, and shield wires in a switchyard to minimize direct lightning strokes to the equipment and the buswork. The applicant also confirmed that as stated in COL FSAR Table 1.9-202, Fermi 3 will conform to the guidance of RG 1.204. The applicant also stated that if any conflicts arise between the guidance of IEEE Std 998–1996 (reaffirmed in 2002) and RG 1.204, the regulatory guide will take precedence. Based on the above information, the staff finds the applicant's response acceptable because the Fermi 3 offsite power lightning protection system is consistent with the guidance of RG 1.204. Therefore, RAI 08.02-5 and RAI 08.02-15 are resolved.

The staff's review of FSAR Subsection 8.2.2.1 determined that it does not identify the maximum and minimum switchyard voltage limits of the 345-kV transmission systems. In RAI 08.02-08, the staff requested the applicant to (1) provide the maximum and minimum switchyard voltage limits; (2) discuss how these limits were established; and (3) confirm that these voltage limits are acceptable for auxiliary power system equipment operation, including safety-related battery chargers and safety-related uninterruptible power supplies, during different operating conditions. The staff also requested the applicant to address assumptions; acceptance criteria; and a summary of results related to the load flow analysis (bus and load terminal voltages of the station auxiliary system), short circuit analysis, equipment sizing studies, protective relay setting and coordination, and motor starting with minimum and maximum grid voltage conditions. Additionally, the staff noted that the applicant should perform a separate set of calculations for each available connection to the offsite power supply and discuss how the results of the calculations will be verified.

The applicant's response to this RAI dated August 26, 2009 (ADAMS Accession No. ML092450483), stated that ITC Transmission typically plans for a voltage range of 97 to 105 percent of nominal voltage, and the same range will be applied to the switchyard. The applicant added that specific transformer impedance and tap settings will be determined during a detailed design of the plant's power distribution system. At that time, the system will be optimized to supply power within the required range of the plant equipment. Analyses of the as-built onsite power system will be performed to determine load requirements during design-basis operating modes and will address the required attributes. These analyses will be completed as part of the plant-specific inspections, tests, analyses, and acceptance criteria (ITAAC). This ITAAC is listed in FSAR Table 2.4.8-1. Based on the above information, the staff finds the applicant's response acceptable as it will ensure that each as-built offsite circuit has sufficient capacity and capability and that this ITAAC is consistent with the requirements of GDC 17, the guidance of RG 1.32 and BTP 8-6, IEEE Std 765-2006, and SRP Section 14.3. Therefore, RAI 08.02-08 is resolved.

Regarding existing ITC Transmission procedures related to switchyard operating voltages and network contingencies, FSAR Subsection 8.2.2.1 states that "Upon approaching or exceeding a limit, these procedures verify availability of required and contingency equipment and materials, direct notifications to outside agencies and address unit technical specifications (TS) actions until the normal voltage schedule can be maintained." Because the FSAR does not identify TS for the offsite power system, the staff issued RAI 08.02-10 requesting the applicant to clarify the reference to the TS in the FSAR subsection. The applicant's response to this RAI dated August 26, 2009 (ADAMS Accession No. ML092450483), stated that Fermi 3 will implement operating procedures to maintain the switchyard voltage schedule and address challenges to the maximum and minimum voltage limits. These procedures, however, will not reference any TS for offsite power, because that is not required of a passive reactor design. The applicant added that FSAR Subsection 8.2.2.1 will be revised to delete the reference to the TS. Since the ESBWR design does not require TS for the offsite power system, the staff finds that the applicant has adequately addressed the staff's concerns. Therefore, RAI 08.02-10 is resolved. The staff confirmed that the applicant has included the proposed changes in Revision 7 of the COL application.

FSAR Chapter 1, Table 1.9-201, "Conformance with Standard Review Plan," for SRP Section 8.2 indicates that Fermi 3 complies with the requirements of 10 CFR 50.65(a)(4) (SRP Section 8.2, Acceptance Criteria II.8). The staff's review of FSAR Chapter 8 determined that there was no discussion regarding 10 CFR 50.65. The staff issued RAI 08.02-11 requesting the applicant to clarify compliance with the requirements of 10 CFR 50.65(a)(4). The staff clarified that the subject regulation is one aspect of the "Maintenance Rule" (10 CFR 50.65), an operational program, the implementation of which is addressed in Item 17 in FSAR Table 13.4-201 and the content is discussed in FSAR Section 17.6. Additionally, the staff requested the applicant to (1) address the applicability of the MR to switchyard components; (2) identify actions to be taken to limit the risk associated with transmission system degradation; and (3) identify actions that are required before performing grid risk-sensitive maintenance activities on switchyard components, as discussed in NRC GL 2006-02, “Grid Reliability and the Impact on Plant Risk and the Operability of Offsite Power,” referenced in SRP Section 8.2.

The applicant’s response to this RAI dated August 26, 2009 (ADAMS Accession No. ML092450483), stated that the Fermi 3 offsite power system complies with the requirements of 10 CFR 50.65(a)(4) by the stated conformance to the guidance of SRP Section 8.2 in FSAR Table 1.9-201. The implementation of 10 CFR 50.65, as addressed in Item 17 of FSAR Table 13.4-201, is scheduled to occur before fuel loading authorization. The applicant adds that the MR Program implementation, discussed in FSAR Section 17.6, incorporates by reference Nuclear Energy Institute (NEI) Technical Report 07–02A, “Generic FSAR Template Guidance for Maintenance Rule Program Description for Plants Licensed under 10 CFR Part 52,” as shown in Table 1.6-201 of the Fermi 3 COL FSAR. This NEI document will be used to determine which of the offsite power system components will be included under the MR. Regarding risk assessment and risk management per 10 CFR 50.65(a)(4), the applicant stated that NEI 07-02A includes considerations associated with grid/offsite power system reliability identified in NRC GL 2006-02. Therefore, the applicant considers the performance of grid reliability evaluations as part of the maintenance risk assessment, a necessary consideration of the program, which needs to be performed before performing grid-risk-sensitive maintenance activities. Based on the above clarifications, the staff finds the applicant’s response consistent with the requirements of 10 CFR 50.65(a)(4). Therefore, RAI 08.02-11 is resolved.

In addition, based on the above review, the staff finds that COL Items 8.2.4-9-A and 8.2.4-10-A are in conformance with the requirements of GDC 17 and the guidelines of RGs 1.32, 1.206, 1.160, and 1.182, BTPs 8-3 and 8-6.

- EF3 COL 8.2-1 Bulletin 2012-01

On July 27, 2012, the NRC issued Bulletin 2012-01, “Design Vulnerability in Electric Power System,” (ADAMS Accession No. ML12074A115) to all holders of operating licenses and combined licenses for nuclear power reactors. Bulletin 2012-01 requested information about each facility’s electric power system designs, in light of the recent operating experience that involved the loss of one of the three phases of the offsite power circuit (single-phase open circuit condition) at Byron Station, Unit 2.

Therefore, the NRC staff asked the applicant in RAI 08.02-18 to describe the design scheme, the surveillance tests and the plant operating procedures concerning Fermi 3 that would address Bulletin 2012-01. In the applicant’s response to this RAI dated December 10, 2012 (ADAMS Accession No. ML12346A449), the applicant referred to the details regarding the development of operating procedures as described in the Final Safety Analysis Report (FSAR) Subsection 13.5.2.1, Operating and Maintenance Procedures, and those found in ESBWR DCD Chapter 18, Human Factors Engineering which includes human factors engineering in those procedures.

The applicant’s letter also includes a description of the ESBWR Distributed Control and Information System (DCIS) logic as a response to a single-phase open circuit condition which will continuously monitor the system, employ digital protective relays and include actions such as alarms or breaker trips. In ESBWR DCD, Revision 10 the details of this design include relays which will monitor and alarm all three phases of the normal and alternate electrical power feeds to the high-voltage side of the Unit Auxiliary Transformers (UATs) and Reserve Auxiliary

Transformers (RATs). Using the potential and current transformers of the digital protective relaying for transformer protection, these relays will be able to detect open phase conditions (1 or 2 phases) with or without accompanying ground faults. All three phases of each transformer will be monitored and if an abnormal condition is detected, the protective relay(s) will send an alarm to the main control room via the DCIS. This ESBWR design is incorporated by reference in Fermi 3's FSAR. The staff completed its review of the DCIS in the "Advanced Supplemental Safety Evaluation Report for the Economic Simplified Boiling-Water Reactor Standard Plant Design" (ADAMS Accession No. ML14043A134). Based on the design details provided for the open-phase monitoring system for detection and alarming in the MCR, the staff finds that EF3 COL 8.2-1 for offsite power system meets the requirements of GDC 17 under loss-of-phase conditions.

In a supplemental RAI response letter, dated December 13, 2013 (ADAMS Accession No. ML13351A049), the applicant provided the following commitments to develop and implement operating, maintenance and testing procedures, and conduct training of their personnel related to the operation and maintenance of the transformer open-phase monitoring system:

> Commitment (COM 8.2 -001) - Plant operating procedures, including off-normal operating procedures, associated with the monitoring system will be developed in accordance with FSAR Subsection 13.5.2.1 at least six months prior to fuel load.
>
> Commitment (COM 8.2-002) - Maintenance and testing procedures, including calibration, set point determination and troubleshooting procedures, associated with the monitoring system will be developed in accordance with FSAR Subsection 13.5.2.2.6.1 prior to fuel loading.
>
> Commitment (COM 8.2-003)] - Control room operator and maintenance technician training associated with the operation and maintenance of the monitoring system will be developed in accordance with FSAR Section 13.2.1 for Reactor Operators and FSAR Section 13.2.2 for Non Licensed Plant Staff. Training will be completed prior to fuel loading.

Additionally, Revision 10 of ESBWR DCD contains an ITAAC to provide the analysis to assure proper set points and testing to demonstrate functionality concerning Bulletin 2012-01 which is incorporated by reference in Fermi 3's FSAR Section 14.3.

Based on the information provided above, the staff finds that the Fermi 3 resolution concerning the loss of phase issue is acceptable and is in compliance with the requirements of GDC 17.

- EF3 SUP 8.2-2 Testing and Inspection

In FSAR Subsection 8.2.1.2.3, the applicant provided the following supplemental information relating to testing and inspecting the offsite power system and components:

> Transmission lines are periodically inspected via an aerial inspection program in accordance with the ITC Transmission inspection plan. The inspection focuses on such items as right-of-way encroachment, vegetation management, conductor and line hardware condition, and the condition of supporting structures.
>
> Routine switchyard inspection activities include, but are not necessarily limited to the following:

- Periodic inspection of circuit breakers
- Semi-annual infrared scan of substation equipment
- Semi-annual inspection of substation equipment
- Periodic relay inspections

Routine switchyard testing activities include, but are not necessarily limited to, the following:

- 5-year relay calibration
- 10-year ground grid testing
- Semi-annual battery/charger inspection w/annual preventative maintenance

The staff's review of Subsection 8.2.1.2.3 noted that the applicant provided a partial list of routine inspections and test activities that will be performed on switchyard equipment and components. In RAI 08.02-06, the staff requested the applicant to describe the periodic surveillance and maintenance tests that will be performed on the batteries and battery chargers located in the 345-kV switchyard and the criteria for battery replacement. Additionally, the staff requested the applicant to describe the periodic surveillance and maintenance tests that will be performed on the circuit breakers, potential transformers, lightning arrestors, capacitive coupling voltage transformers, current transformers, protective relays, microwave channels, communication equipment, annunciator panels, security equipment, switchyard grounding system, and surge arrestors in the 345-kV switchyard.

The applicant's response to this RAI dated August 26, 2009 (ADAMS Accession No. ML092450483), provided a more comprehensive listing of switchyard equipment and components that will be subjected to routine inspections and tests and the frequency that each component will undergo such testing. Regarding the batteries, the applicant stated that the transmission operator has no established criteria for the replacement of switchyard batteries, but that the need for battery replacement will be evaluated by considering the age and the condition of the equipment based upon the inspection and test results. The applicant also agreed to revise the FSAR subsection accordingly.

The staff reviewed the applicant's response and observed that the applicant's list did not include lightning and surge arresters. The staff then issued RAI 08.02-16 requesting the applicant to address the omitted items. The applicant's response to RAI 08.02-16, dated January 29, 2010 (ADAMS Accession No. ML100331450), clarified that the lightning protection system and its periodic monitoring, maintenance, and testing have already been described in the applicant's response to NRC RAI 08.02-5. Specifically, the applicant emphasized that lightning surge arresters are thermally scanned annually using infrared technology, and power factor tested during bus inspections and/or relay control scheme testing is on a 10-year cycle. The applicant added that FSAR Subsection 8.2.1.2.3 will be revised to include a description of the routine testing and maintenance for the lightning surge arresters. Based on the above clarifications, the staff finds the applicant's response acceptable because the periodic monitoring, maintenance, and testing of switchyard equipment important to safety conforms to the requirements of GDC 18 and the guidance of RG. 1.118. Therefore, RAI 08.02-6 and RAI 08.02-16 are resolved. The staff confirmed that the applicant's proposed changes are included in Revision 3 of the COL application. [NOTE: The applicant inserted information concerning Bulletin 2012-01 into Subsection 8.2.1.2.2 in COL Revision 6 and renumbered the Subsections 8.2.1.2.2 and 8.2.1.2.3 as 8.2.1.2.3 and 8.2.1.2.4, respectively.]

In RAI 08.02-9, the staff requested the applicant to discuss the industry standards that will be followed (i.e., the Federal Energy Regulatory Commission [FERC], National Electric Reliability Council [NERC], and IEEE) for monitoring, testing, and maintaining the switchyard protection system. The applicant's response to this RAI dated August 26, 2009 (ADAMS Accession No. ML092450483), stated that the transmission operator will monitor, test, and maintain the switchyard protection system under NERC Standard PRC-005-1, "Transmission and Generation Protection System Maintenance and Testing." The applicant added that the FSAR subsection will be revised to include a discussion of the industry standards used to monitor, test, and maintain the switchyard protection system. Based the above clarifications, the staff finds that the applicant's commitment to the NERC standards provides reasonable assurance that the switchyard components will be adequately tested and maintained. Therefore, RAI 08.02-9 is resolved. The staff confirmed that the applicant has included the proposed change in Revision 7 of the COL application.

Based on the above review, the staff finds that Supplemental Information Item EF3 SUP 8.2-2 is in conformance with the requirements of GDC 18 and the guidelines of RG 1.118.

- EF3 SUP 8.2-3 Failure Modes and Effect Analysis

In FSAR Subsection 8.2.2.3, the applicant addresses failure modes of the offsite power system and provides the supplemental information described below. In particular, in Subsection 8.2.2.3.1, "Introduction," the applicant states the following conclusion:

> There are no single failures that can prevent the Fermi offsite power system from performing its function to provide power to Fermi 3.

Additionally, in Subsection 8.2.2.3.2, "Transmission System Evaluation," the applicant states:

> Fermi 3 is connected to the ITC Transmission system via three 345 kV overhead transmission lines. Each 345 kV transmission line occupies a common right-of-way and traverses from the Fermi site within an anticipated 91 m (300 ft) right-of- way. The 345 kV towers and poles provide clearances consistent with applicable regulatory standards. The towers and poles are grounded to achieve 15 ohms or less per structure. Failure of any one 345 kV tower or pole due to structural failure can at most disrupt and cause a loss of power distribution to itself and the adjacent line, if one is present.
>
> Failure of a line conductor would cause the loss of one of the three 345 kV lines, with the other two lines remaining available as normal and alternate preferred power sources.

Regarding switchyard components, FSAR Subsection 8.2.2.3.3, "Switchyard Evaluation," states the following:

> The equipment in this switchyard is rated and positioned within the bus configuration according to the following criteria:
>
> - Equipment continuous current ratings are such that no single contingency in the switchyard results in current

exceeding100 percent of the continuous current rating of the equipment.

- Interrupting duties are such that no faults occurring on the system exceed the equipment rating.

- Momentary ratings are such that no faults occurring on the system exceed the equipment momentary rating.

- Voltage ratings for the equipment are specified to be greater than the maximum expected operating voltage.

The breaker-and-a-half switchyard arrangement offers the following flexibility to control a failed condition within the switchyard:

- Any faulted transmission line can be isolated without affecting any other transmission line.

- Either bus can be isolated without interruption of any transmission line or other bus.

- Relay schemes include primary and backup protection features. All breakers are equipped with dual trip coils. Each protection circuit that supplies a trip signal is connected to a separate trip coil.

The normal preferred and alternate preferred power supplies are electrically independent and physically separate from each other, as indicated in DCD Section 8.2.3. This power source independence and physical separation along with the isolation flexibility described above to control failed conditions ensures that a minimum of one preferred source of power remains available to supply the load during all plant conditions.

ESBWR DCD Revision 5, Section 8.2.3 states that separate transmission systems feed the normal and the alternate preferred circuits, and each system is capable of supplying the shutdown loads. The staff also noted that although FSAR Subsection 8.2.2.3.3 implies compliance with the DCD, the subsection makes no mention of how the design meets the DCD requirement for separate transmission systems. In particular, the staff noted that both the normal and alternate preferred circuits at Fermi 3 have the same termination points (the site switchyard at one end and the Milan substation at the other) and are in the same transmission corridor for 29.4 miles. Therefore, the staff issued RAI 08.02-02 requesting the applicant to identify how the Fermi 3 design complies with the DCD requirement for separate transmission systems, if there is no diversity in the transmission systems between the normal and the alternate preferred circuits from and to the termination points. The applicant's response to this RAI dated August 26, 2009 (ADAMS Accession No. ML092450483), acknowledges that an inconsistency exists between the design bases in Subsection 8.1.5.1 and Section 8.2.3 of DCD Revision 5. Specifically, Subsection 8.1.5.1 (DCD Revision 5) states, "Electric power from the utility grid to the offsite power system is provided by transmission lines designed and located to minimize the likelihood of failure while ensuring grid reliability. The transmission system serves the main offsite power circuit (Normal Preferred Power), and the reserve offsite power circuit (Alternate Preferred Power) through the site switchyard(s)." This description of a single transmission system serving the normal and the alternate preferred power supply circuits conflicts with the statement in DCD Section 8.2.3, which describes more than one transmission system. The applicant adds that the ESBWR vendor has corrected DCD Revision 6 to make the language in DCD Section 8.2.3 consistent with that in DCD Subsection 8.1.5.1. The staff finds that this change is acceptable because GDC 17 does not require the normal and alternate preferred power be provided from separate transmission systems. The staff verified that the ESBWR vendor has modified Section 8.2.3 in DCD Revision 6 by replacing separate transmission systems with separate transmission lines. The staff found that the applicant has addressed the issue adequately, and therefore, RAI 08.02-02 is resolved.

Based on the above, the staff finds that the applicant's information adequately addresses Supplemental Information Item EF3 SUP 8.2-3. Furthermore, the staff finds that no offsite power contingencies, including a breaker not operating during a fault on an offsite line, fault on a switchyard bus, a spurious relay trip, or a loss of control power, would result in a loss of normal and alternate preferred sources. Also, the staff finds that the supplemental information item is in conformance with the guidelines of RG 1.206.

8.2.5 Post Combined License Activities

An ITAAC related to the Offsite-Power System is found in FSAR Table 2.4.8-1.

The following are commitments made by the applicant for operation and maintenance of the transformer open phase monitoring system:

[COM 8.2-001] Plant operating procedures, including off-normal operating procedures, associated with the monitoring system will be developed in accordance with FSAR Subsection 13.5.2.1 at least six months prior to fuel load.

[COM 8.2-002] Maintenance and testing procedures, including calibration, set point determination and troubleshooting procedures, associated with the monitoring system will be developed in accordance with FSAR Subsection 13.5.2.2.6.1 prior to fuel loading.

[COM 8.2-003] Control room operator and maintenance technician training associated with the operation and maintenance of the monitoring system will be developed in accordance with FSAR Section 13.2.1 for Reactor Operators and FSAR Section 13.2.2 for Non Licensed Plant Staff. Training will be completed prior to fuel loading.

8.2.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The staff's review finds that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the Fermi 3 COL application are documented in NUREG-1966, and NUREG-1966, Supplement 1.

In addition, the staff compared the additional information relating to the COL and supplemental information items in the application to the relevant NRC regulations, the guidance in Section 8.2 of NUREG–0800, and other NRC RGs. The staff's review finds that the applicant has adequately addressed the COL items, and the applicant's site-specific supplemental information adequately addresses the NRC regulations: GDCs 17 and 18; Bulletin 2012-01, and the guidance in RGs 1.32, 1.118, 1.182, 1.160, 1.204, 1.206, NUREG/CR 7000; and recommendations of GL 2007-01.

8.3 Onsite Power Systems

8.3.1 AC Power System

8.3.1.1 *Introduction*

This section of the COL FSAR provides descriptive information, analyses, and referenced documents that include the applicant's information on electrical single-line diagrams, electrical schematics, logic diagrams, tables, and physical arrangement drawings for the onsite ac power system. The onsite ac power system includes those standby power sources, distribution systems, and auxiliary support systems provided to supply power to safety-related equipment or equipment important to safety, for all normal operating and accident conditions.

In the ESBWR passive reactor design used at Fermi 3, the onsite ac power system is a non-Class 1E system that provides reliable ac power to the various electrical loads in the system. The system does not perform any safety-related functions. These loads enhance an orderly shutdown under emergency (not accident) conditions. Additional loads for investment protection can be manually loaded on the standby power supplies. Diesel generator sets are used as the standby power source for the onsite ac power systems. Those portions of the onsite ac power systems that are not related to safety are described only in sufficient detail to permit an understanding of their interactions with the safety-related portions.

The plant's uninterruptible power supply (UPS) system (120 V of ac vital power) comprises independent Class 1E and non-Class 1E UPS systems. Each system consists of rectifiers, inverters, ungrounded batteries, and distribution panels. The Class 1E UPS system provides reliable power for the safety-related equipment required for the plant instrumentation, control, monitoring, and other vital functions needed to shut down the plant. In addition, the Class 1E UPS system provides power to the emergency lighting in the main control room and the remote shutdown area.

8.3.1.2 *Summary of Application*

Section 8.3.1 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 8.3.1 and Appendix 8A of the certified ESBWR DCD, Revision 10.

In addition, in FSAR Appendix 8A and Subsection 8.3.3.2, the applicant provides the following:

COL Items

- EF3 COL 8A.2.3-1-A Cathodic Protection System

The applicant provides additional information regarding a cathodic protection system in FSAR Appendix 8A.

- EF3 COL 8.3.4-2A Identification and Monitoring of Underground or Inaccessible Power and Control Cables to the PSWS and DG Fuel Oil Transfer System

Equipment That Have Accident Mitigation Functions

The applicant provides additional information regarding cable monitoring program in Subsection 8.3.3.2.

8.3.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1966, the FSER related to the ESBWR DCD. In addition, the relevant requirements of the Commission regulations for the ac power system, and the associated acceptance criteria, are in Section 8.3.1 of NUREG–0800. The review of COL Item 8A.2.3-1-A is subject to the guidance of the National Association of Corrosion Engineers (NACE) standards. COL Item 8.3.4-2-A is subject to recommendations of GL 2007-01 and guidance of NUREG/CR 7000 (2010) and SRP Section 8.2, Review Procedure 1.L.

8.3.1.4 *Technical Evaluation*

As documented in NUREG–1966, NRC staff reviewed and approved Section 8.3.1 and Appendix 8A of the certified ESBWR DCD. The staff reviewed the conformance of Section 8.3.1 and Appendix 8A of the Fermi 3 COL FSAR, Revision 7, and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information related to onsite ac power systems.

The staff reviewed the following information in the COL FSAR:

<u>*COL Item*</u>

- EF3 COL 8A.2.3-1-A — Cathodic Protection System

The applicant provides additional information in Section 8A.2.1 to address COL Item 8A.2.3-1-A. In this section, the applicant replaces DCD Section 8A.2.1, "Description," with the following:

> A cathodic protection system is provided to the extent required. The system is designed in accordance with the requirements of the National Association of Corrosion Engineers (NACE) Standards (DCD Reference 8A-5).

The staff reviewed the supplemental information, related to cathodic protection, provided in Section 8A.2.1 of the EF3 FSAR and found it acceptable because it conforms to the industry standard guidance.

- EF3 COL 8.3.4-2-A — Identification and Monitoring of Underground or Inaccessible Power and Control Cables to the PSWS and DG Fuel Oil Transfer System

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Equipment That Have Accident Mitigation Functions

The applicant provides additional information in Subsection 8.3.3.2 to address COL Item 8.3.4-2-A. The applicant replaces last sentence in the last paragraph of DCD, Revision 10, Subsection 8.3.3.2 with the following:

This COL item is evaluated in Section 8.2.4.

- Commitment (COM-8.3-001)-The COL Applicant will verify that owner yard scope site specific underground or inaccessible power and control cable runs to the PSWS and DG Fuel Oil Transfer System that have accident mitigation functions and are susceptible to protracted exposure to wetted environments or submergence as a result of tidal, seasonal, or weather event water intrusion are adequately identified and monitored for appropriate corrective actions under MR program described in Section 17.6.4.

The milestones for implementation of the above commitment are provided in FSAR Table 13.4-201.

8.3.1.5 *Post Combined License Activities*

The applicant identifies the following commitment:

- Commitment (COM-8.3-001)-The COL Applicant will verify that owner yard scope site specific underground or inaccessible power and control cable runs to the PSWS and DG Fuel Oil Transfer System that have accident mitigation functions and are susceptible to protracted exposure to wetted environments or submergence as a result of tidal, seasonal, or weather event water intrusion are adequately identified and monitored for appropriate corrective actions under MR program described in Section 17.6.4.

The milestones for implementation of the above commitment are provided in FSAR Table 13.4-201.

8.3.1.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff's review finds that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the onsite ac power system that were incorporated by reference have been resolved.

The staff compared the information in the application to the relevant NRC regulations, the guidance in Section 8.3.1 of NUREG–0800, and industry standards. The staff's review finds that the applicant has adequately addressed the COL items regarding the Fermi 3 cathodic protection system and cable monitoring program. Therefore, the applicant has satisfied the guidance of NACE standards and NUREG/CR 7000 and recommendations of GL 2007-01.

8.3.2 DC Power Systems

8.3.2.1 *Introduction*

This section of the COL FSAR provides descriptive information, analyses, and referenced documents that include the applicant's information on electrical single-line diagrams, electrical schematics, logic diagrams, tables, and physical arrangement drawings for the onsite DC power systems. The onsite DC power systems include those power sources and their distribution systems that supply motive or control power to safety-related equipment. The nonsafety-related portions are described only in sufficient detail to permit an understanding of their interactions with the safety-related portions. This section clearly identifies the safety loads and states the length of time they would be operable in the event of a loss of ac power.

The plant's DC power system is comprised of independent Class 1E and non-Class 1E DC power systems. Each system consists of ungrounded stationary batteries, DC distribution equipment, and the UPS.

The Class 1E DC and UPS system in the ESBWR passive reactor design plant is capable of providing reliable power for the safe shutdown of the plant without the support of battery chargers, during a loss of all ac power sources coincident with a design-basis accident for 72 hours. The system is designed so that no single failure will result in a condition that will prevent the safe shut down of the plant.

The non-Class 1E DC and UPS system in the ESBWR passive reactor design plant provides continuous and reliable electric power to the plant's non-Class 1E control and instrumentation loads and equipment, which are required for plant operation and investment protection and for the hydrogen igniters located inside containment. Operation of the non-Class 1E DC and UPS system is not required for nuclear safety.

8.3.2.2 *Summary of Application*

Section 8.3.2 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 8.3.2 of the certified ESBWR DCD, Revision 10.

In addition, in FSAR Section 8.3.2, the applicant provides the following:

COL Item

- EF3 COL 8.3.4-1-A — Safety-Related Battery Float and Equalizing Voltage Values

In FSAR Section 8.3.2.1.1, "Safety-Related Station Batteries and Battery Chargers," the applicant provides information on safety-related battery float and equalizing voltage values. Additionally, the applicant modifies DCD Table 8.3-4 item b.

Supplemental Information

- EF3 SUP 8.3-2 — Safety-Related Station Batteries and Battery Chargers Station Blackout

In FSAR Section 8.3.2.1.1, the applicant provides supplemental information on the training and procedures to mitigate an SBO, with references to FSAR Sections 13.2 and 13.5.

8.3.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1966, the FSER related to the ESBWR DCD.

COL Item EF3 COL 8.3.4-1-A is subject to the requirements of GDC 17. In addition, the regulatory bases for acceptance of the supplemental information are established in 10 CFR 50.63, "Loss of All Alternating Current Power"; the guidelines of RG 1.155 (1988), "Station Blackout"; and Nuclear Management and Resource Council (NUMARC) 87–00 (issued in November 1987), "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors."

8.3.2.4 *Technical Evaluation*

As documented in NUREG–1966, NRC staff reviewed and approved Section 8.3.2 of the certified ESBWR DCD. The staff reviewed Section 8.3.2 of the Fermi 3 COL FSAR and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information related to the DC power system.

The staff reviewed the following information in the COL FSAR:

<u>*COL Item*</u>

- EF3 COL 8.3.4-1-A — Safety-Related Battery Float and Equalizing Voltage Values

The applicant provides additional information to address COL Item 8.3.4-1-A. The applicant replaces the fourth paragraph of DCD Subsection 8.3.2.1.1 with the following:

> In Divisions 1, 2, 3, and 4, the two 250 volt safety-related batteries per division are sized together so that their total rated capacity will exceed the required battery capacity per division for 72-hour SBO conditions. The DC system minimum battery terminal voltage at the end of the discharge period is 210 VDC (1.75 volts per cell). The maximum equalizing charge voltage for safety-related batteries is specified by the battery vendor and is as allowed by the voltage rating of the connected loads (UPS inverters). The UPS inverters are designed to supply 120 VAC power with DC input less than the minimum discharge voltage (210 VDC) and greater than the maximum equalizing charge voltage. The safety-related battery float voltage and maximum equalizing charge voltage values are included in Table 8.3-4R.

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Additionally, the applicant modifies DCD Table 8.3-4 item b to include float and maximum equalizing charge voltage as follows:

- float voltage at 77°F- 267.6 VDC at the battery terminals
- maximum equalizing charge voltage at 77°F-288 VDC at the battery terminals.

The staff found that optimum long-term battery performance is obtained by maintaining a float voltage within established design limits of 2.22 volts per cell to 2.24 volts per cell provided by the battery manufacturer, which corresponds to nominally 2.23 volts per cell or 267.6 VDC at 77°F. This provides adequate over-potential, which limits the formation of lead sulfate and self discharge. Therefore, float voltage of 267.6 VDC at 77°F is acceptable. Additionally, the maximum equalizing charge voltage of 288 VDC at the better terminals is acceptable because the UPS inverters (only connected load on DC bus) are designed to function properly with DC input less than the minimum discharge voltage (210 VDC) and greater than the maximum equalizing charge voltage (288 VDC).

The staff found that the applicant adequately resolved COL Item 8.3.4-1-A and float and maximum equalizing charge voltage values were consistent with battery vendor's recommendation and in conformance with the requirements of GDC 17.

Supplemental Information

- EF3 SUP 8.3-2 Safety-Related Station Batteries and Battery Chargers Station Blackout

The applicant provides the following supplemental information at the end of FSAR Subsection 8.3.2.1.1 addressing the training and procedures to mitigate an SBO event:

> Training and procedures to mitigate an SBO event are implemented in accordance with Section 13.2 and 13.5 respectively. The ESBWR is a passive design and does not rely on offsite or onsite AC sources of power for at least 72 hours after an SBO event, as described in DCD Section 15.5.5, SBO. In addition, there are no nearby large power sources, such as a gas turbine or black start fossil fuel plant, that can directly connect to the station to mitigate the SBO event. Restoration from an SBO event will be contingent upon power being made available from any one of the following sources:
>
> - Any of the standby or ancillary diesel generators
> - Restoration of any one of the three 345 kV transmission lines described in Section 8.2.

According to NUMARC 87–00, Revision 0, endorsed in RG 1.155 and referenced in SRP Section 8.4, the SBO response procedures include (1) Station Blackout Response Guidelines, (2) AC Power Restoration, and (3) Severe Weather Guidelines. In RAI 08.03.02-01, the staff asked the applicant to confirm that the training and procedures described in Subsection 8.3.2.1.1 include those three topics. The applicant's response to this RAI dated March 25, 2009 (ADAMS Accession No. ML091060495), states that the training and procedures addressed in Subsection 8.3.2.1.1 will include the three topics listed in the RAI. COL FSAR Sections 13.2 and 13.5 discuss training licensed and non-licensed plant personnel and plant procedures, respectively. However, these discussions do not specifically address SBO events. The applicant adds that, in general, training is described in the FSAR in sufficient detail to assure that plant workers receive adequate training for responding to all plant events, both normal and abnormal, and the training will encompass an SBO event. Additionally, the applicant will revise the FSAR to indicate that the procedures will include (1) Station Blackout Response Guidelines, (2) ac Power Restoration, and (3) Severe Weather Guidelines, as recommended by NUMARC 87–00. Based on the above clarifications, the staff found that the applicant's response adequately addresses the staff's concerns, and therefore, RAI 08.03.02-01 is resolved. The staff confirmed that the applicant's proposed changes are included in Revision 3 of the COL application.

Based on the above review, the staff found that the applicant has adequately addressed Supplemental Information Item EF3 SUP 8.3-2. The staff found that the supplemental information item is in conformance with the requirements of 10 CFR 50.63 and the guidelines of RG 1.155 and NUMARC 87–00.

8.3.2.5 *Post Combined License Activities*

There are no post COL activities related to this section.

8.3.2.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. NRC staff reviewed the application and checked the referenced DCD. The staff's review finds that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the onsite DC power system that were incorporated by reference have been resolved.

In addition, the staff compared the additional information relating to the COL and supplemental information items in the application to the relevant NRC regulations, the guidance in Section 8.3.2 of NUREG–0800, and other NRC RGs. The staff finds that the applicant has adequately addressed the Fermi 3 the COL item regarding safety-related battery float and equalizing voltage values and supplemental information pertaining to training and procedures to mitigate an SBO event. Therefore, the applicant has satisfied the requirements of GDC 17 and 10 CFR 50.63 for this section.

8.4 <u>Station Blackout</u>

The Fermi 3 COL FSAR does not include Section 8.4. The SBO safety analysis is in ESBWR DCD Section 15.5.5. In COL FSAR Section 15.5.5, "Station Blackout," the applicant incorporates by reference Section 15.5.5 of the certified ESBWR DCD, Revision 10, with no departures or supplements.

9.0 AUXILIARY SYSTEMS

9.1 Fuel Storage and Handling

9.1.1 New Fuel Storage

As documented in NUREG-1966, “Final Safety Evaluation Report related to the Certification of the Economic Simplified Boiling-Water Reactor (ESBWR) Standard Design,” (Agencywide Documents Access and Management Systems (ADAMS) Accession No. ML14100A304), and NUREG-1966, Supplement 1 (ADAMS No. ML14265A084), the U.S. Nuclear Regulatory Commission (NRC) staff reviewed and approved Subsection 9.1.1 of the ESBWR Design Control Document (DCD). The staff reviewed Subsection 9.1.1 “New Fuel Storage” of the Fermi 3 Combined License (COL) Final Safety Analysis Report (FSAR), Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the DCD represents the complete scope of information relating to this review topic.[1]

Subsection 9.1.1.7 of the ESBWR DCD, indicates that the applicant is to address DCD COL Item 9.1-4-A. The COL applicant has removed the two references to COL 9.1-4-A in DCD Subsection 9.1.1.7 and has addressed them as STD COL 9.1-4-A in Subsection 9.1.4. The staff’s review of this STD COL item is discussed in Subsection 9.1.4 of this safety evaluation report (SER). The staff’s review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this subsection. Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 52.63(a)(5) and 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” Appendix E, Section VI.B.1, all nuclear safety issues relating to new fuel storage that were incorporated by reference are resolved.

9.1.2 Spent Fuel Storage

Subsection 9.1.2 of the Fermi 3 COL FSAR incorporates by reference Section 9.1.2, “Spent Fuel Storage,” of the certified ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff’s review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this subsection. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the spent fuel storage that were incorporated by reference are resolved.

9.1.3 Spent Fuel Cooling and Cleanup System

Section 9.1.3 of the Fermi 3 COL FSAR incorporates by reference Section 9.1.3, “Spent Fuel Cooling and Cleanup System,” of the certified ESBWR DCD, Revision 10,referenced in 10 CFR Part 52, Appendix E, with no departures or supplements,. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff’s review confirms that there is no outstanding information is expected to be addressed in the COL FSAR related to this subsection. Pursuant to 10 CFR

[1] See *“Finality of Referenced NRC Approvals”* in SER Section 1.2.2 for a discussion on the staff’s review related to verification of the scope of information to be included in a COL application that references a design certification.

52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the spent fuel cooling and cleanup system that were incorporated by reference are resolved.

9.1.4 Light Load Handling System (Related to Refueling)

9.1.4.1 *Introduction*

This FSAR section addresses the light load handling system that is used to handle the spent fuel assemblies underwater from the time they leave the reactor vessel until they are placed in a container for shipment from the site. Characteristics of the system are designed to avoid criticality accidents, radioactivity releases resulting from damage to irradiated fuel, and unacceptable personnel radiation exposure.

9.1.4.2 *Summary of Application*

Subsection 9.1.4 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Subsection 9.1.4 of the certified ESBWR DCD, Revision 10. In addition, in Fermi 3 COLA FSAR, Subsection 9.1.4, the applicant provides the following:

<u>*COL Item*</u>

- STD COL 9.1-4-A Fuel Handling Operations

The applicant provided additional information in STD COL 9.1-4-A to address DCD COL Item 9.1-4-A. The applicant described the scope of the fuel handling procedures and procedures for equipment used to move the fuel. The applicant states that these procedures will be developed 6 months before fuel receipt. The applicant states that the fuel handling equipment is inspected for operating conditions before each refueling and that a quality assurance (QA) program is applied to monitoring, implementing, and assuring compliance with fuel handling procedures. The QA program is described in Section 17.5 of the COL FSAR.

9.1.4.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966, the Final Safety Evaluation Report (FSER) related to the certified ESBWR DCD. In addition, the relevant requirements of the Commission regulations for the light load handling system (related to refueling) and the associated acceptance criteria are in Section 9.1.4 of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” the Standard Review Plan (SRP).

The applicable regulatory requirements and associated guidance for fuel handling operations are as follows:

- General Design Criterion (GDC) 61, “Fuel storage and handling and radioactivity control,” of Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities” as it relates to radioactive releases resulting from fuel damage and the avoidance of excessive personnel radiation exposure.

- GDC 62, “Prevention of criticality in fuel storage and handling,” as it relates to prevention of criticality accidents

- Regulatory Guide (RG) 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition),” June 2007, as relates to the applicant’s cited commitment (COM) in this subsection

9.1.4.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.1.4 of the certified ESBWR DCD. The staff reviewed Subsection 9.1.4 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD the represents the complete scope of information relating to this review topic. [1] The staff’s review confirms that the information in the application and the information incorporated by reference address the required information related to the Light Load Handling System (Related to Refueling).

The staff’s review of the information contained in the Fermi 3 COL FSAR is as follows:

<u>*COL Item*</u>

- STD COL 9.1-4-A Fuel Handling Operations

The NRC staff reviewed STD COL 9.1-4-A related to the fuel handling operations included under Section 9.1.4 of the Fermi 3 COL FSAR. DCD COL Item 9.1-4-A in Section 9.1.6, “COL Information,” of the ESBWR DCD, Revision 10, states that the applicant will provide a description of programs that address the following:

  - Criticality safety of fuel handling operations
  - Fuel handling procedures
  - Maintenance manuals and procedures for equipment used to move fuel
  - Equipment inspection and test plans for equipment used to move fuel
  - Personnel qualifications, training, and control programs for fuel handling personnel
  - [Quality Assurance] QA programs to monitor, implement, and assure compliance to fuel handling operations

[1] See *“Finality of Referenced NRC Approvals”* in SER Section 1.2.2 for a discussion on the staff’s review related to verification of the scope of information to be included in a COL application that references a design certification.

In FSAR Subsections 9.1.4.13, “Refueling Operations,” 9.1.4.18, “Safety Evaluation of Fuel Handling Systems,” and 9.1.4.19, “Inspection and Testing Requirements,” the applicant addressed DCD COL Item 9.1-4-A in STD COL 9.1-4-A. The applicant added a paragraph to the end of FSAR Subsection 9.1.4.13 indicating that FSAR Section 13.5 requires the development of fuel handling procedures. The applicant stated that the procedures will provide “instruction for use of refueling equipment, actions for core alteration, monitoring core criticality status, and accountability of fuel and refueling operations. The applicant also identified key elements to be included in the fuel handling procedures that will be developed. The applicant stated that fuel handling procedures will address, “the status of plant system required for refueling; inspection of replacement fuel and fuel rods; designation of proper tools; proper conditions for spent fuel movement and storage; proper conditions to prevent inadvertent criticality; proper conditions for fuel cask loading and movement; and status of interlocks, reactor trip circuits and mode switches. In FSAR Subsection 9.1.4.13, the applicant also stated that qualifications and training for fuel handlers are addressed in FSAR Section 13.2, “Training.”

In FSAR Subsection 9.1.4.18, the applicant indicates that fuel handling procedures provided to prevent inadvertent criticality was discussed in Subsection 9.1.4.13 of the FSAR. Also in response to DCD COL Item 9.1-4-A, the applicant revised Subsection 9.1.4.19 of the FSAR to identify that the QA program described in FSAR Section 17.5, “Quality Assurance Program Description-Design Certification, Early Site Permits, and New License Applicants,” will monitor, implement and assure compliance with fuel handling procedures.

The program described by the applicant in FSAR Subsections 9.1.4.13, 9.1.4.18, and 9.1.4.19 provide procedures for fuel handling and for inspection and testing of fuel handling equipment in adequate time to support training and qualification of fuel handling personnel. These procedures will be completed 6 months prior to fuel load (COM 9.1-001). Qualifications, training, and control programs for fuel handling personnel are addressed in FSAR Section 13.2, “Training,” which refers to Appendix 13BB, “Training Program,” which incorporates by reference Nuclear Energy Institute (NEI) 06-13A, “Template for an Industry Training Program Description.” On December 5, 2008, the NRC endorsed NEI 06-13A, “Template for an Industry Training Program Description,” Revision 1, as an acceptable template for describing reactor operator (RO) and non-licensed plant staff training programs for COL applications (ADAMS Accession No. ML082950140). The staff finds that the applicant has adequately addressed the development of fuel handling procedures and the training and qualification of fuel handlers. In addition the staff finds that the fuel handling procedures will conform with the requirements of GDC 61 and 62 as they relate to the prevention of radioactivity release as a result of fuel damage, avoidance of excessive personnel radiation exposure, and prevention of criticality accidents.

The applicant has identified Commitment COM 9.1-001 to track the development of fuel handling procedures in order to address COL STD COL 9.1-4-A in accordance with the guidance in RG 1.206, Regulatory Position Part C.III.4.3(4). The staff evaluated COL Item STD COL 9.1-4-A using the relevant NRC regulations and acceptance criteria in Section 9.1.4 of NUREG-0800, along with GDC 61 and 62 and the guidance in RG 1.206. The staff finds that the applicant has satisfactorily addressed this COL Item.

9.1.4.5 *Post Combined License Activities*

The applicant has proposed the following commitment to address COL Item 9.1-4-A:

- Commitment (COM 9.1-001) – Fuel handling procedures are developed six months before fuel receipt to allow sufficient time for plant staff familiarization, to allow NRC staff adequate time to review procedures, and to develop operator licensing examinations.

9.1.4.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the light load handling system (related to refueling), and no outstanding information is expected to be addressed in the COL FSAR related to this subsection. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the light load handling system (related to refueling) that were incorporated by reference are resolved.

In addition, the staff compared the additional information in the application to the relevant NRC regulations, the guidance in Section 9.1.4 of NUREG–0800, and other NRC regulatory guides. The staff's review concludes that the applicant's information is acceptable and meets the requirements of GDC 61 and 62 and the guidance in RG 1.206. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.1-4-A.

9.1.5 Overhead Heavy Load Handling System

9.1.5.1 *Introduction*

This FSAR section addresses the overhead heavy load handling systems that are used to lift loads whose weight is greater than the combined weight of a single spent fuel assembly and its handling device. The principal equipment is the fuel building (FB) crane and reactor building (RB) crane. The overhead heavy load handling system is designed to ensure that inadvertent operations or equipment malfunctions, separately or in combination, will not cause a release of radioactivity, a criticality accident, or an inability to cool fuel within the reactor vessel or spent fuel pool (SFP), and will not prevent safe shutdown of the reactor.

9.1.5.2 *Summary of Application*

Subsection 9.1.5 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Subsection 9.1.5 of the certified ESBWR DCD, Revision 10. In addition, in Fermi 3 COLA FSAR, Subsection 9.1.5, the applicant provides the following:

<u>*COL Items*</u>

- STD COL 9.1-5-A Handling of Heavy Loads

The applicant provided additional information in STD COL 9.1-5-A to address DCD COL Item 9.1-5-A. The applicant described the scope of the heavy load handling procedures. The applicant stated that they will be developed prior to fuel load. The applicant stated that the fuel handling equipment is inspected for operating conditions before each refueling. The applicant described the criteria for inspection of special lifting devices and the inspection and testing of cranes. The applicant described the training and qualification standard for crane operators and the application of specific QA program controls for heavy load handling. The QA program is described in Section 17.5 of the COL FSAR.

9.1.5.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the relevant requirements of the Commission regulations for the overhead heavy load handling system and the associated acceptance criteria are in Section 9.1.5 of NUREG-0800.

The regulatory basis for acceptance of the COL information items is established in:

- GDC 1, “Quality Standards and Records,” of 10 CFR Part 50, as it relates to design, fabrication, and testing of structures systems and components (SSCs) important to maintain quality standards

- GDC 4, “Environmental and dynamic effects design bases” of 10 CFR Part 50, as it relates to the protection of fuel and safety-related equipment from the effects of internally generated missiles (i.e. dropped loads).

9.1.5.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Subsection 9.1.5 of the certified ESBWR DCD. The staff reviewed Subsection 9.1.5 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff’s review confirms that the information in the application and information incorporated by reference address the required information related to this section.

The staff reviewed the information in the Fermi 3 COL FSAR as follows:

- STD COL 9.1-5-A — Handling of Heavy Loads

The NRC staff reviewed COL Item STD COL 9.1-5-A related to the handling of heavy loads under Section 9.1.5 of the Fermi 3 COL FSAR. DCD COL Item 9.1-5-A in Section 9.1.6, “COL Information,” of the ESBWR DCD Tier 2, Revision 10, states that the applicant will provide a description of programs governing heavy load handling, and the schedule for implementation, that address the following:

- Heavy loads and heavy load handling equipment outside the scope of loads described in the referenced certified design and the associated heavy load attributes (load weight and typical load path)

- Requirements for heavy load handling safe load paths and routing plans including descriptions of automatic and manual interlocks not described in the referenced

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[1] See *“Finality of Referenced NRC Approvals”* in SER Section 1.2.2 for a discussion on the staff’s review related to verification of the scope of information to be included in a COL application that references a design certification.

certified design and safety devices and procedures to assure safe load path compliance

- Summary description of requirements to develop heavy load handling equipment maintenance manuals and procedures
- Requirements for heavy load handling equipment inspection and test plans
- Requirements for heavy load personnel qualifications, training, and control programs
- QA program requirements to monitor, implement, and ensure compliance with the heavy load handling program
- Issues described in Regulatory Issue Summary (RIS) 2005-25, Supplement 1, "Clarification of NRC Guidelines for Control of Heavy Loads," related to the use of non-metallic slings with single failure proof lifting devices.

In FSAR Subsections 9.1.5.6, "Other Overhead Load Handling Systems," 9.1.5.8, "Operational Responsibilities", and 9.1.5.9, "Safety Evaluations," the applicant addressed ESBWR DCD COL Item 9.1-5-A in STD COL 9.1-5-A.

The first item listed in COL Item STD COL 9.1-5-A pertaining to heavy loads and heavy load handling equipment outside the scope of loads described in the certified design is addressed in FSAR Subsection 9.1.5.9. In that subsection the applicant states that no heavy loads are identified that are outside the scope of the certified design. The applicant also states that there is no load handling equipment, nor interlocks associated with heavy load handling equipment outside the scope of the certified design. Based on the information provided by the applicant in FSAR Subsection 9.1.5.9, the staff finds that the applicant has satisfied this element of the COL information item requirement.

The second item listed in COL Item STD COL 9.1.5-A pertains to requirements for heavy load handling safe load paths and routing plans. In FSAR Section 9.1.5.8, the applicant discusses procedures. In that section, the applicant specifies that FSAR Subsection 13.5 requires the development of administrative procedures to control heavy loads prior to fuel load. The subsection also specifies that heavy load handling procedures address approved safe load paths and exclusion areas. The applicant states that paths are defined in procedures and equipment layout drawings, and that safe load path procedures address specific requirements. There are procedures to limit the height and the times that heavy loads are carried over the SFP, reactor vessel, or the safe shutdown equipment. In addition, when heavy loads could be carried but are not required to be carried directly over the SFP, reactor vessel, or the safe shutdown equipment, procedures will define an area over which loads shall not be carried so that if the load is dropped, it will not result in damage to spent fuel or operable safe shutdown equipment or compromise reactor vessel integrity. A requirement for supervision to be present during heavy load lifts to enforce procedural requirements is also discussed in FSAR Subsection 9.1.5.8. Based on the information that was provided by the applicant in FSAR Sections 13.5, and Subsection 9.1.5.8, the staff finds that the applicant has satisfied this element of the COL information item requirement since it specifies that the heavy load handling program will include program elements for safe paths, routing plans, and administrative controls.

The third item listed in COL Item STD COL 9.1.5-A pertains to the applicant providing a description of requirements to develop heavy load handling equipment maintenance manuals and procedures, and the fourth item listed in STD COL 9.1.5-A is concerned with the requirements for heavy load handling equipment inspection and test plans. In FSAR Subsection 9.1.5.8, a list of items to be addressed by the heavy loads handling procedures is provided. Among those are procedures to address equipment identification, required equipment inspections and acceptance criteria prior to performing lift and movement operations, safety precautions and limitations, rigging arrangement for loads, and special tools, rigging hardware, and equipment required for the heavy load lifts.

Inspection and test plans for heavy load handling equipment is addressed by the addition of two new paragraphs in Subsection 9.1.5.6 titled, “Special Lifting Devices” and “Other Lifting Devices” and one new paragraph in Subsection 9.1.5.8 titled, “Inspection and Testing.” The “Special Lifting Devices” paragraph states that testing and inspection of special lifting devices will follow the guidelines of American National Standards Institute (ANSI) N14.6, “Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More.” The “Other Lifting Devices” paragraph states that “slings used for heavy load lifts meet the requirements specified for slings in ANSI B30.9 and the guidance specified in NUREG-0612, Section 5.1.1(5).” Additionally, to address COL Item STD COL Item 9.1-5-A, the applicant replaced the information in ESBWR DCD, Subsection 9.1.5.8 with a revised FSAR Subsection 9.1.5.8, “Operational Responsibilities,” that includes a new “Inspection and Testing” paragraph. In this paragraph, the applicant references ANSI B30.2, “Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist),” B30.11, “Monorails and Underhung Cranes,” and B30.16, “Performance Standards for Air Wire Rope Hoists” as the applicable standards for crane testing and inspection.

Based on the information that the applicant has added to FSAR Subsections 9.1.5.6, and 9.1.5.8, the staff finds that the applicant has satisfied these elements of the COL information item requirement.

The fifth item listed in STD COL 9.1.5-A pertains to the requirement for heavy load personnel qualifications, training, and control programs. The applicant stated in Section 9.1.5.6 that the operators will be trained and qualified to meet the requirements of ANSI B30.2. Based on this information, the staff finds that the applicant has satisfied these elements of the COL information item requirement.

The sixth item listed in COL Item STD COL 9.1.5-A pertains to QA program requirements to monitor, implement, and ensure compliance with the heavy load handling program. In Subsection 9.1.5.8 of the FSAR, the applicant states that the QA program described in Section 17.5, “Quality Assurances Program Description-Design Certification, Early Sight Permits, and New License Applicants,” is applicable to the heavy loads handling program. Based on this information, the staff finds that the applicant has satisfied these elements of the COL information item requirement.

The seventh, and last issue, listed in COL Item STD COL 9.1.5-A pertains to issues described in Regulatory Issue Summary (RIS) 2005-25, Supplement 1. In FSAR Subsections 9.1.5.8, the applicant addresses how the procedures address issues described in RIS 2005-25, related to the use of non-metallic slings with single failure proof cranes. The Subsection states that heavy load handling procedures will address, “The use of slings constructed from metallic material where the single-failure-proof features of the handling system are credited in achieving a very low probability of a load drop as described in Regulatory Information Summary (RIS) 2005-25, Supplement 1, and Clarification of NRC Guidelines for Control of Heavy Loads." Based on this information, the staff finds that the applicant has satisfied these elements of the COL information item requirement.

The staff evaluated COL Item STD COL 9.1-5-A using the relevant NRC regulations and acceptance criteria in Section 9.1.5 of NUREG-0800. Based on the above evaluation, the staff finds that the applicant has satisfactorily addressed DCD COL Item 9.1-5-A. The staff also finds that since there will be a QA program with requirements to monitor, implement, and ensure compliance with the heavy load handling program including the program requirements for inspection and testing of equipment, and the program requirements regarding the qualification, and training of personnel, that GDC 1 requirements related to design, fabrication, and testing of SSCs important to maintain quality standards are satisfied. Furthermore, the staff finds that since the heavy load handling program will implement procedures that will provide for the protection of fuel and safety-related equipment from the effects of internally generated missiles that could be generated in the event of a heavy load drop, the requirements of GDC 4 are satisfied.

9.1.5.5 *Post Combined License Activities*

There are no post COL activities related to this section.

9.1.5.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the overhead heavy load handling system and no outstanding information is expected to be addressed in the COL FSAR related to this subsection. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the overhead heavy load handling system that were incorporated by reference are resolved.

In addition, the staff compared the additional COL information in the application to the relevant NRC regulations, the guidance in Section 9.1.5 of NUREG–0800, and other NRC regulatory guides. The staff's review concludes that the information in this FSAR is acceptable because it meets the requirements of GDC 1 and GDC 4 and satisfactorily addresses DCD COL Item 9.1-5-A.

9.2 Water Systems

9.2.1 Plant Service Water System

9.2.1.1 *Introduction*

This FSAR section describes the plant service water system (PSWS). This system is designed to transfer heat from nonsafety-related components in the reactor and turbine buildings to the environment. The PSWS consists of two independent and fully redundant trains that continuously recirculate raw water through the reactor component cooling water system (RCCWS) and turbine component cooling water system (TCCWS) heat exchangers. The source of cooling water for the PSWS is from either the normal power heat sink (NPHS) or the auxiliary heat sink (AHS) depending on plant conditions. A natural draft cooling tower is utilized for the NPHS and mechanical draft cooling towers are utilized for the AHS with heat rejection to the environment.

9.2.1.2 *Summary of Application*

Subsection 9.2.1 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Subsection 9.2.1 of the certified ESBWR DCD, Revision 10. In addition, in Fermi 3 COLA FSAR, Subsection 9.2.1, the applicant provides the following:

COL Item

- EF3 COL 9.2.1-1-A Material Selection

In FSAR Subsection 9.2.1.2, the applicant provided additional information in EF3 COL 9.2.1-1-A to address DCD COL Item 9.2.1-1-A. The applicant selected carbon steel pipe for both the above-grade and below-grade service water system. The applicant also stated that a corrosion protection system consistent with the guidance contained in American Society of Mechanical Engineers (ASME) B31.1, “Power Piping” is provided for the surfaces of buried piping systems. The buried sections of the piping are provided with waterproof protective coating and cathodic protection to control external corrosion. An appropriate chemical treatment is added to the PSWS basin to preclude the long term corrosion and fouling of the PSWS.

Supplemental Information

- EF3 SUP 9.2.1-1 Basin Reserve Storage Capacity

In FSAR Table 9.2-201,the applicant provided the following supplemental information. The PSWS cooling tower basin reserve water storage capacity is 9.08 x 10^3 cubic meters (m^3) (2.4 million gallons), which is needed to provide heat removal capability for 7 days without active makeup.

Site Specific Information Replacing Conceptual Design Information

- EF3 CDI System Description

The applicant provided additional information to replace the conceptual design information (CDI) contained in the ESBWR DCD. During normal power operation, the PSWS flow is directed to either the NPHS cooling tower or the AHS cooling towers where heat removed from the RCCWS and TCCWS is rejected. When the PSWS uses the NPHS, the NPHS basin provides makeup to the AHS basin. When the PSWS uses the AHS, makeup to the AHS basin is provided from the station water system (SWS). The applicant provided Figure 9.2-205, “Plant Service Water System Simplified Diagram” depicting the PSWS.

- EF3 CDI Table 9.2-201, “PSWS Component Design Characteristics”

The applicant provided additional information to replace the CDI contained in the ESBWR DCD. In FSAR Table 9.2-201, the applicant provided site specific temperature parameters and the heat load for the cooling tower design.

Interface Requirement

Section 4.1, "Plant Service Water System," of the ESBWR DCD Tier 1 information specifies as an interface requirement that the PSWS plant-specific heat rejection facilities must be capable of supporting the post-72 hour cooling function of the PSWS and must ensure that PSWS pumps have sufficient available net positive suction head (NPSH) at the pump suction. Part 10 of the COL application, Section 2.4.3, Table 2.4.3-1 "ITAAC for Plant Service Water Reserve Storage Capacity," provides the required plant-specific Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) for this interface requirement.

9.2.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the relevant requirements of the Commission regulations for the PSWS and the associated acceptance criteria are in Section 9.2.1 of NUREG-0800.

The applicable regulatory requirements for the PSWS are as follows:

- GDC 2, "Design bases for protection against natural phenomena"
- GDC 4, "Environmental and dynamic effects design bases"
- GDC 44, "Cooling water"
- GDC 45, "Inspection of cooling water system"
- GDC 46, "Testing of cooling water system"
- Item (a) of 10 CFR 52.80, "Contents of applications; additional technical information", which requires the applicant to address ITAAC

9.2.1.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.2.1 of the certified ESBWR DCD. The staff reviewed Subsection 9.2.1 of the Fermi 3 COL FSAR, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff's review confirms that information in the application and information incorporated by reference address the required information related to the PSWS.

The PSWS is a nonsafety-related system that provides defense-in-depth decay heat removal capability and is subject to regulatory treatment of nonsafety systems (RTNSS) based on risk considerations (i.e., RTNSS Criterion C). RTNSS Criterion C is described in SECY-94-084, "Policy, Technical, and Licensing Issues Pertaining to Evolutional and Advanced Light-Water Reactor Designs," date March 28, 1994 (ADAMS Accession No. 003708086) and in SECY-95-132, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs (SECY-94-084)," dated May 22, 1995 (ADAMS Accession

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

No. ML003708005). The staff's evaluation of plant-specific PSWS considerations for the ESBWR design focuses primarily on confirming the capability of the PSWS to perform its defense-in-depth and RTNSS functions; confirming that the PSWS will not adversely impact safety-related SSCs; and confirming that ITAAC, test program specifications, and RTNSS availability controls for PSWS are appropriate.

The staff reviewed the relevant information in the COL FSAR as follows:

COL Information Item

EF3 COL 9.2.1-1-A Material Selection

As discussed in Tier 2 of the DCD, Subsection 9.2.1.6, "COL Information," the COL applicant needs to determine PSWS material selection and provide provisions to preclude long-term corrosion and fouling based on site water quality analysis. In the letter dated January 29, 2010 (ADAMS Accession No. ML100331450). The applicant addressed this COL information item by using fiberglass reinforced polyester pipe (FRPP) for buried PSWS piping to preclude long-term corrosion.

The staff determined that the specifications and limitations for using FRPP should be described in the FSAR to properly document the plant design basis. In Request for Additional Information (RAI) 09.02.01-3, the staff requested the applicant to provide additional information to address these considerations and to update the FSAR accordingly.

In the letter dated July 9, 2010 (ADAMS Accession No. ML101930518), the applicant revised its response to EF3 COL 9.2.1-1-A, in Subsection 9.2.1.2 of the Fermi 3 COL FSAR to state the following:

> "PSWS basin water is treated for biofouling, scaling, and suspended matter with biocides, anti-scalants, and dispersants, respectively. In addition, the anti-scalants and/or dispersants contain corrosion inhibitors as appropriate. This water treatment regime mitigates the long-term effects of fouling and corrosion within the PSWS.
>
> PSWS materials are compatible with the PSWS water treatment regime. Based on the selected regime, carbon steel that meets ASTM standards is used as the pipe material for above-grade and below-grade portions of the PSWS. A corrosion protection system consistent with the guidance contained in ASME B31.1, Power Piping Code, Nonmandatory Appendix IV, Corrosion Control for ASME B31.1 Power Piping Systems is provided for the surfaces of buried piping systems. The buried sections of the piping are provided with waterproof protective coating and cathodic protection to control external corrosion."

The use of carbon steel to meet the American Society for Testing and Materials (ASTM) standard is consistent with the requirements for PSWS outlined in ESBWR DCD, Revision 10, Table 3.2-1, "Classification Summary," indicating that the PSWS is Quality Group D. The ESBWR DCD, Table 3.2-3, "Quality Group Designations – Codes and Industry Standards," states that Quality Group D piping is designed to ASME B31.1. Further, the buried portion of the carbon steel piping will have corrosion protection consistent with ASME B31.1, Power Piping Code, Nonmandatory Appendix IV, Corrosion Control for ASME B31.1. The buried section of the PSWS piping will be provided with waterproof protective coating and cathodic protection to control external corrosion. Based on the above, the staff has determined that the material selection of the carbon steel and the provisions to preclude the long-term corrosion and fouling based on site water quality analysis are acceptable because these are consistent with ASME B31.1 code requirements for the PSWS in the nuclear power plants. Therefore, this RAI 09.02.01-3 is closed. Furthermore, the staff has confirmed the above FSAR markup provided in the referenced RAI response has been incorporated into the Fermi 3 COL FSAR.

In FSAR Revision 1, responding to this COL information item, the staff noted that the applicant only addressed the buried PSWS piping but did not address material selections for any other parts of the PSWS, including cooling towers and related components. Consequently, in RAI 09.02.01-4, the staff requested the applicant to provide additional information to specify and explain the material selections that pertain to the rest of the PSWS. The applicant's response dated January 29, 2010 (ADAMS Accession No. ML100331450), indicated that material selections for the PSWS (which include the AHS) will take into consideration PSWS water quality, water treatment options that are compatible with Lake Erie discharge limits, economic considerations, and DCD-related RTNSS criteria. In addition, the applicant provided a COL FSAR markup that stated carbon steel material will be utilized for above ground location and will meet ASTM standards.

Based on the review of this RAI response and FSAR markup the staff agrees that carbon steel material and referencing ASTM is a common industry practice for above ground SWS installations and finds this acceptable because the applicant addressed the previously missing information regarding what materials are to be utilized. Therefore, RAI 09.02.01-4 is closed. Furthermore, the staff has confirmed the above FSAR markup provided in the referenced RAI response has been incorporated into the Fermi 3 COL FSAR.

SRP Section 9.2.1 and Generic Letter (GL) 89-13, "Service Water System Problems Affecting Safety-Related Equipment" (as referred to by SRP Section 9.2.1), dated July 18, 1989, provide guidance for evaluating long-term corrosion and fouling considerations associated with SWS. In particular, these considerations include: (i) establishing a program of surveillance and control techniques to prevent flow blockage problems due to biofouling; (ii) establishing a routine inspection and maintenance program to assure that corrosion, erosion, protective coating failure, silting, biofouling and others that are applicable cannot degrade the PSWS defense-in-depth and the RTNSS cooling functions; and (iii) establishing a test program to verify (initially and periodically) the heat transfer capability of heat exchangers that are important to safety.

In order to prevent the long-term corrosion and fouling of the PSWS, the applicant proposes to chemically treat the water in the PSWS basin. Revision 1 of the FSAR did not explain (a) what specific vulnerabilities were considered to be pertinent based upon siting considerations and operational experience that applies, and (b) why chemical treatment alone was sufficient for addressing these vulnerabilities. While chemical treatment is a common practice and suitable for addressing service water system corrosion and fouling problems to some extent, it did not resolve all of the potential vulnerabilities that are referred to in SRP Section 9.2.1 and GL 89-13. In RAI 09.02.01-5, the staff requested the applicant to address the considerations referred to above and to fully address this COL information item.

In a letter dated January 29, 2010 (ADAMS Accession No. ML100331450), the applicant indicated that the PSWS is a closed system with makeup water treated to preclude long-term corrosion and fouling based on the site water quality analysis. The approach in maintaining the PSWS against its site-specific vulnerabilities reflects Detroit Edison's experience with Fermi Unit 2. The PSWS is a nonsafety-related system that is designated in the DCD as RTNSS, Criterion C, a "Low Regulatory Oversight, Maintenance Rule" support system. As a

Maintenance Rule system, system operation will be monitored for degradation, and deficiencies will be addressed. Consistent with the ESBWR DCD, Table 19A-2, the PSWS (including the AHS cooling towers) is a nonsafety-related system that is designated as a RTNSS Criterion C. The PSWS is subject to reliability and availability controls in accordance with the Maintenance Rule Program requirements. In addition, as stated in DCD Section 19A.8.2, all RTNSS systems are in the scope of the Design Reliability Assurance Program (D-RAP), as described in Fermi 3 COL FSAR, Section 17.4. Based on the staff's review of this RAI response, which addresses the site-specific vulnerabilities, applicable maintenance rule, and D-RAP, the staff has concluded that sufficient programmatic controls exist to address the potential vulnerabilities, GL 89-13, and the COL information item. Therefore, RAI 09.02.01-5 is closed.

The staff finds that the applicant has satisfactory addressed COL information item EF3 COL 9.2.1-1-A because the applicant has adequately determined PSWS material selection and provided provisions to preclude the long-term corrosion and fouling based on site water analysis.

Supplemental Information

- EF3 SUP 9.2.1-1 Basin Reserve Storage Capacity

Table 9.2-201 provides supplemental plant-specific information (EF3 SUP 9.2.1-1) that specifies a basin reserve storage capacity of $9.08 \times 10^3\ m^3$ (2.4 million gallons), an ambient wet bulb temperature of 22.8 degrees Celsius (C) (73 degrees Fahrenheit(F)), and a heat load of 83.5 megawatts (MW) (2.85×10^8 British thermal units per hour (Btu)/hour) for each mechanical-draft cooling tower. The Fermi 3 COL FSAR supplemental information refers to FSAR Figure 9.2-205, "Plant Service Water System Simplified Diagram," for a diagram of the PSWS.

The staff reviewed Revision 1 of Fermi 3 COL FSAR, Table 9.2-201 and found that the Fermi 3 COL FSAR has the basin reserve storage capacity of $9.08 \times 10^3\ m^3$ (2.4 million gallons). The FSAR does not have any discussion on how the value was established. In RAI 09.02.01-6, the staff requested for the applicant to discuss how the water capacity of $9.08 \times 10^3\ m^3$ (2.4 million gallons) was established including the assumptions and methodology being used. In a letter dated January 29, 2010 (ADAMS Accession No. ML100331450), the applicant provided an analysis to demonstrate how to determine the basin capacity. In the analysis, the value of $9.08 \times 10^3\ m^3$ (2.4 million gallons) was established by determining the evaporation rate for the Auxiliary Heat Sink (AHS) using the heat load of 2.02×10^7 megajoules (MJ) (1.92×10^{10} Btu) over a 7-day period as defined in the DCD Revision 10. The staff reviewed the analysis of the assumptions and methodology, and determined it to be acceptable. Therefore, RAI 09.02.01-6 is closed.

Based on the above information, the staff finds that the applicant's supplemental information provided in EF3 SUP 9.2.1-1 for this subsection is acceptable because a 9.08×10^3-m^3 (2.4 million gallon) reserve water storage capacity is adequate based on a heat load of 2.02×10^7 MJ (1.92×10^{10} Btu) over a 7- day period that was used in the applicant's analysis.

Site-Specific Information Replacing Conceptual Design Information (CDI)

- EF3 CDI — System Description
- EF3 CDI — Table 9.2-201, "PSWS Component Design Characteristics"

In ESBWR DCD Tier 2, Subsection 9.2.1.2, states that the heat rejection facilities are dependent upon actual site conditions and are not part of the ESBWR standard plant. The conceptual design for the standard plant uses the NPHS and an AHS as the heat rejection facilities. The NPHS consists of a natural draft cooling tower and the AHS consists of mechanical draft cooling towers. A cross-tie for the standard plant permits aligning PSWS to either of these heat sinks.

The applicant provided conceptual design information (EF3 CDI) in Subsection 9.2.1.2 of the Fermi 3 COL FSAR to address this item and indicated that the PSWS rejects heat from the RCCWS and TCCWS heat exchangers to the environment via either the NPHS or the AHS. A natural draft cooling tower is utilized for the NPHS and mechanical draft cooling towers are utilized for the AHS. The FSAR provides a revised Table 9.2-201 that incorporates the cooling tower characteristics of the mechanical draft cooling towers. Table 9.2-201 provides supplemental plant-specific information (EF3 SUP 9.2.1-1) that specifies a basin reserve storage capacity of 9.08×10^3 m^3 (2.4 million gallons), an ambient wet bulb temperature of 22.8 degrees C (73 degrees F), and a heat load at 83.5 MW (2.85×10^8 Btu/h). The Fermi 3 COL FSAR supplemental information refers to FSAR Figure 9.2-205, "Plant Service Water System Simplified Diagram," for a schematic diagram of the PSWS.

Tier 2 of the DCD, Subsection 9.2.1.2, indicates that the heat rejection facilities are dependent upon actual site conditions and provides CDI for the standard plant design. Subsection 9.2.1.2 of the Fermi 3 COL FSAR replaced the CDI with plant-specific information (EF3 CDI), indicating that the heat rejection facility for Fermi 3 consists of natural draft and mechanical draft cooling towers. In order for the NRC to determine if the cooling towers are capable of performing their defense-in-depth and RTNSS functions, the staff issued RAI 09.02.01-7, requesting the applicant to address cooling tower design attributes, plant-specific vulnerabilities and degradation mechanisms, programmatic controls, and potential impacts on safety-related SSCs resulting from postulated cooling tower failures.

In a letter dated January 29, 2010 (ADAMS Accession No. ML100331450), the applicant stated that sufficient information was provided in FSAR Subsection 9.2.1.2 subsection of the "Detailed Design Description" with its referenced tables to demonstrate that PSWS is capable of meeting its RTNSS functions. For example, maximum allowed PSWS water supply temperature (cold leg temperature), limiting meteorological assumptions (ambient wet bulb temperature), heat dissipation capability, and water inventory requirements are listed in FSAR Table 9.2-201. The minimum net positive suction head for the PSWS pumps is ensured by maintaining the required water inventory above pump minimum submergence. The minimum water inventory requirements are met by maintaining the level at or above the minimum operating level in the cooling tower basin. Each PSWS cooling tower has a heat rejection capacity much greater than the RTNSS heat load. Therefore, each tower is capable of meeting the system's RTNSS function to support the required cooling of the RCCWS. Preoperational and startup testing is conducted to demonstrate that the PSWS can perform its intended functions. Those testing requirements are described in DCD Subsections 14.2.8.1.51 and 14.2.8.2.18, respectively. Operational functionality is assured by the normal operation and monitoring of the system. The specific vulnerabilities and degradation mechanisms that are anticipated, based on operational experience and site location, are long-term corrosion and fouling. Subsection 9.2.1.2 of the FSAR states that PSWS water is chemically treated to preclude long-term corrosion and fouling of the PSWS based on site water quality analysis. The failure of cooling tower components will not cause the potential for any adverse impacts on the intended design functions of the safety-related SSCs. Water from a postulated PSWS cooling tower riser break will drain eastward and southward away from any power block structures because of the slope of the elevated plateau the power block structures are to be built on. Based on the RAI response and staff's review of the above information, the staff has determined that the cooling towers are capable of performing their intended functions. Therefore, RAI 09.02.01-7 is closed.

Revision 1 of Fermi 3 COL FSAR Subsection 9.2.1.2 specifies that during operation, PSWS flow is directed either to the NPHS cooling tower or the AHS cooling tower where heat removed from the RCCWS and TCCWS is rejected. During this mode of operation using NPHS, the NPHS basin provides makeup to the AHS basin. During the mode of operation using AHS, the SWS provides makeup to the AHS basin. While this supplemental information explains how makeup is provided to the AHS depending on how the PSWS is aligned for heat rejection, it is not clear what the different "modes" of power operation are. This is confusing because the term "mode" has a specific meaning in the Technical Specifications (TSs), and specific modes of power operation are not assigned for when the NPHS or the AHS should be used. In RAI 09.02.01-8, the staff requested the applicant to revise the FSAR to eliminate this confusion and to better explain when the NPHS versus the AHS will be used for various operating, transient, and accident conditions. In a letter dated January 29, 2010 (ADAMS Accession No. ML100331450), the applicant revised the FSAR section in question. It reads "During normal power operation, PSWS flow is directed to either the NPHS cooling tower or the AHS cooling towers where heat removed from the RCCWS and TCCWS is rejected. When PSWS uses the NPHS, the NPHS basin provides makeup to the AHS basin. When PSWS uses the AHS, makeup to the AHS basin is provided from the Station Water System (SWS)." The staff determined the revised FSAR resolved the confusion in question. Therefore, this RAI 09.02.01-8 is closed. Further, the staff has confirmed the above FSAR markup provided in the referenced RAI response has been incorporated into the Fermi 3 COL FSAR.

Based on the above information, the staff finds that the site-specific CDI provided by the applicant in this subsection is acceptable because the applicant has adequately described the function and components of the NPHS and the AHS.

Interface Requirement

Tier 1 of the ESBWR DCD, Section 4.1, specifies an interface requirement that the PSWS plant-specific heat rejection facilities must be capable of supporting the post-72 hour RTNSS cooling function of the PSWS. In particular, the PSWS must be capable of removing at least 2.02×10^7 MJ (1.92×10^{10} Btu) over a period of 7 days without active makeup. In addition, the PSWS pumps must have sufficient available NPSH at the pump suction location for the lowest probable water level of the heat sink. The COL applicant is required to develop plant-specific ITAAC that demonstrate that each train of the plant-specific cooling tower and basin satisfies this interface requirement.

The applicant provided plant-specific ITAAC item, "ITAAC for Plant Service Water Reserve Storage Capacity," for the PSWS in Section 2.4.3, "ITAAC for Plant Service Water System (Portion Outside the Scope of the Certified Design)," Table 2.4.3-1, "ITAAC for Plant Service Water Reserve Storage Capacity," of COLA Part 10. The proposed Design Commitment is for the PSWS to contain an inventory of cooling water sufficient for removing post-72- hour heat from the RCCWS for a period of seven days without active makeup. The proposed Acceptance Criteria are to document that the usable water volume in the PSWS basins is sufficient to remove 2.02 x 10^7 MJ (1.92 x 10^{10} Btu) over a period of seven days without active makeup.

SRP Section 9.2.5 and RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants" (as referred to by SRP Section 9.2.5), provide guidance for evaluating the adequacy of cooling towers. Important factors that need to be considered when demonstrating that cooling towers are capable of dissipating the required heat load include (among other factors) the capability to satisfy the PSWS pump's minimum NPSH requirements for the most limiting cooling tower basin water level; the maximum allowed PSWS water supply temperature; and the most limiting meteorological assumptions that pertain to the site for determining the heat dissipation capability, and the water inventory requirements. Transient analyses that take these factors into consideration (including margin for expected degradation and operating flexibility) and confirmatory testing are usually necessary in order to demonstrate that the cooling tower performance satisfies the specified heat removal capability.

The ITAAC proposed by the applicant specifies the PSWS basin water inventory requirement as a way of demonstrating that the heat removal capability specified by the DCD has been satisfied. However, the applicant provided no explanation or description for other attributes such as how this water inventory requirement was established, cooling tower design attributes, the capability to satisfy the PSWS pump's minimum NPSH requirements, temperature and flow conditions, the maximum allowed PSWS water supply temperature, and the most limiting meteorological assumptions that pertain to the site. While water inventory is an important consideration for assuring that the cooling towers are capable of performing their defense-in-depth and RTNSS functions, the review considerations discussed in the paragraph above were not addressed by the applicant and the proposed ITAAC do not adequately demonstrate that the cooling towers are capable of dissipating the specified heat load. The staff asked the applicant in RAI 09.02.01-1 to address the considerations referred to above and to revise the FSAR and ITAAC accordingly.

In the letters dated January 29 and July 9, 2010 (ADAMS Accession Nos. ML100331450 and ML101930518, respectively), the applicant responded to RAI 09.02.01-1. In these responses, the applicant stated that the capability of the PSWS cooling towers is based on the typical design attributes associated with the design of nonsafety-related systems utilizing cooling towers. The minimum heat duty for each tower is 83.5 MW (2.85 x 10^8 Btu/hour) and the design uses ambient wet bulb temperature of 22.8 degrees C (73 degrees F), an approach temperature of 8.3 degrees C (47 degrees F), and a cold water (supply) temperature of 31.1 degrees C (88 degrees F). The system's normal loads are from the RCCWS and TCCWS and the system is designed as a nonsafety-related system to perform a cooldown assuming a loss of preferred power (LOPP) and a single train operation. Initial testing of the system includes the performance testing of the cooling towers for conformance with design heat loads and waterflows. This information is incorporated by reference from the DCD in FSAR Section 9.2.1, with the necessary supplements.

Furthermore, the applicant stated that during a postulated event where the PSWS functions as a RTNSS Criterion C system, the normal makeup water to the cooling tower is not qualified as a RTNSS function and is considered to be unavailable. The cooling tower basin must have a sufficient volume of water to allow the tower to perform its cooling function without active makeup.

In addition, the applicant revised acceptance criteria to state that the volume of water in the PSWS heat sink is sufficient to remove 2.02 x 10^7 MJ (1.92 x 10^{10} Btu) over a period of 7 days without active makeup. Also the applicant provided a design commitment and acceptance criteria confirming that there is sufficient available net positive suction head at the PSWS pump suction location for the lowest probable water level of the heat sink. In addition, the applicant provided a markup to Fermi 3 COLA, Part 10, Tier 1 ITAAC, Section 2.4.3, and Table 2.4.3-1.

The staff finds the applicant's response is acceptable because it is consistent with the ESBWR DCD, Tier 1, Revision 6, Section 4.1 "Plant Service Water System," Interface Requirements. The staff finds this RAI response acceptable since it satisfies DCD Tier 1, Section 4.1, Interface Requirement. The staff confirmed the above change was incorporated into Fermi 3 COLA, Revision 3. Therefore, RAI 09.02.01-1 is closed.

The staff's review of Revision 1 of the COLA application identified that the proposed ITTAC did not address the interface requirement that the PSWS pumps must have sufficient NPSH at the pump suction location for the lowest probable water level of the heat sink. In RAI 09.02.01-2, the staff asked the applicant, to address the NPSH in the ITAAC. In the letter, dated January 29, 2010 (ADAMS Accession No. ML100331450), the applicant, as a part of the response to RAI 09.02.01-1, provided the requested change in Revision 2 of Fermi 3 COL application, Part 10, Tier 1, ITAAC, Section 2.4.3, and Table 2.4.3-1. The revised information states that the PSWS pumps must have sufficient NPSH at the pump suction location for the lowest probable water level. The staff's review of the above information as a part of RAI 09.02.01-1 finds it acceptable because the commitment is consistent with the DCD Tier 1, Section 4.1, interface requirement. Therefore, RAI 09.02.01-2 is closed.

The staff finds that the applicant has satisfactorily addressed this interface requirement because the PSWS plant-specific heat rejection facilities are capable of supporting the post-72 hour RTNSS cooling function and the PSWS pumps have sufficient available NPSH for the lowest probable water level of the heat sink.

ITAAC

As specified in the Fermi 3 COL application, Part 10, Section 1, the ITAAC from Tier 1 of the DCD is incorporated by reference. However, in Part 10, Section 2.4.3 the applicant proposes ITAAC for the interface requirement that is specified in Section 4.1 of the DCD Tier 1. The adequacy of the proposed plant-specific ITAAC that are proposed is evaluated above under "Interface Requirements." The applicant's responses to RAI Questions 09.02.01-1 and 09.02.01-2 were reviewed and determined to be acceptable in the above staff's evaluation.

Initial Plant Test Program

As indicated in the FSAR, Section 14.2, "Initial Plant Test Program for Final Safety Analysis Reports," the initial plant test program specified in DCD Tier 2 for the PSWS is incorporated by reference. The PSWS initial test program is discussed in the DCD Tier 2, Subsections 14.2.8.1.51, "Plant Service Water System Preoperational Test," and 14.2.8.2.18, "Plant Service Water System Performance Test." However, these tests do not verify that performance of the PSWS (including the NPHS and AHS) satisfies design specifications for all configurations and heat loads. In RAI 09.02.01-9, the staff asked the applicant to establish and describe initial plant test program requirements for the PSWS accordingly.

In the response to this RAI dated January 29, 2010 (ADAMS Accession No. ML100331450), the applicant stated that "preoperational and startup testing requirements for the PSWS, which includes the CDI portion of the PSWS (including AHS), are described in DCD Sections 9.2.1.4, 14.2.8.1.51, and 14.2.8.2.18. The DCD is incorporated by reference into the COLA FSAR." The two mechanical draft cooling towers in the AHS are specific to Fermi 3 but are an integral part of the PSWS. Preoperational and startup testing of the AHS will occur during the initial test program for the PSWS. Such testing will demonstrate the proper functioning of the PSWS and its components, including the AHS, under various operational configurations. Performance testing of the PSWS using the NPHS is not required because of the operational conditions in which the NPHS is allowed to be used. When the NPHS is used in conjunction with PSWS during normal power operation, the AHS cooling towers are not in use. If the NPHS is insufficient, then the AHS must be used. Performance testing done using the AHS is sufficient. In addition, in the response to RAI 09.02.01-9, the applicant proposed revisions to FSAR Subsections 14.2.8.1.51 and 14.2.8.2.18 by adding supplemental information EF3 SUP 14.2-4 and EF3 SUP 14.2-5 in order to clarify the purpose and criteria of the PSWS preoperational test, along with the purpose and description of the PSWS performance test.

Based on the staff's review of this RAI response, the staff finds the applicant has addressed the identified shortcomings in the RAI for the initial test program related to the AHS in the CDI. In addition, the staff finds that the water hammer design features had been added and had been adequately addressed to ensure the CDI had been properly tested. Therefore, this RAI 09.02.01-9 is closed. Furthermore, the staff has confirmed that the above FSAR markup provided in the referenced RAI response is incorporated into the Fermi 3 COL FSAR.

9.2.1.5 *Post Combined License Activities*

There are no post COL activities related to this section.

9.2.1.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the PSWS, and no outstanding information is expected to be addressed in the COL FSAR related to this subsection. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the PSWS that were incorporated by reference are resolved.

In addition, the staff compared the additional COL information in the application to the relevant NRC regulations, the guidance in Section 9.2.1 of NUREG–0800, and other NRC regulatory guides. The staff's review concludes that the applicant's information is acceptable and meets the requirements of GDC 2, 4, 44, 45,46, and 10 CFR 52.80(a). The staff has evaluated COL Items EF3 COL 9.2.1-A, EF3 SUP 9.2.1-1, EF3 CDI, along with the DCD ITAAC and Interface Requirement for this subsection to the relevant NRC regulations and acceptance criteria in Sections 9.2.1 and 9.2.5 of NUREG-0800. The staff's evaluation finds that the applicant has satisfactorily addressed these items.

9.2.2 Reactor Component Cooling Water System

Subsection 9.2.2 of the Fermi 3 COL FSAR incorporates by reference Section 9.2.2, "Reactor Component Cooling Water System", of Revision 10 of the certified ESBWR DCD, Revision 10 referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to RCCWS that were incorporated by reference are resolved.

9.2.3 Makeup Water System

9.2.3.1 *Introduction*

The makeup water system (MWS) provides high purity demineralized water to various plant systems. The MWS consists of two subsystems; a demineralization subsystem and a storage and transfer subsystem. Feedwater for the demineralization subsystem is provided by the Frenchtown Township municipal water system. Treated water is stored in a demineralized water storage tank and distributed throughout the plant using transfer pumps. Except for the piping penetrating the containment and the associated containment isolation valves, the MWS is not safety-related. However, if available, the MWS can provide makeup to the isolation condenser/passive core cooling (IC/PCC) pool following an anticipated operational occurrence (AOO) or any abnormal event.

9.2.3.2 *Summary of Application*

Section 9.2.3 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 9.2.3 of the certified ESBWR DCD, Revision 10. In addition, in FSAR, Section 9.2.3, the applicant provides the following:

Site Specific Information Replacing Conceptual Design Information

- EF3 CDI System Description

The applicant provided site-specific information to replace the CDI contained in the ESBWR DCD. The applicant added activated carbon filters upstream of the reverse osmosis unit based on site specific considerations. The MWS major equipment is housed entirely in the service water/water treatment. Building except for the demineralized 950 m^3 (250,963 gallon) water storage tank (which is outdoors and adjacent to this building) and the distribution piping to the interface systems. Freeze protection is provided for the demineralized water storage tank and piping exposed to freezing conditions. Table 9.2-202, "Major Makeup Water System Components," in the Fermi 3 COL application lists the major MWS components.

ITAAC

In COL application Part 10, Section 2.4.10, the applicant states that for the MWS there are no entries.

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

9.2.3.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, there is no associated SRP section in NUREG-0800 for the MWS.

The applicable regulatory requirements for the site specific aspects of the MWS are:

- GDC 2, in that failure of the nonsafety-related system or component due to natural phenomena such as earthquakes, tornadoes, hurricanes, and floods should not adversely affect SSCs important to safety

- RG 1.29, Revision 4 "Seismic Design Classification," Revision 4, March 2007

- 10 CFR 52.80(a), which requires the applicant to address ITAAC

9.2.3.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Subsection 9.2.3 of the certified ESBWR DCD. The staff reviewed Section 9.2.3 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the required information related to the MWS.

The staff's review of FSAR Subsection 9.2.3 is limited to the following Fermi 3 COL FSAR site-specific design replacing the CDI in the ESBWR DCD, Revision 10.

Site-Specific Information Replacing Conceptual Design Information

- EF3 CDI — FSAR Subsection 9.2.3.2, "System Description."

In FSAR Subsection 9.2.3.2, the applicant replaced the introductory text and demineralization subsystem portions of the ESBWR DCD, Subsection 9.2.3.2. In FSAR Subsection 9.2.3.2, the applicant provided site-specific system description of the MWS.

The MWS consists of two subsystems: (1) the demineralization subsystem and (2) the storage and transfer subsystem. The makeup water transfer pumps and the demineralization subsystem are sized to meet the demineralized water needs of all operational conditions except for the shutdown/refueling/startup mode. During the shutdown/refueling/startup mode, the increases in plant water consumption may require the use of a temporary demineralization subsystem and temporary makeup water transfer pumps to be used as a supplemental water source.

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

The MWS major equipment is housed entirely in the service water/water treatment. Building except for the demineralized water storage tank (which is outdoors and adjacent to this building) and the distribution piping to the interface systems. Freeze protection is provided for the demineralized water storage tank and piping exposed to freezing conditions.

The staff reviewed the site-specific MWS and its components and finds that the applicant's proposed system design is similar to the MWS described in Subsection 9.2.3.2 of the ESBWR DCD, Revision 10. The EF3 MWS components and associated piping in contact with demineralized water are fabricated from corrosion resistant materials such as stainless steel to prevent contamination of the makeup water.

Demineralization Subsystem

Water for the demineralization subsystem is provided by the Frenchtown Township municipal water system. Production of demineralized water by the demineralization subsystem can be initiated and shut down either automatically (based on the demineralized water storage tank level) or manually. Feedwater is treated in the following sequence via activated carbon filters, reverse osmosis modules, and mixed bed demineralizers.

Each reverse osmosis module includes cartridge filters. The reverse osmosis modules are separated by an inter-stage break tank. Chemical addition is provided upstream of the reverse osmosis module cartridge filters as required. High pressure pumps provide the pressure required for flow through the reverse osmosis unit membranes. The reverse osmosis unit reject flow is sent to the blowdown. The reverse osmosis product water is temporarily stored in an reverse osmosis product water storage tank before being pumped by one of the forwarding pumps to the mixed bed demineralizer unit. Operation of the reverse osmosis high-pressure pumps is interlocked with that of the forwarding pumps. The mixed bed demineralizer consists of both strong cation and anion resins in the same vessel that polishes the reverse osmosis product water. The mixed bed unit effluent is monitored for water quality. This effluent is automatically recirculated to the station water storage tank (SWST) until the water quality requirements are met. Makeup water is then delivered to the MWS demineralized water storage tank. The modular design of the reverse osmosis unit and the mixed bed unit allows continuous demineralized water production. Cleaning, back flushing, or module removal are manual operations based on elevated differential pressure across the module or total flow through the system. No regeneration of mixed bed modules is performed on-site.

The NRC reviewed the design information provided in the FSAR Subsection 9.2.3 for the Fermi 3 COL FSAR MWS and finds that the applicant did not identify any further supplements and/or departures, except the site-specific information discussed above. The site-specific portion of the MWS is nonsafety-related and its failure does not compromise any safety-related system or component nor does it prevent a safe-shutdown. Also, the site-specific design will not change the conclusion of ESBWR DCD for MWS, as it relates to GDC 2.

Furthermore, the site-specific portion of the MWS does not interface with any potentially radioactive system. Therefore, no interface requirements needed to be satisfied. Because of the above information, the site-specific portion of the design provided in the Fermi 3 COL application does not affect the conclusions in the ESBWR FSER (NUREG-1966).

The staff finds that the site-specific conceptual design information for the MWS presented within this subsection of the Fermi 3 COL FSAR is acceptable and does not change the conclusions of ESBWR DCD, as it relates to GDC 2. The staff also finds that the EF3 CDI for the MWS meets the guidance of Regulatory Position C.2 of RG 1.29 regarding nonsafety-related systems because the failure of the nonsafety-related portions of the systems does not impact any safety-related SSCs.

ITAAC

In COL application Part 10, Section 2.4.10 described the site-specific ITAACs for the MWS. The staff reviewed this section for the MWS against selection criteria in SRP Section 14.3. The staff's review concludes that the MWS does not perform a safety-related function and is not considered a system "important to safety;" therefore, as-built verification, i.e., a site-specific ITAAC, is not required.

9.2.3.5 *Post Combined License Activities*

There are no post COL activities related to this section.

9.2.3.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the MWS, and no outstanding information is expected to be addressed in the COL FSAR related to this subsection. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the MWS that were incorporated by reference are resolved.

In addition, the staff compared the additional information in the application to the relevant NRC regulations and other NRC regulatory guides. The staff's review concludes that the applicant has provided sufficient information on the site-specific conceptual design information for the MWS presented within this subsection of the Fermi 3 COL FSAR. The staff finds that the information is acceptable and does not change the conclusions of ESBWR DCD. The staff also finds that the EF3 CDI for the MWS meets the guidance of Regulatory Position C.2 of RG 1.29 regarding nonsafety-related systems because the failure of the nonsafety-related portions of the systems does not impact any safety-related SSCs. With respect to MWS failures and GDC 2, SSCs important to safety are able to withstand the effects of natural phenomena without loss of capability to perform their safety function. The staff finds that these requirements have been met.

Additionally, the staff concludes that the applicant has adequately addressed 10 CFR 52.80(a). The staff confirms that COL ITAACs are not required for the MWS.

9.2.4 Potable and Sanitary Water Systems

9.2.4.1 *Introduction*

The potable water system (PWS) supplies clean water for domestic use and human consumption. The sanitary waste discharge system (SWDS) collects and treats sanitary wastes from plant restrooms and locker room facilities. The system design ensures that there is no possibility for radioactive contamination of the potable water or the sanitary waste drainage system. Neither the PWS nor the SWDS has a safety design basis.

9.2.4.2 *Summary of Application*

Section 9.2.4 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 9.2.4 of the certified ESBWR DCD, Revision 10. In addition, in FSAR, Section 9.2.4, the applicant provides the following:

Site Specific Information Replacing Conceptual Design Information

- EF3 CDI Potable and Sanitary Water Systems

The applicant provided additional information to replace CDI contained in the ESBWR DCD. The applicant described the site specific potable and sanitary water system. The PWS is supplied by the Frenchtown Township municipal water system. The sanitary wastes are collected and forwarded to the Frenchtown Township Sewage Treatment facility. Neither the PWS nor the SWDS interconnects with any system that contains radioactive fluids. The sanitary waste system is monitored for radioactivity. The applicant provided Figure 9.2-201, “Potable Water System Simplified Diagram,” depicting the potable water system and Figure 9.2-202, “Sanitary Waste Discharge System Simplified Diagram,” depicting the SWDS. Table 9.2-203, “Potable Water System Component Design Characteristics,” provides information about major PWS components.

ITAAC

In COL application Part 10, Section 2.4.7, the applicant states that for the PWS and SWDS there are no entries.

9.2.4.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the relevant requirements of the Commission regulations for the potable and sanitary water systems and the associated acceptance criteria are in Section 9.2.4 of NUREG-0800.

The applicable regulatory requirements for the potable and sanitary water system are as follows:

- GDC 60, “Control of releases of radioactive materials to the environment,” of 10 CFR Part 50, Appendix A which relates to design provisions provided to control the release of liquid effluents containing radioactive material from contaminating the PSWS.

- 10 CFR 52.80(a), which requires the applicant to address the ITAAC.

Since the PWS/SWDS may affect SSCs due to nonsafety-related equipment failures, additional regulatory requirements for the potable and sanitary water system are as follows:

- GDC 2 as it relates to structures housing the system and the system itself having the capability of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes and floods without loss of safety-related functions.

- GDC 4 as it relates to effects of missiles inside and outside of the containment, pipe whip, jets, and environmental conditions from high and moderate energy line breaks and dynamic effects of flow instabilities and loads (e.g. water hammer) during normal plant operation, as well as during accident conditions.

9.2.4.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.2.4 of the certified ESBWR DCD. The staff reviewed Section 9.2.4 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff's review confirms that information in the application and the information incorporated by reference address the required information related to the PWS.

The staff reviewed the relevant information in the COL FSAR:

Site-Specific Information Replacing Conceptual Design Information

- EF3 CDI — Potable and Sanitary Water Systems

The staff reviewed EF3 CDI related to the conceptual design of the PSWS included under Section 9.2.4 of the Fermi 3 COL FSAR including Figures 9.2-201 and 9.2-202, and Table 9.2-203. Meeting the requirements of GDC 60 for this system ensures that design provisions are in place to prevent liquid effluents containing radioactive materials from contaminating the PWS and SWDS and potentially being released to the environment.

The PWS and SWDS do not perform any safety-related function and are not connected to any safety-related systems. A failure of these systems does not affect any safety-related components or prevent a safe shutdown of the plant.

The proposed source of potable water for the PWS is treated water from the Frenchtown Township municipal water system, at a supply capacity of 12.6 liters per second (L/s) (200 gallons per minute [gpm]). The applicant stated in the application that the water quality will meet the standards of the authorities having jurisdiction. The PWS does not handle radioactive fluids, and it is not connected to and does not interface with any system potentially containing radioactive fluids. However, potable water is supplied to areas where potential backflow could cause radiological contamination. In the unlikely event of radiological intrusion into the PWS in these areas, the applicant has proposed using of backflow preventers to preclude the spread of contamination into the PWS. The staff concludes that because the PWS is not connected to or does not interface with systems that contain radioactivity, and backflow preventers are installed

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

in areas of potential contamination, acceptable design provisions have been included to prevent the inadvertent contamination of the PWS with radioactive material.

The proposed Fermi 3 SWDS consists of a waste basin, wet well, septic tank, settling tank, and associated pumps. The sewage is routed from the septic tank to the Frenchtown Township Sewage Treatment facility and is not discharged to the environment. The SWDS does not handle radioactive fluids. It is not connected to and does not interface with any system potentially containing radioactive fluids. Analyses of routing septic tank grab samples, which is described in COL FSAR Table 11.5-201, "Provisions for Sampling Liquid Streams" will detect events that might contaminate the SWDS downstream of the septic tanks and are also discussed in Section 11.5 of this SER. In the event that radioactivity is detected above predetermined limits, controls are in place to prevent the offsite disposal of sewage sludge prior to on-site evaluation of potential radiological contamination and treatment when contamination is beyond acceptable limits.

Fermi 3 COL FSAR, Section 9.2.4, describes the PWS and SWDS and that failure of the system does not compromise any safety-related equipment or component and does not prevent safe shutdown of the plant. In addition, Table 9.2-203, "Potable Water System Component Design Characteristics" states that the PWS design includes a potable water storage tank capacity of 75.7 m^3 (20,000 gallons). Since the exact location of the potable water storage tank was not specified in Revision 3 of the COL FSAR, the staff could not conclude that if an event were to occur that affects the integrity of the potable water storage tank and flooding occurs, SSCs would not be affected. For this reason, the staff issued RAI 09.02.04-1 asking the applicant to address the following five items:

1. The exact location of the potable water storage tank with respect to building or yard location.

2. Discussion of the potable water storage tank and any bounding flooding analysis in Sections 3.4 and 9.2.4 of the COL FSAR and any effects on safety-related SSCs. If the tank is located in the yard, discuss the site grading around the tank and direction of water away from safety-related SSCs.

3. Discussion of this potable water storage tank and any bounding flooding analysis in Sections 3.4 and 9.2.4 of the COL FSAR and any effects on the nonsafety-related SSCs that are designated as "Regulatory Treatment of Nonsafety-Related Systems" (RTNSS) SSCs. If the tank is located in the yard, discuss the site grading around the tank and direction of water away from RTNSS SSCs.

4. Discussion in Section 9.2.4 of the PWS and SWDS, specifically the potable water storage tank, related to GDC 2 (protection against natural phenomena such as earthquakes).

5. Discussion in Section 9.2.4 of the PWS and SWDS, specifically the potable water storage tank, related to GDC 4 (protection against environmental and dynamic effects) as it related to discharging fluids which may result from PWS and SWDS equipment failures.

The applicant responded to RAI 09.02.04-1 in letters dated August 12 and 26, 2011 (ADAMS Accession Nos. ML11228A127 and ML11241A195, respectively) and provided the following:

> The potable water storage tank will be located inside the water treatment/service water building. There are no safety-related SSCs in the water treatment/service water building. In the event that a failure of the potable water storage tank resulted in water exiting the water treatment/service water building, the water would flow away from any safety-related SSCs as shown on the final grade drainage area figures, FSAR Figure 2.4-215, "Final Grade Drainage Area," and Figure 2.4-217, "Final Grade Drainage Area Assuming Clogged Underground Storm Drains and Culverts". The plant service water system (PSWS) is classified as a regulatory treatment of nonsafety-related systems (RTNSS) system with components located inside and outside the water treatment/service water building. Per ESBWR DCD Table 19A-4, "Capability of RTNSS Related Structures," design and installation of RTNSS equipment in the water treatment/service water building includes protection from the effects of internal flooding and PSWS equipment located outdoors includes protection from flooding. Therefore, RTNSS equipment located inside and outside the water treatment/service water building will be protected from flooding caused by a postulated failure of the potable water storage tank.
>
> As stated in FSAR Subsection 9.2.4.3, the PWS and SWDS are not safety-related and do not connect to any safety-related systems. As described above, failure of the potable water storage tank would not adversely impact any safety-related or RTNSS SSCs; therefore, those safety-related and RTNSS SSCs satisfy 10 CFR Part 50, Appendix A, Criteria GDC 2 and GDC 4. A FSAR markup was provided which describes the potable water tank to be located in the water treatment/service water building and the potable water storage tank has been evaluated with respect to GDC 2 and 4.

The staff reviewed the applicant's responses to RAI 09.02.04-1. The staff's review finds the responses acceptable because the postulated failure of the potable water storage tank does not adversely affect safety-related or RTNSS SSCs. Since the potable water storage tank is located in the water treatment/service water building, water would flow away from any safety-related SSCs. The RTNSS SSCs are protected from the effects of internal flooding and the PSWS located outdoors are protected from flooding. For example, flooding protection is provided by adequate building seals and or access building openings above flood levels. The staff finds the FSAR markups provided by the applicant to be acceptable. Therefore, the staff has determined that RAI 09.02.04-1 is resolved. The applicant's proposed revisions to the Fermi 3 COL FSAR were tracked as Confirmatory Item 9.2.4-1. The staff confirmed that these changes have been incorporated into the Fermi 3 COL FSAR. Therefore, Confirmatory Item 9.2.4-1 and RAI 09.02.04-1 are closed.

Based on the staff's review of the applicant's information for the PWS and SWDS, the staff finds that the applicant has made acceptable design to prevent the inadvertent contamination of the systems with radioactive material, and therefore the proposed design of the PSWS meets the requirements of GDC 60 and therefore is acceptable.

No departures or COL information items are identified in this section. The TSs, ITAAC, and initial plant test program are not applicable for these systems. There is no ESBWR DCD Tier 1 interface associated with these systems.

The staff finds that the site-specific CDI presented within this subsection of the Fermi 3 COL FSAR is acceptable and meets the requirements of GDC 2, 4, and 60. The staff bases its conclusion on the fact that the potable and sanitary water systems have no safety-related function and failure of the system would not compromise any safety-related system or component, nor would it prevent a safe shutdown of the plant. The EF3 CDI for the PWS and SWDS have no interface with any safety-related equipment, and no interconnections exist between the PWS and SWDS and any potentially radioactive system. In addition, flooding consequences from the PWS storage tank was evaluated and determined to be acceptance since safety-related or RTNSS SSCs would not be negatively affected from performing their intended functions.

ITAAC

In COL application Part 10, Section 2.4.7 describes the site-specific ITAACs. The staff reviewed this section for the PWS and SWDS against selection criteria in SRP Section 14.3. The staff concludes that the PWS and SWDS do not perform a safety-related function and are not considered a system "important to safety;" therefore, as-built verification, i.e., site-specific ITAAC, is not required.

9.2.4.5 *Post Combined License Activities*

There are no post COL activities related to this section.

9.2.4.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information relating to the potable and sanitary water systems, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the potable and sanitary water systems that were incorporated by reference are resolved.

In addition, the staff compared the additional supplemental information in the application to the relevant NRC regulations, the guidance in Section 9.2.4 of NUREG–0800, and other NRC regulatory guides. The staff concludes that the applicant's information on site-specific conceptual design in this section of the Fermi 3 COL FSAR is acceptable and meets the requirements of GDC 2, 4, and 60.

The staff bases its conclusion on the fact that the potable and sanitary water systems have no safety-related function and failure of the system would not compromise any safety-related system or component, nor would it prevent a safe shutdown of the plant. The EF3 CDI for the PWS and SWDS have no interface with any safety-related equipment, and no interconnections exist between the PWS and SWDS and any potentially radioactive system. In addition, flooding consequences from the PWS storage tank was evaluated and determined to be acceptance since safety-related or RTNSS SSCs would not be negatively affected from performing their intended functions.

Additionally, the staff concludes that the applicant has adequately addressed 10 CFR 52.80(a). The staff confirmed that COL ITAACs are not required for the PWS and SWDS.

9.2.5 Ultimate Heat Sink

9.2.5.1 *Introduction*

Section 9.2.5 of the ESBWR DCD Tier 2, Revision 10, describes the ultimate heat sink (UHS). The UHS consists of the isolation condenser (IC) and the passive containment cooling (PCC) pools, the dryer/separator pool and reactor well, fire protection system (FPS) makeup water for the IC/PCC pools, and SFP from the primary (Seismic Category I) firewater storage tanks via the safety-related fuel and auxiliary pools cooling system (FAPCS) piping, and other water sources that are credited for providing makeup water for the IC/PCC pools, and the SFP after water from the firewater storage tanks has been depleted. The dryer/separator pool and reactor well provide sufficient makeup water for the IC/PCC expansion pools to support operation of the IC System and PCC systems during the initial 72 hours following an accident. A source of makeup water for the SFP is not credited during this period. After the initial 72 hours, the FPS is relied upon for supplying the necessary makeup water for the IC/PCC pools and the SFP for up to seven days. The parts of the UHS that are relied upon for the first 72 hours following an accident are safety-related and are evaluated in Section 5.4,,"Reactor Coolant System Component and Subsystem Design," and Section 6.2.2, "Passive Containment Cooling System" of this SER. The parts of the UHS that are relied upon for providing makeup water during the period from 72 hours through seven days post-accident are not required to be safety-related, but must be readily available on-site and are subject to RTNSS as discussed in Chapter 19A, "Regulatory Treatment of Non-Safety Systems," of the ESBWR DCD, Revision 10. This section evaluates the adequacy of the capability that is credited for providing makeup water to the IC/PCC pools, and SFP after the initial seven days have elapsed following an accident.

9.2.5.2 *Summary of Application*

Section 9.2.5 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Subsection 9.2.5 of the certified ESBWR DCD, Revision 10. In addition, in FSAR Section 9.2.5, the applicant provides the following:

<u>*COL Item*</u>

- STD COL 9.2.5-1-A — Post Seven Day Makeup to Ultimate Heat Sink (UHS)

The applicant provided additional information in FSAR Section 9.2.5 to address DCD COL Item 9.2.5-1-A. The applicant committed (COM 9.2-001) to provide procedures that identify and prioritize available makeup water 7 days after an accident and provide instructions for establishing the necessary connections. The procedures will be developed in accordance with the procedure development milestone in Section 13.5.

9.2.5.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the relevant requirements of the Commission regulations for the UHS and the associated acceptance criteria are in Section 9.2.5 of NUREG-0800.

The applicable regulatory guidance for the evaluation of COL 9.2.5-1-A is as follows:

- GDC 2, 4, 44, 45, and 46
- GDC 5, “Sharing of structures, systems and components”
- RG 1.206, as it relates to the applicant’s cited commitment (COM) in this section

9.2.5.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.2.5 of the certified ESBWR DCD. The staff reviewed Section 9.2.5 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff’s review confirms that the information in the application and information incorporated by reference address the required information related to the UHS.

Section 1.2.3 of this SER discusses the NRC’s strategy for performing one technical review for each standard issue outside the scope of the design certification (DC) and to use this review to evaluate subsequent COL applications. To ensure that the staff’s findings on standard content that were documented in the SER with open items issued for the North Anna application are equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes made to the Fermi 3 COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the North Anna SER with open items.
- The staff confirmed that the applicant has endorsed all responses to the RAIs identified in the corresponding standard content (the North Anna SER) evaluation.
- The staff verified that the site-specific differences are not relevant to this section.

The staff has completed the review and finds the evaluation performed for the North Anna standard content to be directly applicable to the Fermi 3 COL application. This SER identifies the standard content material with italicized, double-indented formatting.

The staff reviewed the information in the Fermi 3 COL FSAR as follows:

<u>*COL Item*</u>

- STD COL 9.2.5-1-A Post Seven Day Makeup to Ultimate Heat Sink (UHS)

The following portion of this technical evaluation section is reproduced from Section 9.2.5 of the North Anna SER (ADAMS Accession No. ML091730520):

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[1] See *“Finality of Referenced NRC Approvals”* in SER Section 1.2.2 for a discussion on the staff’s review related to verification of the scope of information to be included in a COL application that references a design certification.

- *STD COL 9.2.5-1-H Post 7 Day Makeup to UHS*

The NRC staff reviewed STD COL 9.2.5-1-H related to the makeup water to the UHS included under Section 9.2.5 of the North Anna 3 COL FSAR. As discussed above in the Introduction Section, the UHS consists of both safety-related and non-safety-related SSCs. The staff's evaluation of the UHS for the ESBWR design focuses primarily on assuring that sufficient makeup water is available and can be supplied to the IC/PCC pools, and SPF for long-term cooling after the initial seven days have elapsed following an accident. Acceptability is judged based upon conformance with the regulatory basis referred to above, as applied to the standard plant design and reflected in Tier 2 of the ESBWR DCD, Revision 5, Section 9.2.5.

This COL information item is listed in Tier 2 of the ESBWR DCD, Section 9.2.5.1, "COL Information," and specifies that COL applicants need to develop procedures for supplying makeup water to the IC/PCC pools and SFP for 7 days after an accident. During the period from 72 hours up to 7 days following an accident, the FPS is credited for providing post-accident makeup water to the UHS through safety-related FAPCS piping. After 7 days, the applicant can either use offsite makeup sources to replenish the UHS water supply via safety-related FAPCS connections that are located outside the reactor and fuel buildings, or the applicant can use on-site water sources if they are available. The minimum required flow rate that is specified for post-72 hour makeup is 46 m^3/hr (200 gpm), and makeup water quality is normally required to meet demineralized water chemistry specifications. However, during accident conditions, makeup water quality that satisfies FPS or SWS chemistry specifications can be used. The post 7-day makeup water source is not required to be safety-related or subject to RTNSS, but should be from sources that are diverse or highly reliable. These considerations are discussed in Tier 2 of the ESBWR DCD, Section 9.2.5, which specifically states: "The COL applicant will develop procedures to supply makeup water 7 days after an accident (9.2.5-1-H)."

The applicant provided the following response for this COL Item:

> *"Procedures that identify and prioritize available makeup sources seven days after an accident, and provide instructions for establishing necessary connections, will be developed in accordance with the procedure development milestones in Section 13.5."*

Except for the development milestones that are referred to by the proposed response, it is not clear to what extent the other provisions of Section 13.5, "Plant Procedures," will be implemented, what makeup considerations will be addressed, what criteria will be satisfied, and how soon after an accident the makeup capability will be assessed. Therefore, the staff asked the applicant in ***RAI 9.2.5-01*** *to provide additional information to address these considerations. In a response dated August 4, 2008, the applicant described likely details associated with UHS makeup procedure development. For "STD COL 9.2.5-1-H", the applicant has committed to develop procedures to identify and prioritize available makeup sources for 7 days after an accident. In addition, the applicant made reference to Section 13.5.2.1.4, "Emergency Operating Procedures," and identified that this procedure, "STD COL 9.2.5-1-H", will be developed through the implementation of these processes. The staff determined that this approach is acceptable since the applicant committed to develop this procedure and develop the* *details to address available means of makeup delivery which includes permanent plant systems, portable equipment and temporary delivery/processing systems in NAPS FSAR Section 9.2.5. Based on the RAI response, the statement in FSAR Section 9.2.5, and the schedule defined in FSAR Section 13.5, the staff determined this issue can be closed.*

In Revision 6 of the DCD, COL STD COL 9.2.5-1-H was renamed STD COL 9.2.5-1-A. The applicant has addressed this COL information item in the same manner documented in the North Anna COL application. In addition, the applicant has identified Commitment COM 9.2-001 to track the development of makeup source procedures in order to address this COL information item in accordance with the guidance set forth in RG 1.206, Regulatory Position C.III.4.3(4). The staff evaluated COL Item STD COL 9.2.5-1-A using the relevant NRC regulations and acceptance criteria in Section 9.2.5 of NUREG-0800, along with the guidance in RG 1.206. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.2.5-1-A.

9.2.5.5 *Post Combined License Activities*

The applicant has proposed the following commitment in this section:

- Commitment (COM 9.2-001) – Procedures that identify and prioritize available makeup sources seven days after an accident, and provide instructions for establishing necessary connections, will be developed in accordance with the procedure development milestone in Section 13.5.

9.2.5.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the UHS, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the UHS that were incorporated by reference are resolved.

In addition, the staff compared the additional supplemental information in the application to the relevant NRC regulations, the guidance in Section 9.2.5 of NUREG–0800, and other NRC regulatory guides. The staff's review concludes that the applicant's information is acceptable and meets the requirements of GDC 2, 4, 5, 44, 45, and 46, and the guidance in RG 1.206. Therefore, the staff finds that the applicant has satisfactorily addressed DCD COL Item 9.2.5-1-A.

9.2.6 Condensate Storage and Transfer System

9.2.6.1 *Introduction*

This FSAR section describes the condensate storage and transfer system (CS&TS) which supplies condensate-quality water for makeup to selected plant systems. This system consists of two independent and 100 percent redundant transfer pumps, which take suction from a single condensate storage tank (CST) and provide water to interface systems as required. The CST serves as a reservoir for the CS&TS water inventory and is the normal source of water for makeup to selected plant systems. This system also provides storage capacity for condensate rejected from the condensate and feedwater system (CFS), for the condensate quality liquid waste management system (LWMS) effluent during normal operation, and for CFS and hotwell inventory during system maintenance outages. The CS&TS is not a safety-related system, and does not perform any safety-related function.

9.2.6.2 *Summary of Application*

Section 9.2.6 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 9.2.6 of the certified ESBWR DCD, Revision 10. In addition, in Fermi 3 COLA FSAR, Section 9.2.6, the applicant provides the following:

Supplemental Information

- STD SUP 9.2.6-1 System Description

The applicant provided supplemental information regarding freeze protection provided for the CS&TS.

9.2.6.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the relevant requirements of the Commission regulations for the CS&TS and the associated acceptance criteria are in Section 9.2.6 of NUREG-0800.

NUREG-0800, Section 9.2.6 states that "The safety-related portions of the CSF are protected from the effects of natural phenomena – including cold weather, tornadoes, and flooding – such that the event will not adversely affect the safety function of the system."

Since the CS&TS is not a safety-related system, and does not perform any safety-related functions, there is no applicable regulatory requirement for the freeze protection for the CS&TS.

9.2.6.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.2.6 of the certified ESBWR DCD. The staff reviewed Section 9.2.6 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the required information related to the CS&TS.

Section 1.2.3 of this SER discusses the NRC's strategy for performing one technical review for each standard issue outside the scope of the DC and to use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the North Anna application are equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes made to the Fermi 3 COL

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the North Anna SER with open items.

- The staff confirmed that the applicant has endorsed all responses to RAIs identified in the corresponding standard content (the North Anna SER) evaluation.

- The staff verified that the site-specific differences are not relevant to this section.

The staff has completed the review and finds the evaluation performed for the North Anna standard content to be directly applicable to the Fermi 3 COL application. This SER identifies the standard content material with of italicized, double-indented formatting.

The staff reviewed the information in the COL FSAR as follows:

<u>*Supplemental Information*</u>

- STD SUP 9.2.6-1 System Description

The following portion of this technical evaluation section is reproduced from Section 9.2.6 of the North Anna SER (ADAMS Accession No. ML091730520):

> - *STD SUP 9.2.6-1 System Description*
>
> *The NRC staff reviewed STD SUP 9.2.6-1 related to the freeze protection for the CS&TS included under Section 9.2.6 of the North Anna 3 COL FSAR. The staff reviewed conformance of Section 9.2.6 of the North Anna COL FSAR to the relevant NRC regulations and acceptance criteria defined in NUREG-0800, Section 9.2.6, "Condensate Storage Facilities." The staff's review finds that the applicant appropriately incorporated by reference Section 9.2 of the ESBWR DCD, Revision 5, with the following Tier 2 supplemental information added:*
>
> > *The applicant provided supplemental information as part of the FSAR with regards to CS&TS freeze protection. In FSAR Section 9.2.6, the applicant added the following text to the end of the first paragraph of Section 9.2.6.2 of the ESBWR DCD, Revision 5: "Freeze protection is provided for the CS&TS."*
>
> *The NRC staff reviewed the standard supplemental information provided in STD SUP 9.2.6-1. Freeze protection for the CS&TS is addressed in Tier 2, Section 1.2.2.12.2, "Condensate Storage and Transfer System," of the ESBWR DCD, Revision 5. Although the CS&TS does not perform or ensure any safety-related function, and is not required to achieve or maintain safe shutdown, DCD Tier 2, Section 1.2.2.12.2 specifies that if required, the CS&TS will be provided with freeze protection. A general discussion on freeze protection is provided in FSAR Section 1.2.2.12.16, "Freeze Protection." The incorporation of freeze protection in the CS&TS design is a system enhancement that has no impact on the system's regulatory compliance, but could result in increase system reliability and availability; therefore the staff finds the proposed standard supplement acceptable.*

The staff finds that the applicant's supplemental information provided in STD SUP 9.2.6-1 addresses the intent of DCD Tier 2, Section 1.2.2.12.2 with regard to incorporating freeze protection for the CS&TS.

9.2.6.5 *Post Combined License Activities*

There are no post COL activities related to this section.

9.2.6.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the CS&TS, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the CS&TS that were incorporated by reference are resolved.

In addition, the staff compared the additional supplemental information in the application to the relevant NRC regulations, the guidance in Section 9.2.6 of NUREG–0800, and other NRC regulatory guides. The staff's review concludes that the applicant's information provided in Supplemental Information STD SUP 9.2.6-1 is acceptable. The staff bases its conclusion on the fact that freeze protection in the CS&TS design is a system enhancement that has no impact on the system's regulatory compliance.

9.2.7 Chilled Water System

Section 9.2.7 of the Fermi 3 COL FSAR incorporates by reference, Section 9.2.7, "Chilled Water System," of the ESBWR DCD, Revision 10 of referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to chilled water system that were incorporated by reference are resolved.

9.2.8 Turbine Component Cooling Water System

Subsection 9.2.8 of the Fermi 3 COL FSAR incorporates by reference Section 9.2.8, "Turbine Component Cooling Water System," of the ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to TCCWS that were incorporated by reference are resolved.

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

9.2.9 Hot Water System

Subsection 9.2.9 of the Fermi 3 COL FSAR incorporates by reference Section 9.2.9, "Hot Water System," of the ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to hot water system that were incorporated by reference are resolved.

9.2.10 Station Water System

9.2.10.1 *Introduction*

This FSAR section COL describes the SWS which provides filtered and treated water as makeup to the circulating water system (CWS) cooling tower basin, the PSWS cooling tower basin, and the primary firewater tanks.

9.2.10.2 *Summary of Application*

Section 9.2.10 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 9.2.10 of the certified ESBWR DCD, Revision 10. In addition, in FSAR, Section 9.2.10, the applicant provides the following:

Site Specific Information Replacing Conceptual Design Information

- EF3 CDI Detailed System Description

The applicant provided additional site specific information to replace CDI contained in the ESBWR DCD and described the SWS. The SWS is comprised of two subsystems: (1) the plant cooling tower makeup subsystem (PCTMS) which provides makeup to the plant service water cooling towers and the main CWS cooling tower and (2) the pretreated water supply subsystem (PWSS) which is used for filling the primary firewater tanks. The applicant provided Tables 9.2-204, "Station Water System – Plant Cooling Tower Makeup System Component Design Parameters," and 9.2-205, "Station Water System – Pretreated Water Supply System Component Design Parameters, which list the design parameters of the SWS equipment. The applicant provided Figures 9.2-203, "Station Water System – Plant Cooling Tower Makeup System (PCTMS)," and 9.2-204, "Station Water System – Pretreated Water Supply System (PWSS)," which depict the SWS.

9.2.10.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, there is no associated SRP section in NUREG-0800 for the SWS.

The applicable regulatory requirement for the SWS is as follows:

- GDC 2 as it relates to ensuring that failure of the nonsafety-related system or component due to natural phenomena such as earthquakes, tornadoes, hurricanes, and floods should not adversely affect the safety-related SSCs.

9.2.10.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.2.10 of the certified ESBWR DCD. The staff reviewed Section 9.2.10 of the Fermi 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the required information related to the SWS.

The staff reviewed the information in the COL FSAR as follows:

Site Specific Information Replacing Conceptual Design Information

- EF3 CDI Detailed System Description

The NRC staff reviewed EF3 CDI related to the ESBWR conceptual design of the SWS and the design parameters for the SWS components included under Section 9.2.10 of the Fermi 3 COL FSAR.

In FSAR Subsection 9.2.10.2, "System Description," the applicant replaced the "Detailed System Description," portion of this section in the reference ESBWR DCD, Revision 10. In FSAR Subsection 9.2.10.2, the applicant provided the site specific detailed description of the SWS design proposed for Fermi 3. The SWS consists of two subsystems, the PCTMS, and the PWSS.

The PCTMS provides makeup water to the cooling tower basins for both the PSWS and the CWS to compensate for losses of inventory from the cooling towers. The PCTMS also supplies makeup water to replace water used for strainer backwashes. The PCTMS consists of a water source, pumps, strainers, connecting piping, valves and instrumentation. The applicant provided a simplified system diagram in FSAR Figure 9.2-203, and component design parameters for the PCTMS in FSAR Table 9.2-204.

The PWSS supplies water to the FPS for filling the primary firewater tanks and provides alternate cooling tower makeup to the PSWS. The PWSS also provides water for the strainers. The PWSS consists of a water source, pumps, strainers, filters, chemical injection equipment, SWST, connecting piping, valves and instrumentation. Furthermore, the applicant provided a simplified system diagram in FSAR Figure 9.2-204, and component design parameters for the PWSS in Table 9.2-205.

The applicant replaced the detailed system description in the referenced ESBWR DCD, Subsection 9.2.10.2, "System Description," with site specific EF3 CDI. The applicant did not

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

identify any departures and/or supplements, except that the applicant included additional information by providing the SWS flow diagrams in FSAR Figure 9.2-203 and 9.2-204, and component design parameters in FSAR Tables 9.2-204 and 9.2-205. In Subsection 9.2.10.3, "Safety Evaluation," of the ESBWR DCD it is stated that the SWS has no safety-related function. The DCD further states that failure of the SWS does not compromise any safety-related system or component, nor does it prevent a safe shutdown of the plant. Furthermore, the Fermi 3 SWS has no interface with any safety-related equipment, and no interconnections exist between the SWS and any potentially radioactive system. The design information in the Fermi 3 COL application does not impact the conclusions in the staff's FSER for the ESBWR DCD (NUREG-1966), and therefore the staff finds the Fermi 3 SWS design acceptable.

Based on the above discussion, the staff finds that the EF3 CDI provided in this subsection related to the site specific conceptual design of the SWS meets the requirements of GDC 2 because SWS is a nonsafety-related system, and failure of the system or its components due to natural phenomena will have no adverse affects on safety-related SSCs.

Site Specific Pre-Operational Tests

In Supplemental Information STD SUP 14.2-1 the applicant provided information in Subsection 14.2.9.1.1, "Station Water System Pre-Operation Test" to address the SWS pre-operational testing. The preoperational testing review is performed under Section 14.2 of this SER.

9.2.10.5 *Post Combined License Activities*

There are no post COL activities related to this section.

9.2.10.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the SWS, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the SWS that were incorporated by reference are resolved.

In addition, the staff concludes that the site-specific design portion of the Fermi 3 SWS is acceptable and does not change the conclusions in the staff's FSER for the ESBWR DCD, as they relate to GDC 2.

9.3 Process Auxiliaries

9.3.1 Compressed Air Systems

Subsection 9.3.1 of the Fermi 3 COL FSAR incorporates by reference Section 9.3.1, "Compressed Air Systems," of the certified ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to compressed air systems that were incorporated by reference are resolved.

9.3.2 Process Sampling System

9.3.2.1 *Introduction*

This FSAR section addresses information related to the ESBWR process sampling system (PSS). The PSS is designed to collect representative water and gaseous samples for analysis from the reactor coolant system and associated auxiliary system process streams during all normal modes of operation and following an accident. The proposed design includes permanently installed sample lines, sampling panels with analyzers and associated sampling equipment, provisions for local grab sampling, and permanent shielding. Provisions are made to ensure that representative samples are obtained from turbulent flow zones to ensure adequate mixing. Continuous sample flows are routed from selected locations to the sampling stations where pressure, temperature, and flow adjustments are made as necessary. Effluents from sample stations are returned to an appropriate process stream or to the radwaste drain headers through a common return line.

9.3.2.2 *Summary of Application*

Section 9.3.2 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 9.3.2 of the certified ESBWR DCD, Revision 10. In addition, in Fermi 3 COLA FSAR, Section 9.3.2, the applicant provides the following:

<u>*COL Item*</u>

- STD COL 9.3.2-1-A Post Accident Sampling Program

The applicant provided additional information in STD COL 9.3.2-1-A to address DCD COL Item 9.3.2-1-A. The applicant described the post-accident sampling (PAS) program which consists of emergency operating procedures that rely on installed post-accident radiation monitoring instrumentation, plant procedures for obtaining highly radioactive grab samples, a containment monitoring system capable of operation in post loss-of-coolant accident (LOCA) mode, and effluent radiation monitoring. The PAS program functions in lieu of a dedicated post-accident sampling system (PASS).

9.3.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the relevant requirements of the Commission regulations for the PSS and the associated acceptance criteria are in Section 9.3.2 of NUREG-0800.

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

The applicable regulatory requirements for the PAS program are as follows:

- GDC 64, “Monitoring Radioactivity Releases”
- Item (b) of10 CFR 20.1101(b), “Radiation Protection Programs”
- Section IV.B of Appendix E, “Emergency Planning and Preparedness for Production and Utilization Facilities,” to 10 CFR Part 50

9.3.2.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.3.2 of the certified ESBWR DCD. The staff reviewed Section 9.3.2 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff’s review confirms that the information in the application and the information incorporated by reference address the required information related to the PSS.

Section 1.2.3 of this SER discusses the NRC’s strategy for performing one technical review for each standard issue outside the scope of the DC and to use this review to evaluate subsequent COL applications. To ensure that the staff’s findings on standard content that were documented in the SER with open items issued for the North Anna application are equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes made to the Fermi 3 COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the North Anna SER with open items.
- The staff confirmed that all the applicant has endorsed responses to the RAIs identified in the corresponding standard content (the North Anna SER).
- The staff verified that the site-specific differences are not relevant to this section.

The staff has completed its review and finds the evaluation performed for the standard content to be directly applicable to the Fermi 3 COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting.

The staff reviewed the information in the COL FSAR as follows:

<u>*COL Item*</u>

- STD COL 9.3.2-1-A Post-Accident Sampling Program

The following portion of this technical evaluation section is reproduced from Section 9.3.2. of the North Anna SER (ADAMS Accession No. ML091730520):

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[1] See *“Finality of Referenced NRC Approvals”* in SER Section 1.2.2 for a discussion on the staff’s review related to verification of the scope of information to be included in a COL application that references a design certification.

- *STD COL 9.3.2-1-A Post Accident Sampling Program*

The NRC staff reviewed STD COL 9.3.2-1-A related to the post accident sampling program included under Section 9.3.2 of the North Anna 3 COL FSAR. The staff reviewed conformance of Section 9.3.2 of the North Anna 3 COL FSAR to the guidance in RG 1.206, Section C.III.1, Chapter 9, C.I.9.3.2, "Process and Post-Accident Sampling Systems." The staff's review of the North Anna 3 COL FSAR, Section 9.3.2 finds that it appropriately incorporates by reference Section 9.3.2 of the ESBWR DCD, Revision 5. In addition the applicant provided information on the North Anna 3 post-accident sampling program as required by STD COL 9.3.2-1-A of the ESBWR DCD. The post-accident sampling program meets the guidance provided in SRP Section 9.3.2.I.6 for actions required in lieu of a Post Accident Sampling System (PASS) as follows:

> *Emergency Operating Procedures that rely on Emergency Action Levels, defined in the Emergency Plan (EP), are used to classify fuel damage events. These procedures rely on installed post-accident radiation monitoring instrumentation described in DCD Section 7.5 and do not require the capability to obtain and analyze highly radioactive coolant samples although sample analyses may be used for classification as well.*
>
> *Plant procedures contain instructions for obtaining highly radioactive grab samples from the following:*
>
> - *Reactor Coolant – from the reactor water cleanup/shutdown cooling sample line using the RB Sample Station. These samples can be analyzed for the parameters indicated in DCD Table 9.3-1. If coolant activity is greater than 1.0 Ci/ml, handling of the samples is delayed to avoid overexposure of personnel.*
> - *Suppression Pool – from FAPCS sample line at the RB Sample Station. These samples can be analyzed for the parameters indicated in DCD Table 9.3-1. If coolant activity is greater than 1.0 Ci/ml, handling of the samples is delayed to avoid overexposure of personnel.*
> - *Containment Atmosphere - may be taken as described in DCD Section 11.5.3.2.12 and analyzed for fission products.*

DCD Section 7.5.2.2 describes Containment Monitoring System operation in post-LOCA mode for gaseous sampling for O2 and H2.

Effluent radiation monitoring is described in DCD Section 7.5. Field sampling and monitoring capability is maintained in accordance with the EP.

Post accident monitoring is adequate to implement the EP without reliance on post accident sampling capability; therefore, the absence of a dedicated Post-Accident Sampling System does not reduce the effectiveness of the EP.

As part of the review of FSAR, Revision, 0, Section 11.5, the staff noted that FSAR Subsection 9.3.2.2 (System Description) refers incorrectly to Section 11.5.3.2.12 of the ESBWR DCD (Tier 2) regarding available provisions for sampling the containment atmosphere. This subsection of the ESBWR DCD addresses the radiation monitoring system for the technical support center (TSC) air intake and not the containment.

Accordingly, the applicant was requested, under RAI 9.03.02-1, to update the reference citation in FSAR Section 9.3.2.2 with the proper DCD Tier 2, Chapter 11.5 subsection addressing provisions for the sampling of containment atmosphere. In response to RAI 09.03.02-1, the applicant proposed a revision to the section of the FSAR by correcting the improper reference. The staff finds that the applicant has revised their FSAR accordingly and RAI 09.03.02-1 is resolved.

The staff finds that the North Anna 3 COL FSAR has adequately addressed STD COL 9.3.2-1-A by providing information that adequately describes the North Anna Unit 3 post-accident sampling program capability.

The staff evaluated COL Item STD COL 9.3.2-1-A using the relevant NRC regulations and acceptance criteria in Section 9.3.2 of NUREG-0800. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.3.2-1-A with respect to the requirements of GDC 64, 10 CFR 20.1101(b) and Section IV.B of Appendix E to 10 CFR Part 50.

9.3.2.5 *Post Combined License Activities*

There are no post COL activities related to this section.

9.3.2.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the PSS, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the PSS, that were incorporated by reference are resolved.

In addition, the staff compared the additional supplemental information in the application to the relevant NRC regulations, the guidance in Section 9.3.2 of NUREG–0800, and other NRC regulatory guides. The staff's review concludes that the applicant's information presented in this section of the FSAR is acceptable and meets the requirements of GDC 64, 10 CFR 20.1101(b), and Section IV.B of Appendix E to 10 CFR Part 50. Therefore, staff finds that the applicant has satisfactorily addressed DCD COL Item 9.3.2-1-A.

9.3.3 Equipment and Floor Drain System

Section 9.3.3 of the Fermi 3 COL FSAR incorporates by reference Section 9.3.3, "Equipment and Floor Drain System," of the certified ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to equipment and floor drain system that were incorporated by reference are resolved.

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

9.3.4 Chemical and Volume Control System

Section 9.3.4 of the Fermi 3 COL FSAR incorporates by reference Section 9.3.4, “Chemical and Volume Control System,” of the certified ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff’s review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to chemical and volume control system that were incorporated by reference are resolved.

9.3.5 Standby Liquid Control System

9.3.5.1 *Introduction*

This FSAR section addresses the standby liquid control system (SLCS) which is an independent reactivity control system designed to provide both manual and automatically initiated capability for bringing the reactor from full power and minimum control rod inventory to a subcritical condition with the reactor in the most reactive state without taking credit for control rod movement. The SLCS performs safety-related functions; therefore, it is classified as safety-related and is designed as a Seismic Category I system. The SLCS meets the following safety design bases by providing: (1) a diverse backup capability, independent of normal reactor shutdown methods, to shutdown the reactor when the control rods fail to insert during AOOs and anticipated transients without scram (ATWS), and (2) makeup water to the reactor pressure vessel (RPV) to mitigate the consequences of a LOCA.

The SLCS is a passive system which consists of two identical and separate trains. Each SLCS train includes a nitrogen pressurized accumulator containing sodium pentaborate solution and is connected by piping through two parallel injection squib valves to the RPV. Each SLCS provides 50 percent of the required SLCS injection capacity required for an ATWS event.

9.3.5.2 *Summary of Application*

Section 9.3.5 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 9.3.5 of the certified ESBWR DCD, Revision 10. In addition, in Fermi 3 COLA FSAR, Section 9.3.5, the applicant provides the following:

<u>*Supplemental Information*</u>

- STD SUP 9.3.5-1 System Description

The applicant provided the following supplemental information:

In Supplemental Information STD SUP 9.3.5-1, the applicant added the following to the end of the fifth paragraph under “Detailed System Description” of DCD Section 9.3.5.2, “System Description”:

> “The above provisions adequately prevent loss of solubility of borated solutions (sodium pentaborate).”

9.3.5.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the relevant requirements of the Commission regulations for the SLCS and the associated acceptance criteria are in Section 9.3.5 of NUREG-0800.

The applicable regulatory requirements for the SLCS thermal environmental conditions are as follows:

- GDC 2, 4 and 5
- GDC 26, "Reactivity control system redundancy and capability"
- GDC 27, "Combined reactivity control systems capability"
- Item (c)(4) of 10 CFR 50.62(c)(4), "Requirements for reduction or risk from anticipated transients without scram (ATWS) events for light-water-cooled nuclear power plants"
- 10 CFR 52.80(a)

9.3.5.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.3.5 of the certified ESBWR DCD. The staff reviewed Section 9.3.5 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the required information related to the SLCS.

Section 1.2.3 of this SER discusses the NRC's strategy for performing one technical review for each standard issue outside the scope of the DC and to use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the North Anna application are equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes made to the Fermi 3 COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the North Anna SER with open items.
- The staff confirmed that the applicant has endorsed all responses to the RAIs identified in the corresponding standard content (the North Anna SER) evaluation were endorsed.
- The staff verified that the site-specific differences are not relevant to this section.

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

The staff completed the review and finds the evaluation performed for the North Anna standard content to be directly applicable to the Fermi 3 COL application. This SER identifies the standard content material with of italicized, double-indented formatting.

The staff reviewed the information in the COL FSAR as follows:

Supplemental Information

- STD SUP 9.3.5-1 System Description

The following portion of this technical evaluation section is reproduced from Section 9.3.5 of the North Anna SER (ADAMS Accession No. ML091730520):

> - *STD SUP 9.3.5-1 System Description*
>
> *The NRC staff reviewed STD SUP 9.3.5-1-A related to the SLCS included under Section 9.3.5 of the North Anna 3 COL FSAR. The NRC staff reviewed conformance of Section 9.3.5 of the COL FSAR to the guidance in RG 1.206, Section C.III.1, Chapter 9, C.I.9.3.5, "Standby Liquid Control System (BWRs)." The staff's review of Section 9.3.5 of the COL FSAR finds that it appropriately incorporates by reference Section 9.3.5 of the ESBWR DCD, Revision 5.*
>
> *The staff review of this application is limited to the following item: STD SUP 9.3.5-1 in which the applicant summarized that the provisions adequately prevent loss of solubility of borated solutions (sodium pentaborate).*
>
> *The NRC staff reviewed the resolution to the supplementary item related to the provisions to prevent loss of solubility of borated solutions (sodium pentaborate) included under Section 9.3.5.2 of the North Anna 3 COL FSAR. STD SUP 9.3.5-1, supplemental information item, is an editorial change which enlightens and summarizes the technical information of the previous paragraphs in the DCD with respect to preventing the loss of solubility of borated solutions of the SLCS. The statement does not alter the technical information related to preventing loss of solubility of borated solutions and hence is acceptable.*

The staff evaluated COL Item STD SUP 9.3.5-1 using the relevant NRC regulations and acceptance criteria in Section 9.3.5 of NUREG-0800. The staff finds that the applicant has satisfactorily addressed the requirements of GDC 2, 4, 5, 26, 27, 10 CFR 50.62(c)(4), and 10 CFR 52.80(a).

9.3.5.5 *Post Combined License Activities*

There are no post COL activities related to this section.

9.3.5.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the SLCS, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the SLCS, that were incorporated by reference are resolved.

In addition, the staff compared the supplemental information in the COL application to the relevant NRC regulations, the guidance in Section 9.3.5 of NUREG–0800, and other NRC regulatory guides. The staff's review concludes that applicant's information in this section of the COL FSAR is acceptable and meets the requirements of GDC 2, 4, 5, 26, 27, 10 CFR 50.62(c)(4), and 10 CFR 52.80(a). The staff has evaluated STD SUP 9.3.5-1 to the relevant NRC regulations and acceptance criteria in Section 9.3.5 of NUREG-0800. The staff finds that the applicant has satisfactorily addressed the necessary requirements.

9.3.6 Instrument Air System

Subsection 9.3.6 of the Fermi 3 COL FSAR incorporates by reference Section 9.3.6, "Instrument Air System," of the certified ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to instrument air system that were incorporated by reference are resolved.

9.3.7 Service Air System

Subsection 9.3.7 of the Fermi 3 COL FSAR incorporates by reference Section 9.3.7, "Service Air System," of the certified ESBWR DCD, Revision 10,referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to service air system that were incorporated by reference are resolved.

9.3.8 High Pressure Nitrogen Supply System

Subsection 9.3.8 of the Fermi 3 COL FSAR incorporates by reference Section 9.3.8, "High Pressure Nitrogen Supply System," of the certified ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to high pressure nitrogen supply system that were incorporated by reference are resolved.

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[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

9.3.9 Hydrogen Water Chemistry System

9.3.9.1 *Introduction*

This FSAR section describes the hydrogen water chemistry (HWC) system (HWCS) which injects hydrogen into the feedwater system at the suction of the feedwater pumps to reduce oxidizing species in the reactor coolant system. The addition of hydrogen reduces the likelihood of corrosion failures that would adversely affect plant availability. Oxygen is injected into the offgas system to ensure a proper mixture of hydrogen and oxygen.

ESBWR DCD, Section 9.3.9 addresses information related to the ESBWR HWCS. The ESBWR standard plant design includes the capability to incorporate a HWCS.

9.3.9.2 *Summary of Application*

Subsection 9.3.9 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Subsection 9.3.9 of the certified ESBWR DCD, Revision 10. In addition, in Fermi 3 COLA FSAR, Subsection 9.3.9, the applicant provides the following:

COL Items

- STD COL 9.3.9-1-A Implementation of Hydrogen Water Chemistry

The applicant provided additional information in STD COL 9.3.9-1-A to address DCD COL Item 9.3.9-1-A. The applicant stated that the HWC option is included in the plant's design.

- EF3 COL 9.3.9-2-A Hydrogen and Oxygen Storage and Supply

The applicant provided additional information in EF3 COL 9.3.9-2-A to address DCD COL Item 9.3.9-2-A. The applicant stated that the hydrogen supply system for the HWCS will meet the requirements of ASME Code, Section VIII, "Rules for Construction of Pressure Vessels," Division 1: Electric Power Research Institute (EPRI) Report NP-4947-SR, "BWR Hydrogen Water Chemistry Guidelines" and EPRI Report NP-4947-SR and EPRI Report NP-5289-SR-A, "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations".

Site Specific Information Replacing Conceptual Design Information

- EF3 CDI System Description

The applicant provided additional information to replace CDI in the ESBWR DCD. The applicant described the HWC injection points and states that a monitoring system is provided to track the effectiveness of the HWCS.

- EF3 CDI Hydrogen Storage Facility

The applicant provided additional information to replace CDI in the ESBWR DCD. The applicant provided a description of the hydrogen storage facility. The hydrogen is stored in an 68.13-m^3 (18,000 gallon) ASME Section VIII, Division 1 cryogenic tank located outside the plant protected area.

- STD CDI Power Generation Design Basis

The applicant provided additional information to replace CDI in the ESBWR DCD. The applicant stated that hydrogen is injected into the feedwater at the suction of the feedwater pumps and oxygen is injected into the off-gas system.

- STD CDI Inspection and Testing Requirements

The applicant provided additional information to replace CDI in the ESBWR DCD. The applicant stated that the connections for the HWCS are tested and inspected with the feedwater and off-gas piping. Major components of the HWCS are inspected and tested as separate components prior to installation.

- STD CDI Instrumentation and Controls

The applicant provided additional information to replace CDI in the ESBWR DCD. The applicant stated that instrumentation is provided to control the injection of hydrogen and to augment the injection of oxygen.

9.3.9.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, there is no associated SRP section in NUREG-0800 for the HWCS. However, the staff uses the following applicable industry standards and requirements for the HWCS:

- EPRI Report NP-4947-SR, 1987 Revision
- EPRI Report NP-5283-SR-A, 1987 Revision

9.3.9.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.3.9 of the certified ESBWR DCD. The staff reviewed Section 9.3.9 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the required information related to the HWCS.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the North Anna application are equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes made to the Fermi 3 COL

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the North Anna SER with open items.

- The staff confirmed that the applicant has endorsed all responses to the RAIs identified in the corresponding standard content (the North Anna SER) evaluation were endorsed.

- The staff verified that the site-specific differences are not relevant to this section.

The staff has completed the review and finds the evaluation performed for the North Anna standard content to be directly applicable to the Fermi 3 COL application. This SER identifies the standard content material with italicized, double-indented formatting.

The staff reviewed the information in the COL FSAR as follows:

<u>*COL Items*</u>

The following portion of this technical evaluation section is reproduced from Section 9.3.5 of the North Anna SER (ADAMS Accession No. ML091730520):

- *STD COL 9.3.9-1-A Implementation of Hydrogen Water Chemistry*

The HWCS is composed of hydrogen and oxygen supply systems to inject hydrogen in the feedwater and oxygen in the off-gas while several monitoring systems track the effectiveness of the HWCS. Provisions are made in the design to allow for installation of a system adding hydrogen to the feedwater at the suction of the feedwater pumps. The ESBWR DCD requires that the HWCS utilizes the guidance included in the Electric Power Research Institute (EPRI) Report NP-4947-SR, "BWR Hydrogen Water Chemistry Guidelines," 1987 Revision. The report provides guidelines on how to operate the HWCS. The NRC staff has endorsed the report in its SER of the EPRI Utility Requirements Document and on that basis the staff finds Report NP-4947-SR, 1987 Revision acceptable. In addition, the staff finds that the North Anna COL FSAR has adequately addressed STD COL 9.3.2-1-A by providing information that adequately describes the North Anna Unit 3 HWCS and incorporates the EPRI guidance

The staff evaluated COL Item STD COL 9.3.9-1-A t using the relevant NRC endorsed EPRI guidelines. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.3.9-1-A.

- EF3 COL 9.3.9-2-A Hydrogen and Oxygen Storage and Supply

The HWCS is nonsafety-related; however, given the potential for hydrogen combustion or detonation, the handling of hydrogen at nuclear power plant facilities needs to be safe, reliable, and consistent with the requirements for using hydrogen gas. The ESBWR DCD requires that any HWCS installations including the means for storing and handling hydrogen meet the EPRI Report NP-5283-SR-A, "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations." The EPRI report provides guidance on an acceptable method to store and handle hydrogen at nuclear power facilities. The staff has approved EPRI Report NP-5283-SR-A in a letter dated July 13, 1987 from J.E. Richardson to G.H. Niels (Legacy ADAMS Accession Nos. 8707230357 and 8707240210). Therefore, the staff finds that the Fermi 3 COL FSAR specifies an acceptable method to handle and store hydrogen for the HWCS and incorporates the EPRI guidance.

Site Specific Information Replacing Conceptual Design Information

The staff finds that all the EF3 and STD CDIs listed below are acceptable because they do not affect the Staff's safety evaluation of the HWCS in the ESBWR DCD. These site-specific CDIs also do not affect the COL applicant's incorporation of the EPRI guidelines as the main guidance for the proper operation and installation of the HWCS.

- EF3 CDI System Description

The staff finds the CDI acceptable because it provides a monitoring system to track the effectiveness of the HWCS.

- EF3 CDI Hydrogen Storage Facility

The staff finds that the Fermi 3 COL FSAR specifies an acceptable method to store hydrogen.

- STD CDI Power Generation Design Basis

The staff finds the CDI acceptable because it provides the location where each gas is injected

- STD CDI Inspection and Testing Requirements

The staff finds the CDI acceptable because it ensures the HWCS will work as designed.

- STD CDI Instrumentation and Controls

The staff finds the CDI acceptable because it provides information on the proper functionality of the HWCS.

9.3.9.5 *Post Combined License Activities*

There are no post COL activities related to this section.

9.3.9.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the HWCS, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the HWCS, that were incorporated by reference are resolved.

In addition, the staff compared the additional COL supplemental information in the application to the relevant NRC regulations, the guidance in applicable industry standards, and other NRC regulatory guides. The staff's review concludes that the applicant's information on STD CDI and EF3 CDI in this FSAR section is acceptable and meets the NRC endorsed EPRI guidelines.

The staff also finds that the applicant has satisfactorily addressed DCD COL Items 9.3.9-1-A and 9.3.9-2-A with respect to the NRC endorsed EPRI guidelines.

9.3.10 Oxygen Injection System

9.3.10.1 *Introduction*

This FSAR section addresses information related to the ESBWR oxygen injection system (OIS). The OIS does not perform any safety-related function. The OIS is designed to add oxygen to the CFS in order to reduce corrosion and suppress corrosion product release. Industry experience has shown that the most beneficial oxygen concentration is between 30 to 200 parts per billion (ppb). The OIS is also designed to inject oxygen into the off-gas system when the HWCS is implemented, to ensure that excess hydrogen in the off-gas stream is recombined.

9.3.10.2 *Summary of Application*

Section 9.3.10 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 9.3.10 of the certified ESBWR DCD, Revision 10. In addition, in Fermi 3 COLA FSAR, Section 9.3.10, the applicant provides the following:

<u>*COL Item*</u>

- EF3 COL 9.3.10-1-A Oxygen Storage Facility

The applicant provided additional information in EF3 COL 9.3.10-1-A to address DCD COL Item 9.3.10-1-A. The applicant described the bulk oxygen storage facility which consists of a 34.07-m^3 (9,000 gallon) ASME Section VIII, Division 1 cryogenic tank located outside the plant fenced area. The tank is equipped with an atmospheric vaporizer, a pressure regulating valve, an excess flow check valve and relief valves.

9.3.10.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, there is no associated SRP section in NUREG-0800 for the oxygen storage facility. However, the staff uses the following applicable industry standards and requirements for the HWCS:

- EPRI Report NP-4947-SR, 1987 Revision
- EPRI Report NP-5283-SR-A, 1987 Revision

9.3.10.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.3.10 of the certified ESBWR DCD. The staff reviewed Section 9.3.10 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

information in the application and the information incorporated by reference address the required information related to the OIS.

The staff reviewed the information in the COL FSAR as follows:

<u>*COL Item*</u>

- EF3 COL 9.3.10-1-A Oxygen Storage Facility

The NRC staff reviewed COL Item EF3 COL 9.3.10-1-A related to the oxygen storage facility included under Section 9.3.10 of the Fermi 3 COL FSAR. The OIS is designed to add sufficient oxygen (30 to 200 ppb) to reduce corrosion, general corrosion, and the release of corrosion products in the CFSs. The requirements for design, operation, maintenance, surveillance, and testing of the oxygen storage facility are specified in EPRI Report NP-5283-SR-A. The ESBWR DCD requires that any HWCS and OIS installations meet the guidance in EPRI Report NP-5283-SR-A. In addition, the oxygen storage facility is located in an area where the amount of combustible material is limited through design and administrative controls. Fermi 3 COL FSAR uses the guidance of EPRI Report NP-5283-SR-A to store and handle oxygen. The staff has approved EPRI Report NP-5283-SR-A in a letter dated July 13, 1987 from J.E. Richardson to G.H. Niels (Legacy ADAMS Nos. 8707230357 and 8707240210). Therefore, the staff finds that the Fermi 3 COL FSAR specifies an acceptable method to handle and store oxygen for the OIS and incorporates the EPRI guidance..

In addition, the staff finds that the Fermi 3 COL FSAR has adequately addressed COL Item EF3 COL 9.3.2-1-A by providing (1) information that adequately describes the Fermi 3 oxygen injection module of the HWCS and (2) an acceptable description of the oxygen storage facility.

9.3.10.5 *Post Combined License Activities*

There are no post COL activities related to this section.

9.3.10.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the OIS, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the OIS, that were incorporated by reference are resolved.

In addition, the staff compared the additional COL supplemental information in the application to the relevant NRC regulations, the guidance in applicable industry standards, and other NRC regulatory guides. The staff's review concludes that the applicant's information in this FSAR section is acceptable and meets the NRC endorsed EPRI guidelines. The staff also finds that the applicant has satisfactorily addressed DCD COL Item 9.3.10-1-A with respect to the NRC-endorsed EPRI guidelines.

9.3.11 Zinc Injection System

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.3.11 of the certified ESBWR DCD. The staff reviewed Section 9.3.11 "Zinc Injection System" of the Fermi 3

COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1]

Section 9.3.11 of the ESBWR DCD states that the ESBWR Standard Plant design includes provisions for connecting an optional Zinc Injection System (ZIS). This section also provides two COL Items, stating that the COL applicant shall determine if a ZIS is required to be implemented at startup based on plant configuration and material selection (COL 9.3.11-1-S), and if a ZIS were to be installed the applicant shall include necessary information on system description, test and inspection (COL 9.3.11-2-A). In FSAR Section 9.3.11 of the Fermi 3 COL FSAR the applicant stated that for both COL Items (STD COL 9.3.11-1-A and STD COL 9.3.11-2-A) a ZIS will not be utilized. The NRC staff's review confirms that the applicant has addressed the relevant information and no outstanding information is expected to be addressed in the COL FSAR related to this subsection. From a dose reduction perspective of the ZIS, in Section 12.3 of this SER, the staff provides an evaluation of the applicant's justification for not using ZIS.

The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this subsection. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Appendix E, Section VI.B.1, all nuclear safety issues relating to ZIS that were incorporated by reference are resolved.

9.3.12 Auxiliary Boiler System

Subsection 9.3.12 of the Fermi 3 COL FSAR incorporates by reference Section 9.3.12, "Auxiliary Boiler System," of the ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to auxiliary boiler system that were incorporated by reference are resolved.

9.4 Heating, Ventilation, and Air Conditioning

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.4 of the certified ESBWR DCD. The staff reviewed Section 9.4 "Heating, Ventilation, and Air Conditioning" of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1]

In Fermi 3 COL Revision 3, the applicant identified Departure DEP 11.4-1 as having a Tier 2 impact on the information contained in this section. In addition, in Part 7 of the Fermi 3 COL application, Revision 3, the applicant classified the above departure as a Tier 1 Departure. In a letter dated August 24, 2011 (ADAMS Accession No. ML11238A049), the applicant re-classified this departure as a Tier 2 departure that does not require prior NRC approval in accordance with

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

10 CFR Part 52, Appendix E, Section VIII.B.5. In addition, the applicant revised Section 9.4 of the Fermi 3 FSAR to fully incorporate by reference Section 9.4 of the DCD with no departures or supplements. This item was tracked as Confirmatory Item 9.4-1. The staff has confirmed that these changes have been incorporated into the Fermi 3 COL FSAR. Therefore, Confirmatory Item 9.4-1 is closed.

The staff's review confirms that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the heating, ventilation, and air conditioning (HVAC) that were incorporated by reference are resolved.

9.5 Other Auxiliary Systems

9.5.1 Fire Protection System

9.5.1.1 *Introduction*

This FSAR section describes the FPS which provides assurance, through a defense-in-depth philosophy, that the Commission's fire protection objectives are satisfied. These objectives are: (1) to prevent fires from starting; (2) to detect rapidly, control, and extinguish promptly those fires that do occur; and (3) to provide protection for SSCs important to safety so that a fire that is not promptly extinguished by the fire suppression activities will not prevent the safe shutdown of the plant. In addition, the FPS must be designed such that a failure or inadvertent operation does not adversely impact the ability of the SSCs important to safety to perform their safety functions. The FPS has a RTNSS function to provide post 72 hour makeup to the IC/PCC pools and the SFP.

9.5.1.2 *Summary of Application*

Section 9.5.1, Appendices 9A, and 9B of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 9.5.1, Appendices 9A and 9B of the certified ESBWR DCD, Revision 10. In addition, in Fermi 3 COL FSAR Section 9.5.1 and Appendix A the applicant provides the following:

<u>*Tier 2 Departure Not Requiring NRC Approval*</u>

EF3 DEP 11.4-1	Long-Term, Temporary Storage of Class B and C Low-Level Radioactive Waste

In Part 7 of the Fermi 3 COL application, Revision 3, the applicant classified Departure EF3 DEP 11.4-1 as a Tier 1 departure. In letter dated August 24, 2011 (ADAMS Accession No. ML11238A049), the applicant re-classified this Departure as a Tier 2 Departure that does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix E, Section VIII.B.5.

The applicant summarizes this departure as follows:

> The ESBWR DCD identifies that on-site storage space for a six-month volume of packaged waste is provided in the Radwaste Building (RWB). The Fermi 3 Radwaste Building is configured to accommodate a minimum of ten years volume of packaged Class B and C waste, while maintaining space for at least three months of packaged

Class A waste. This departure is affected by reconfiguring the arrangement of systems and components within the ESBWR RWB volume. The systems structures and components requiring re-arrangement are associated with the LWMS and Solid Waste Management System (SWMS). The existing Radwaste Building Fire Protection and HVAC Systems have sufficient capacity to accommodate the extra volume of Class B and C wastes, and require no modification.

<u>*COL Item*s</u>

- EF3 COL 9.5.1-1-A Secondary Firewater Storage Source

The applicant provided additional information in COL Item EF3 COL 9.5.1-1-A to address DCD COL Item 9.5.1-1-A. The applicant identified Lake Erie as the secondary source of water. The lake has a capacity well in excess of 2,082 m^3 (550,000 gallons) as specified in ESBWR DCD, Revision 10, and as per guidance given in RG 1.189, "Fire Protection for Nuclear Power Plants," Regulatory Position 3.2.1.

- EF3 COL 9.5.1-2-A Secondary Firewater Capacity

The applicant provided additional information in EF3 COL 9.5.1-2-A to address DCD COL Item 9.5.1-2-A. The applicant stated that tests will be performed to demonstrate that the secondary fire protection pump circuit supplies the required flow and pressure at the turbine building/yard interface boundary. DCD Subsection 14.2.8.1.39 which is incorporated by reference states that FPS tests are in accordance with the criteria in codes and standards listed in Table 9.5-1. Therefore, secondary pump curve tests and flow test will be in accordance with National Fire Protection Association (NFPA) 20, "Standard for the Installation of Stationary Pumps for Fire Protection."

- EF3 COL 9.5.1-4-A Piping and Instrumentation Diagrams

The applicant provided additional information in EF3 COL 9.5.1-4-A to address DCD COL Item 9.5.1-4-A. The applicant provided Figure 9.5-201, and DCD Figure 9.5-1 depicting the site-specific firewater supply piping.

- STD COL 9.5.1-5-A Fire Barriers

The applicant provided additional information in STD COL 9.5.1-5-A to address DCD COL Item 9.5.1-5-A. The applicant stated that the mechanical and electrical penetration seals and electrical raceway fire barrier systems are qualified to the requirements in RG 1.189 through testing by a recognized laboratory in accordance with the applicable guidance of NFPA 251, "Standard Methods of Test of Fire Resistance of Building Construction and Materials," and/or ASTM E-119, "Standard Test Methods for Fire Tests of Building Construction and Materials". Certification test results will be available for review at least six months prior to receipt of fuel.

- STD COL 9.5.1-6-A Smoke Control

The applicant provided additional information in STD COL 9.5.1-6-A to address DCD COL Item 9.5.1-6-A. The applicant stated that the procedures for manual smoke control will be developed as part of the Fire Protection Program implementation. The program will be operational for areas storing new fuel and adjacent fire areas that could affect the fuel storage area prior to receipt of the fuel. Other required elements of the Fire Protection Program will be operational prior to initial fuel load.

- STD COL 9.5.1-7-A Fire Hazards Analysis (FHA) Compliance Review

The applicant provided additional information in STD COL 9.5.1-7-A to address DCD COL Item 9.5.1-7-A. The applicant stated that the compliance review of the as-built design against the assumptions and requirements stated in the fire hazards analysis (FHA) will be completed prior to fuel load.

- STD COL 9.5.1-8-A Fire Protection Program Description

The applicant provided additional information in STD COL 9.5.1-8-A to address DCD COL Item 9.5.1-8-A. The applicant stated that the fire protection program will be operational for areas storing new fuel and adjacent fire areas that could affect the fuel storage area prior to receipt of the fuel. Other required elements of the fire protection program will be operational prior to initial fuel load per FSAR Section 13.4.

- EF3 COL 9.5.1-10-A Fire Brigade

The applicant provided additional information in EF3 COL 9.5.1-10-A to address DCD COL Item 9.5.1-10-A. The applicant stated that the fire brigade will be implemented in accordance with the milestones in FSAR Section 13.4 for the Fire Protection Program.

- STD COL 9.5.1-11-A Quality Assurance

The applicant provided additional information in STD COL 9.5.1-11-A to address DCD COL Item 9.5.1-11-A. The applicant stated the following:

"Quality assurance controls are applied to the activities involved in the design, procurement, installation, and testing and the administrative controls of FPS, in accordance with the measures outlined in Chapter 17.

For the operational fire protection program, the Quality Assurance Program implements the requirements of RG 1.189 through site-specific administrative controls procedures. The procedures will be developed six months before fuel receipt and will be fully implemented prior to fuel receipt."

- EF3 COL 9A.7-1-A Yard Fire Zone Drawings

The applicant provided additional information in EF3 COL 9A.7-1-A to address DCD COL Item 9A.7-1-A. EF3 COL 9A.7-1-A provides fire zone drawings for the site-specific portions of the Yard.

- EF3 COL 9A.7-2-A Detailed Fire Hazards Analysis of the Yard

The applicant provided additional information in EF3 COL 9A.7-2-A to address DCD COL Item 9A.7-2-A. The applicant commits (COM 9A-001) to performing a detailed FHA of the yard area, service building, and service water treatment building that is outside the scope of the certified design. This information will be provided six months prior to fuel load.

<u>*Supplemental Information*</u>

- EF3 SUP 9.5.1-1 and EF3 SUP 9A-01 Codes, Standards and Regulatory Guidance

The applicant provided Table 9.5-201 to supplement DCD Table 9.5-1 for those portions of the Fire Protection Program that are not addressed in the ESBWR DCD and for operational aspects of the fire detection and suppression systems. In addition, the applicant provided Table 1.9-204 which identifies the relevant editions for each applicable code and standard.

- STD SUP 9.5.1-3 Combustible and Ignition Source Controls

The applicant revised FSAR Subsection 9.5.1.15.6 to add combustible and ignition source controls for areas adjacent to the main control room (MCR) and in computer rooms that are not part of the control room complex and to (1) prohibit storage of transient combustibles below the raised floor in the MCR complex and (2) prohibit the storage of hazardous chemicals in areas that contain or expose equipment important to safety.

9.5.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the relevant requirements of the Commission regulations for the FPS and the associated acceptance criteria are in Section 9.5.1 of NUREG-0800.

In accordance with Section VIII, “Process for Changes and Departures,” of Appendix E to Part 52 “Design Certification Rule for the U.S. Economic Simplified Boiling Water Reactor,” the applicant has identified a Tier 2 Departure not requiring NRC approval for this subsection. Tier 2 departures not requiring prior NRC approval are subject to the requirements of 10 CFR Part 52, Appendix E, Section VIII.B.5, which are similar to the requirements in 10 CFR 50.59, “Changes, tests, and experiments.”.

The applicable regulatory requirements and associated guidance/standards for the Fire Protection Program are as follows:

- 10 CFR Part 50.48, “Fire Protection”
- GDC 3 and 5
- GDC 19, “Control room”
- GDC 23, “Protection system failure modes”
- Item (d) of 10 CFR 52.79(d), “Contents of applications; technical Information in Final Safety analysis Report”

- 10 CFR 52.80(a)

- SECY-90-016, “Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements”

- SECY-93-087, “Policy, Technical, and Licensing Issues pertaining to Evolutionary and Advanced Light-Water Reactor Designs”

- SECY-94-084, “Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs”

- RG 1.189, Revision 2

- RG 1.206, as it relates to the applicant’s cited commitments in this subsection

9.5.1.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.5.1 of the certified ESBWR DCD. The staff reviewed Section 9.5.1 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff’s review confirms that the information in the application and the information incorporated by reference address the required information related to the FPS.

Section 1.2.3 of this SER discusses the NRC’s strategy for performing one technical review for each standard issue outside the scope of the DC and to use this review in evaluating subsequent COL applications. To ensure that the staff’s findings on standard content that were documented in the SER with open items issued for the North Anna application are equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes made to the Fermi 3 COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the North Anna SER with open items.

- The staff confirmed that the applicant has endorsed all responses to the RAIs identified in the corresponding standard content (the North Anna SER) evaluation were endorsed.

- The staff verified that the site-specific differences are not relevant to this section.

The staff has completed the review and finds the evaluation performed for the North Anna standard content to be directly applicable to the Fermi 3 COL application. This SER identifies the standard content material with italicized, double-indented formatting.

[1] See *“Finality of Referenced NRC Approvals”* in SER Section 1.2.2 for a discussion on the staff’s review related to verification of the scope of information to be included in a COL application that references a design certification.

The staff reviewed the relevant information in the COL FSAR:

Tier 2 Departure Not Requiring Prior NRC Approval:

EF3 DEP 11.4-1	Long-Term, Temporary Storage of Class B and C Low-Level Radioactive Waste

Under Departure EF3 DEP 11.4-1, the applicant has reconfigured specific areas of the RWB to accommodate the long-term storage of Class B and Class C low-level radioactive waste. The reconfiguration involves plant systems and components within specific areas of the ESBWR RWB. The SSCs requiring re-arrangement are associated with the LWMS and SWMS. The applicant stated that the existing RWB fire protection and HVAC systems have sufficient capacity to accommodate the volumes of Class B and C wastes stored in the designated area, and require no modification. For more information regarding the technical discussion of this departure, please see Section 11.4 of this SER.

With respect to the review scope of Subsection 9.5.1, due to Departure EF3 DEP 11.4-1 the applicant has replaced DCD Tier 2, Table 9A.5-5 with FSAR Tier 2, Table 9A.5-5R. In addition, the applicant has replaced DCD Tier 2 Figures 9.A-2-20 through Figure 9.A-2-24 with FSAR Tier 2, Figures 9.A-2-20R through Figure 9.A-2-24R.

The applicant's Part 7 Departures Report evaluation in accordance with 10 CFR Part 52, Appendix E, Section VIII, Item B.5 determined that this departure does not require prior NRC approval. Within the review scope of this section, the staff reviewed the proposed changes specified above and finds it reasonable that the departure does not require prior NRC approval since they should not have any adverse effect on the fire protection system. In addition, the applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

As stated above, in Part 7 of the Fermi 3 COL Revision 3, the applicant classified the above departure as a Tier 1 departure. In a letter dated August 24, 2011 (ADAMS Accession No. ML11238A049), the applicant re-classified this Departure as a Tier 2 departure that does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix E, Section VIII.B.5 as discussed above. This item was tracked as Confirmatory Item 9.5.1-1. The staff has confirmed that these changes have been incorporated into the Fermi 3 COL FSAR. Therefore Confirmatory Item 9.5.1-1 is closed.

COL Items

- EF3 COL 9.5.1-1-A — Secondary Firewater Storage Source

The NRC staff reviewed EF3 COL 9.5.1-1-A related to secondary firewater sources included under Section 9.5.1.4 of the Fermi 3 COL FSAR, Revision 7. The staff has determined that the secondary firewater source is Lake Erie, which is well in excess of the 2,082 m^3 (550,000 gallons) specified in the ESBWR DCD, Revision 10, and is also in excess of the guidance given in RG 1.189 Regulatory Position 3.2.1 for a secondary firewater source. The staff finds that the Fermi 3 COL FSAR fully addresses this COL Information Item.

- EF3 COL 9.5.1-2-A Secondary Firewater Capacity

The NRC staff reviewed EF3 COL 9.5.1-2-A related to secondary firewater capacity included under Subsection 9.5.1.4 of the Fermi 3 COL FSAR, Revision 7. The staff has determined that each secondary fire pump will be tested to show that each pump can supply a minimum of 484 m^3 per hour (m^3/hr) (2130 gpm) with sufficient discharge pressure to develop a minimum of 738 kilopascal gage (kPaG) (107 pounds per square inch gage (psig)) at the turbine building/yard interface boundary, which is the level required by the DCD. DCD Subsection 14.2.8.1.39 which is incorporated by reference states that FPS tests are in accordance with the criteria in codes and standards listed in Table 9.5-1. Therefore, secondary pump curve tests and flow test will be in accordance with NFPA 20. However, this testing cannot be performed until the system is built and the applicant has specified that this testing will be completed prior to fuel receipt. The applicant has identified Commitment COM 9.5-001 as a commitment to track the testing of the secondary fire capacity in order to address this COL information item in accordance with the guidance set forth in RG 1.206, Regulatory Position C.III.4.3(4). The staff evaluated EF3 COL 9.5.1-2-A using the relevant NRC regulations and acceptance criteria in Section 9.5.1 of NUREG-0800, along with the guidance in RG 1.206. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.5.1-2-A.

- EF3 COL 9.5.1-4-A Piping and Instrumentation Diagrams

The NRC staff reviewed EF3 COL 9.5.1-4-A related to the site specific simplified piping and instrumentation diagrams included under Section 9.5.1 of the Fermi 3 COL FSAR, Revision 7. The staff reviewed FSAR Figure 9.5.201 of the Fermi 3 COL application and DCD Figure 9.5.1 and has determined that these figures provide simplified diagrams of the site-specific firewater piping as requested by the DCD. The staff finds that Fermi 3 COL FSAR fully addresses this COL Information Item.

- EF3 COL 9.5.1-10-A Fire Brigade

The NRC staff reviewed EF3 COL 9.5.10-1-A related to implementation of the fire brigade included under Subsection 9.5.1.15.4 of the Fermi 3 COL FSAR, Revision 7. The staff has determined that the implementation of the fire brigade will be in accordance with the milestones in Section 13.4 for the Fire Protection Program. The staff accepts Fermi 3’s fire brigade implementation milestones as given in Section 13.4 since they will provide appropriate protection consistent with the plant’s completion schedule. Additionally, the fire brigade requirements in the DCD are incorporated by reference. The applicant has identified Commitment COM 9.5-006 to track the implementation of the fire brigade in order to address this COL information item in accordance with the guidance set forth in RG 1.206, Regulatory Position C.III.4.3(4). The staff evaluated EF3 COL 9.5.1-10-A to the relevant NRC regulations and acceptance criteria in Section 9.5.1 of NUREG-0800, along with the guidance in RG 1.206. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.5.1-10-A.

- STD COL 9.5.1-5-A Fire Barriers

The following portion of this technical evaluation section is reproduced from Section 9.5.1 of the North Anna SER (ADAMS Accession No. ML091730520):

- *STD COL 9.5.1-5-A Fire Barriers*

The NRC staff reviewed NAPS COL 9.5.1-5-A related to the qualification of fire barriers included under Section 9.5.1.10 of the North Anna 3 COL FSAR Revision 1. The staff determined that mechanical and electrical penetration seals and electrical raceway fire barrier systems will be qualified to the requirements delineated in RG 1.189 by a recognized testing laboratory in accordance with the applicable guidance of NFPA 251 and/or American Society for Testing and Materials E-119. Detailed design in this area is not complete. Specific design and certification test results for penetration seal designs and electrical raceway fire barrier systems will be available for review at least six months prior to fuel receipt. The staff finds that North Anna 3 COL FSAR Revision 1 fully addresses this COL Information Item.

The applicant has identified Commitment COM 9.5-002 to track the specific design and certification testing of the fire barriers in order to address this COL information item in accordance with the guidance set forth in RG 1.206, Regulatory Position C.III.4.3(4). The staff evaluated COL Item STD COL 9.5.1-5-A using the relevant NRC regulations and acceptance criteria in Section 9.5.1 of NUREG-0800, along with the guidance in RG 1.206. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.5.1-5-A.

- STD COL 9.5.1-6-A Smoke Control

The following portion of this technical evaluation section is reproduced from Section 9.5.1 of the North Anna SER (ADAMS Accession No. ML091730520):

- *STD COL 9.5.1-6-H Smoke Control*

The NRC staff reviewed STD COL 9.5.1-6-H related to manual smoke control included under Section 9.5.1.11 of the North Anna 3 COL FSAR Revision 1. The staff determined that procedures for manual smoke control will be developed as part of the Fire Protection Program implementation in accordance with milestones in FSAR Section 13.4. Smoke removal provisions are in accordance with NFPA 804 except Sections 8.4.3 (3) and 8.4.3.2 as per the DCD. NFPA 804 has not been endorsed by the NRC but is considered acceptable where it does not conflict with regulatory requirements and guidance. The applicant's response to RAI 09.05.01-3 states that should a conflict exist between RG 1.189 and NFPA 804 the COL application conforms to RG 1.189. Automatic sprinkler protection is provided where applicable to limit heat and smoke generation as per the DCD.

RAI 09.05.01-16 addresses issues related to smoke control as follows:

Summary:

Describe how the FHA will evaluate the potential for the migration of smoke, hot gases or fire suppressant to prevent safe shutdown and verify that fire dampers that do not close on smoke detection will not be relied upon to prevent the migration of smoke from one redundant train to another.

Resolution:

The applicant's response to RAI 09.05.01-16 stated that FSAR Section 9.5.1 incorporated by reference ESBWR DCD, Section 9.5.1, which describes the ESBWR plant design features that address building ventilation, fire barriers, and smoke control necessary for safe shutdown. As stated in the ESBWR DCD the ESBWR design satisfies the guidance from the NUREG-0800 SRP Section 9.5.1 and BTP SPLB 9.5-1, that smoke, hot gases, or the fire suppressant does not migrate into other fire areas to the extent that safe shutdown capabilities, including operator actions, could be adversely affected. The ESBWR fire protection design satisfies this guidance with a combination of fire dampers and other barriers, smoke evacuation capabilities, and minimal required operator actions. Additionally, manual smoke control procedures will be developed as part of the Fire Protection Program implementation. Smoke –rated dampers that close on smoke detection are provided in areas where smoke migration into other areas can adversely affect safe shutdown. Details are provided in the FHA in Appendix 9A. There are no fire protection-related site-specific design features that are required to ensure safe-shutdown of the plant.

The NRC staff finds that North Anna 3 COL FSAR Revision 1 fully addresses this COL Information Item.

In Revision 6 of the DCD, STD COL 9.5.1-6-H was renamed STD COL 9.5.1-6-A. The applicant has identified Commitment COM 9.5-003 to track the development of manual smoke control procedures in order to address this COL information item in accordance with the guidance set forth in RG 1.206, Regulatory Position C.III.4.3(4). The staff evaluated COL Item STD COL 9.5.1-6-A to the relevant NRC regulations and acceptance criteria in Section 9.5.1 of NUREG-0800, along with the guidance in RG 1.206. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.5.1-6-A.

- STD COL 9.5.1-7-A Fire Hazards Analysis (FHA) Compliance Review

The following portion of this technical evaluation section is reproduced from Section 9.5.1 of the North Anna SER (ADAMS Accession No. ML091730520):

- *STD COL 9.5.1-7-H FHA Compliance Review*

The NRC staff reviewed STD COL 9.5.1-7-H related to review for FHA compliance included under Section 9.5.1.12 of the North Anna 3 COL FSAR Revision 1. The staff determined that a compliance review of the as-built design against the assumptions and requirements stated in the FHA will be completed in accordance with the milestones in FSAR Section 13.4. This is acceptable to the staff. ESBWR DCD, Revision 5 added all the specific items to be reviewed into STD 9.5.1-7-H and deleted STD SUP 9.5.1-2. The staff finds that North Anna 3 COL FSAR Revision 1 fully addresses this COL Information Item.

In Revision 6 of the DCD, STD COL 9.5.1-7-H was renamed STD COL 9.5.1-7-A. The applicant has identified Commitment COM 9.5-004 as a commitment to track FHA compliance review in order to address this COL information item in accordance with the guidance set forth in RG 1.206, Regulatory Position C.III.4.3(4). The staff evaluated COL Item STD COL 9.5.1-7-A to the relevant NRC regulations and acceptance criteria in Section 9.5.1 of NUREG-0800, along with the guidance in RG 1.206. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.5.1-7-A.

- STD COL 9.5.1-8-A Fire Protection Program Description

The following portion of this technical evaluation section is reproduced from Section 9.5.1 of the North Anna SER (ADAMS Accession No. ML091730520):

> - *STD COL 9.5.1-8-A Fire Protection Program Description*
>
> *The NRC staff reviewed STD COL 9.5.1-8-A related to the operational status of the Fire Protection Program included under Section 9.5.1.15 of the North Anna 3 COL FSAR Revision 1. The staff determined that the elements of the Fire Protection Program necessary to support receipt and storage of fuel onsite for buildings storing new fuel and adjacent fire areas that could affect the fuel storage area are fully operational prior to receipt for new fuel. Other required elements of the Fire Protection Program described in this section are fully operational prior to initial fuel loading per Section 13.4. NUREG-0800, Section 9.5.1, Revision 5 states that Fire Protection Program should be fully implemented prior to fuel receipt at the plant site. Additionally, the Fire Protection Program requirements are incorporated by reference to the DCD. The staff accepts North Anna 3's fire protection implementation milestones as given in Section 13.4 since they will provide appropriate protection consistent with the plant's completion schedule. The staff finds that North Anna 3 COL FSAR Revision 1 fully addresses this COL Information Item.*

The staff evaluated COL Item STD COL 9.5.1-8-A using the relevant NRC regulations and acceptance criteria in Section 9.5.1 of NUREG-0800,. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.5.1-8-A.

- STD COL 9.5.1-11-A Quality Assurance

The following portion of this technical evaluation section is reproduced from Section 9.5.1 of the North Anna SER (ADAMS Accession No. ML091730520):

> - *STD COL 9.5.1-11-A Quality Assurance*
>
> *The NRC staff reviewed STD COL 9.5.1-11-A related to implementation of the QA program included under Section 9.5.1 of the North Anna 3 COL FSAR Revision 1. The staff determined that the QA controls for activities involved in the design, procurement, installation, and testing and administrative controls of FPS is in accordance with the measures outlined in Chapter 17 and for the operational Fire Protection Program the QA Program implements the requirements of RG 1.189 through site-specific administrative controls procedures. These operational QA procedures will be developed six months prior to fuel receipt and will be fully implemented prior to fuel receipt.*
>
> *The NRC staff accepts North Anna 3's fire protection QA program milestones since they will provide appropriate protection consistent with the plant's completion schedule and provide sufficient time for NRC review. The staff finds that North Anna 3 COL FSAR Revision 1 fully addresses this COL Information Item.*

The applicant has identified Commitment COM 9.5-007 to track the development of quality assurance controls of the FPS in order to address this COL information item in accordance with the guidance set forth in RG 1.206, Regulatory Position C.III.4.3(4). The staff evaluated COL Item STD COL 9.5.1-11-A using the relevant NRC regulations and acceptance criteria in Section 9.5.1 of NUREG-0800, along with the guidance in RG 1.206. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.5.1-11-A.

- EF3 COL 9A.7-1-A Yard Fire Zone Drawings

The NRC staff reviewed EF3 COL 9A.7-1-A related to yard fire zone drawings included under Appendix 9A of the Fermi 3 COL FSAR, Revision 7. The staff reviewed the revised fire zone drawings, Figures 9A.2-33R and 9A.2-201, and determined that the site-specific fire zones have been included as needed. They reflect design evolution changes unrelated to fire protection, and added missing information. The staff finds that the Fermi 3 COL FSAR fully addresses this COL Information Item. The staff evaluated COL Item EF3 COL 9A.7-1-A using the relevant NRC regulations and acceptance criteria in Section 9.5.1 of NUREG-0800. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9A.7-1-A.

- EF3 COL 9A.7-2-A Detailed Fire Hazards Analysis of the Yard

The NRC staff reviewed EF3 COL 9A.7-2-A related to Fermi 3 site detailed FHA included under Appendix 9A of the Fermi 3 COL FSAR, Revision 7. The staff reviewed the information in Sections 9A.4.7, 9A.5.7, 9A.5.8, 9A.5.9, and Table 9A.5-7R and determined that the detailed FHA of the plant areas that are outside the scope of the certified design will be completed six months prior to fuel load. The staff accepts Fermi 3's site-specific FHA milestones since they will provide appropriate protection consistent with the plant's completion schedule and provide sufficient time for the NRC to review. The applicant has identified Commitments COM 9A-001, COM 9A-002 and COM 9A-003 as commitments to track the completion of the detailed fire hazard analysis of the yard area in accordance with the guidance set forth in RG 1.206, Regulatory Position C.III.4.3(4). The staff evaluated COL Item EF3 COL 9A.7-2-A using the relevant NRC regulations and acceptance criteria in Section 9.5.1 of NUREG-0800, along with the guidance in RG 1.206. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9A.7-2-A.

Supplemental Information Items

- EF3 SUP 9.5.1-1 and EF3 SUP 9A-01 Codes, Standards and Regulatory Guidance

The NRC staff reviewed EF3 SUP 9.5.1-1 and EF3 SUP 9A-01 related to the codes and standards included under Section 9.5.1 and Appendix 9A of the Fermi 3 COL FSAR, Revision 7. The staff has determined that Table 9.5-201 added the codes and standards that are applicable for those portions of the Fire Protection Program outside the scope of the DCD and for the operational aspects of the Fire Protection Program. These added codes and standards are acceptable for Fermi 3 since the NFPA standards listed are referenced in RG 1.189. The Michigan Building Code is a local code that is required to be met by Fermi 3; the Environmental Protection Agency standards are Federal standards that apply to Fermi 3; and the ASME Code Section IX "Welding and Brazing Qualifications," is referenced in SRP Section 6.1.1 "Engineered Safety Features Materials. The above added codes and standards are in accordance with the guidelines given in RG 1.189, Revision 1 where applicable. Additionally, two footnotes were removed from DCD Table 9.5-2 that do not apply to the Fermi 3 COL application. The staff finds that Fermi 3 COL FSAR fully addresses this Supplemental Information Item.

- STD SUP 9.5.1-3 Combustible and Ignition Source Controls

The following portion of this technical evaluation section is reproduced from Section 9.5.1 of the North Anna SER (ADAMS Accession No. ML091730520):

> - *STP SUP 9.5.1-3 Combustible and Ignition Source Controls*
>
> *The NRC staff reviewed revised FSAR Section 9.5.1.15.6 and the applicant's responses to RAIs 09.05.01-5, 6, 7, and 13 to add combustible and ignition source controls for areas adjacent to the MCR and in computer rooms that are not part of the control room complex and prohibit storage of transient combustibles below the raised floor in the MCR complex and prohibit the storage of hazardous chemicals in areas that contain or expose equipment important to safety. The staff finds that the responses to these RAIs (significant RAIs for this issue shown below) are acceptable and that the proposed FSAR revision has been incorporated into the North Anna 3 COL FSAR Revision 1 as required.*
>
> *RAI 09.05.01-5 "Automatic Suppression in Rooms Adjacent to MCR"*
>
> ***Summary:***
>
> *Describe the program to control the MCR complex fire hazard presented by paper or other combustible materials, as well as ignition sources (e.g., coffee makers).*
>
> ***Resolution:***
>
> *The ESBWR DCD took exception to the RG 1.189 guidance to provide automatic suppression in the rooms adjacent to the MCR. The applicant's response to RAI 09.05.01-5 stated that in addition to the administrative controls described in the ESBWR DCD, the North Anna 3 FSAR will be revised to include administrative requirements to specifically control combustible materials and potential sources in rooms adjacent to the MCR. The NRC staff finds that the response to this RAI is acceptable and that the proposed FSAR revision has been incorporated into the North Anna 3 COL FSAR Revision 1 as required.*
>
> *RAI 09.05.01-6 "Automatic Suppression below the Raised Floor in the MCR Complex"*
>
> ***Summary:***
>
> *The ESBWR DCD took exception to the RG 1.189 guidance to providing automatic fire suppression below the raised floor in the MCR complex. Describe the approach to restricting transient combustibles in this area. Also describe the extent to which cabling below the raised floor will be contained in conduit.*

Resolution:

The applicant's response to RAI 09.05.01-6 stated that in addition to the administrative controls described in the ESBWR DCD, the North Anna 3 COL FSAR will be revised to prohibit the storage of transient combustibles below the raised floor in the MCR complex. The NRC staff finds that the response to this RAI is acceptable and that the proposed FSAR revision has been incorporated into the North Anna 3 COL FSAR Revision 1 as required.

RAI 09.05.01-7 "Automatic Suppression for Computer Rooms that are not part of the MCR Complex"

Summary:

The ESBWR DCD took exception to the RG 1.189 guidance to providing fixed automatic suppression for computer rooms for computers performing functions important to safety that are not part of the Control Room Complex. Describe the program to control the fire hazard presented by paper or other combustible materials, as well as potential ignition sources in these rooms.

Resolution:

The applicant's response to RAI 09.05.01-7 stated that in addition to the administrative controls described in the ESBWR DCD, the North Anna 3 COL FSAR will be revised to include administrative requirements to specifically control combustible materials and potential sources in computer rooms that are not part of the MCR complex. The NRC staff finds that the response to this RAI is acceptable and that the proposed FSAR revision has been incorporated into the North Anna 3 COL FSAR Revision 1 as required.

<u>*Significant RAI Responses Not addressed above (all RAIs are resolved)*</u>

RAI 09.05.01-2 "Multiple Spurious Actuations"

Summary:

What assumptions and methodologies will be used by the applicant to identify, assess, and resolve the potential for multiple spurious actuations that may prevent post-fire safe-shutdown?

Resolution:

The applicant stated that General Electric-Hitachi will perform all safe shutdown analysis for the ESBWR plant and, therefore, this issue will be addressed in the DCD and is being tracked as Open Item 1-1. The NRC staff finds that the response to this RAI is acceptable and that there are no FSAR changes required.

RAI 09.05.01-18 "Smoke Detectors in the MCR Cabinets and Consoles"

Summary:

The ESBWR DCD took exception to the RG 1.189 guidance to providing smoke detectors in the control room cabinets and consoles. Describe the cabinet design features that will facilitate the rapid identification of the specific cabinet/console that is on fire and facilitate rapid access to the cabinets/consoles for fire fighting.

Resolution:

The applicant's response to RAI 09.05.01-18 stated that requirements to develop specific fire fighting procedures and train fire brigade members are addressed in the ESBWR DCD and in the North Anna 3 COL FSAR. ESBWR DCD, Section 9.5.1.15.5 requires that procedures be developed to, in part; define the strategies established for fighting fires in safety-related areas and areas presenting a hazard to safe shutdown equipment. Strategies for fighting fires in the MCR will be included in these procedures and will address specific cabinet design features, as appropriate. The development of these procedures will be as per North Anna 3 COL FSAR Table 13.5-202.

The NRC staff finds that the response to this RAI is acceptable and that there are no FSAR changes required.

With respect to RAI 09.05.01-2 identified above, this RAI was resolved in Revision 6 of the ESBWR DCD Tier 2, Subsection 9.5.1.10. The applicant incorporated this subsection by reference accordingly. The staff evaluated Supplemental Information STD SUP 9.5.1-3 using the relevant NRC regulations and acceptance criteria in Section 9.5.1 of NUREG-0800. The staff finds that the applicant has satisfactorily addressed STD SUP 9.5.1-3.

9.5.1.5 *Post Combined Licensing Activities*

The applicant has proposed the following commitments in this section:

- Commitment (COM 9.5-001)Testing will be performed to demonstrate that the secondary fire protection pump circuit supplies a minimum of 484 m^3/hr (2130 gpm) with sufficient discharge pressure to develop a minimum of 738 kPaG (107 psig) line pressure at the Turbine Building/yard interface boundary. This cannot be performed until the system is built. This activity will be completed prior to fuel receipt.

- Commitment (COM 9.5-002) Mechanical and electrical penetration seals and electrical raceway fire barrier systems are qualified to the requirements delineated in RG 1.189 by a recognized laboratory in accordance with the applicable guidance of NFPA 251 and/or ASTM E-119. Detailed design in this area is not complete. Specific design and certification test results for penetration seal designs and electrical raceway fire barrier systems will be available for review at least six months prior to fuel receipt.

- Commitment (COM 9.5-003) – Procedures for manual smoke control will be developed as part of Fire Protection Program implementation.

- Commitment (COM 9.5-004) – A compliance review of the final as-built design against the assumptions and requirements stated in the FHA will be completed prior to fuel load.

- Commitment (COM 9.5-006) – Implementation of the fire brigade will be in accordance with the milestone in Section 13.4 for the Fire Protection Program.

- Commitment (COM 9.5-007) – The procedures will be developed six months prior to fuel receipt and will be fully implemented prior to fuel receipt.

- Commitment (COM 9A-001) – A detailed fire hazards analysis of the yard area that is outside the scope of the certified design cannot be completed until cable routing is performed during final design. This information will be provided six months prior to fuel load.

- Commitment (COM 9A-002) – A detailed fire hazards analysis of the yard area that is outside the scope of the certified design, which includes the Service Building, cannot be completed until cable routing is performed during final design. This information will be provided six months prior to fuel load.

- Commitment (COM 9A-003) – A detailed fire hazards analysis of the yard area that is outside the scope of the certified design, which includes the Service Water/Water Treatment Building, cannot be completed until cable routing is performed during final design. This information will be provided six months prior to fuel load.

9.5.1.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the fire protection system, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the fire protection system, that were incorporated by reference are resolved.

For the purposes of the staff's Subsection 9.5.1 review, the staff finds that it is reasonable to conclude that the identified Tier 2 Departure DEP 11.4-1 for this section do not require prior NRC approval per 10 CFR Part 52 Appendix E Section VIII.B.5.

In addition, the staff compared the supplemental information in the COL application to the relevant NRC regulations, the guidance in Section 9.5.1 of NUREG–0800, and other NRC regulatory guides. The staff's review concludes that the applicant's information in the COL FSAR is acceptable and meets the requirements of GDC 3, 5, 19 and 23 of Appendix A to 10 CFR Part 50 and 10 CFR 50.48, 52.79(d), 52.80(a), and the criteria in SECY-90-016, SECY-93-087 and SECY-94-084, along with the guidance in RGs 1.189 and 1.206. The also finds that the applicant satisfactorily addressed the EF3 COL items, STD COL items, EF3 SUP items, and STD SUP items identified in this section.

9.5.2 Communication Systems

9.5.2.1 *Introduction*

This FSAR section describes the communication systems which provide interplant communications and plant-to-offsite communications during normal, maintenance, transient, fire, and accidents conditions.

9.5.2.2 *Summary of Application*

Section 9.5.2 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 9.5.2 of the certified ESBWR DCD, Revision 10. In addition, in Fermi 3 COLA FSAR, Section 9.5.2, the applicant provides the following:

<u>*COL Items*</u>

- EF3 COL 9.5.2.5-1-A Emergency Notification System

This COL item requested a description of the emergency notification system (ENS). The applicant stated that this COL item is addressed in FSAR Subsection 9.5.2.2.

- EF3 COL 9.5.2.5-2-A Grid Transmission Operator

This COL item requested a description of the transmission system operator communication link. The applicant stated that this COL item is addressed in FSAR Subsection 9.5.2.2 and in the Emergency Plan Section II.F.1.

- EF3 COL 9.5.2.5-3-A Offsite Interfaces (1)

This COL item requested a description of the means of communication between the MCR, technical support center (TSC), emergency operations facility (EOF), state and local emergency operation centers and radiological field personnel in accordance with NUREG-0696, "Functional Criteria for Emergency Response Facilities," issued February 1981, and NUREG-0654/FEMA-REP-1, Revision 1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," issued in November 1980. The applicant stated that this COL item is addressed in FSAR Subsection 9.5.2.2 and in the Emergency Plan Sections II.E.1 and II.F.1.

- EF3 COL 9.5.2.5-4-A Offsite Interfaces (2)

This COL item requested a description of the communication methods from the MCR, TSC, and EOF to the NRC headquarters including establishment of emergency response data systems (ERDS) in accordance with NUREG-0696. The applicant stated that this COL item is addressed in FSAR Subsection 9.5.2.2 and in the Emergency Plan Sections II.E.1 and II.F.1.

- EF3 COL 9.5.2.5-5-A Fire Brigade Radio System

This COL item requested a description of the fire brigade radio system. The applicant stated that this COL item is addressed in FSAR Subsection 9.5.2.2.

9.5.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the relevant requirements of the Commission regulations for the communication systems and the associated acceptance criteria are in Section 9.5.2 of NUREG-0800.

Also, specific applicable regulatory requirements for the communications associated with and in support of the Fermi 3 COL items are as follows:

- 10 CFR Part 50, Appendix E, Part IV.E.9
- 10 CFR 50.47(b)(5) and (b)(6)

The related acceptance criteria are as follows:

- NRC Bulletin (BL) 80-15, "Possible Loss of Emergency Notification System (ENS) with Loss of Offsite Power," June 18, 1980
- NUREG-0696
- NUREG-0654/FEMA-REP-1
- RG 1.189, Section 4.1.7
- GL 91-14, "Emergency Telecommunications," dated September 23, 1991

9.5.2.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.5.2 of the certified ESBWR DCD. The staff reviewed Section 9.5.2 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWER DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the required information related to the Communication Systems.

The staff also examined the Fermi 3 Emergency Plan Sections II.E and II.F that are relevant to the COL item responses. The detailed review of the Emergency Plan Sections II.E and II.F is reflected in SER Section 13.3, "Emergency Planning." The staff reviewed conformance of Section 9.5.2 of the Fermi 3 COLA FSAR to the regulatory basis and guidance listed in Section 9.5.2.3 above and the guidance in RG 1.206, Regulatory Positions C.III.1, and, C.I.9.5.2, "Communication Systems."

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

COL Items

- EF3 COL 9.5.2.5-1-A Emergency Notification System

The NRC staff reviewed COL Item EF3 COL 9.5.2.5-1-A related to the ENS included under Subsection 9.5.2.5 of the Fermi 3 COL FSAR. The DCD COL Item 9.5.2.5-1-A states that, "The COL applicant will describe the Emergency Notification System provisions required by 10 CFR 50.47(b)(6) and address recommendations described in BL-80-15." The applicant addressed this item in FSAR Subsection 9.5.2.5 in their application by describing key features of the ENS.

10 CFR 50.47(b)(6) requires that provisions exist for prompt communications among principal response organizations to emergency personnel and to the public. The key provisions of NRC BL 80-15 state in part that, " … all extensions of the ENS located at your facility(ies) would remain fully operable from the facility(ies) to the NRC Operations Center in the event of a loss of offsite power to your facility(ies)." The ENS is a dedicated NRC Federal Technology Services (FTS)-2001 system that is normally used only for plant communications with the NRC and is independent from other site telephone systems. The ENS provides a means for initial notifications to the NRC, as well as ongoing communications about plant systems, status, and parameters. FTS-2001 telephones for the ENS are located in the MCR, TSC and EOF. The ENS phone lines connect via fiber optics (see Figure II.F-1, in COL Application Part 5: Emergency Plan) to the local telephone company (Century Telephone Company). This telephone system is normally powered by two redundant alternating current (ac) power sources. These power sources are backed up by batteries with an 8 hour capacity rating, which would automatically supply power to the ENS phones if a complete loss of AC power (to the phones) occurred. The applicant states, "This design ensures that the ENS located at the site is fully operable from the site in the event of a loss of offsite power at the site and is in compliance with the guidance of NRC BL 80-15 for the ENS." Through EF3 COL 9.5.2.5-1-A, Fermi 3 committed that the ENS is in compliance with the recommendations of NRC BL 80-15, which is concerned with having a, "… safeguards instrumentation bus backed up by automatic transfer to batteries and an inverter or equally reliable power supply." Accordingly, based on the description provided in COL Item EF3 COL 9.5.2.5-1-A, the information in Fermi 3 COL Application Part 5: Emergency Plan, Section II.F, on emergency communications, and the description in ESBWR DCD, Section 9.5.2, the staff finds that the applicant has adequately addressed the recommendations in NRC BL 80-15. Also, Fermi 3 has multi-line Radiological Emergency Response Preparedness (RERP) telephones (marked for "Emergency Use Only") that have an ENS button to allow access to the ENS. Furthermore, the applicant states, "If the ENS is inoperable, the required notifications can be made via commercial telephone or any other method to ensure that a report is made as soon as practical."

During the review, the staff noted that it was unclear if the RERP is intended as a backup to the ENS or an alternate access. In RAI 09.05.02-1 the NRC staff requested the applicant to clarify whether the RERP is intended as a backup to the ENS or an alternate access and what specific systems are referred to by, "… the required notifications can be made via commercial telephone or any other method to ensure that a report is made as soon as practical," so the evaluation of EF3 COL 9.5.2.5-1-A could be completed. In response to this RAI dated September 24, 2009 (ADAMS Accession No. ML092720656), the applicant revised FSAR Subsection 9.5.2.2 to clarify that there is no specific backup system for the ENS. In the event the ENS is unavailable, notifications can be made through a number of alternate methods. These include: (1) the RERP phone system that is a dedicated phone system with battery backup; (2) the AT&T phone system that is intended to provide communication with local and state authorities; (3) the commercial phone system; and (4) the 800 megahertz (MHz) band radio communications with local law enforcement agencies. The staff finds the applicant's response to RAI 09.05.02-1 is acceptable because several alternate communication methods are available including at least one with a battery backup and meets the guidance of NRC BL 80-15. RAI 09.05.02-1 is therefore closed.

Based on the above information, the staff finds that the applicant has adequately addressed the DCD COL Item 9.5.2.5-1-A, because the design meets the requirements of 10 CFR 50.47(b)(6) and guidance of NRC BL 80-15.

- EF3 COL 9.5.2.5-2-A Grid Transmission Operator

The NRC staff reviewed COL Item EF3 COL 9.5.2.5-2-A related to the grid transmission operator communications included under Subsection 9.5.2.5 of the Fermi 3 COL FSAR. The DCD COL Item 9.5.2.5-2-A states, "The COL applicant will describe the voice communication link availability with the grid transmission operator." The applicant addressed this item in FSAR Subsection 9.5.2.2 and in Emergency Plan Section II.F.1.

The NRC staff reviewed the applicant's resolution to the DCD COL Item 9.5.2.5-2-A involving the grid transmission operator communication link included under Subsection 9.5.2.2 of the Fermi 3 COL FSAR and addressed in Emergency Plan Section II.F.1. In DCD Subsection 9.5.2.2 under Emergency Communication Systems, "(COL 9.5.2.5-1-A)" the last bullet is replaced by a paragraph labeled "EF3 COL 9.5.2.5-2-A" that states, "Transmission System Operator Communications Link: Voice communications with the grid operator are provided via a company-owned and company-maintained transmission system that allows telephone communications with the entire Corporate System. Access to this mode of transmission is made via the plant telephone system. A dedicated line is provided between the Control Room and the power system operator." Furthermore, this mode of communication to the grid transmission operator is backed up by the regular commercial telephone system. The Fermi 3 COL Application Part 5: Emergency Plan, Section II.F.1, states that Detroit Edison has extensive and reliable communications systems installed at Fermi 3 and maintains the capability to make initial notifications to the designated offsite agencies on a 24-hour per day basis. Section II.F.1 also describes the various and diverse communication systems (see Figure II.F-1, COL Application Part 5: Emergency Plan) and backup methods that are available for use in emergency events as well as normal operations.

10 CFR 50.47(b)(6) requires that, "Provisions exist for prompt communications among principal response organizations to emergency personnel and to the public." DCD Section 9.5.2, "Communications System," lists communications subsystems that are to provide the means to conveniently and effectively communicate between various parts of the nuclear power plant and with offsite company, governmental, support agencies, and other locations during normal operations, testing and drills, and during maintenance, transients, fire, emergency, and accident conditions under maximum potential noise levels. These subsystems include the capability to communicate with the Grid Transmission Operator through the normal means of the company-owned and company-maintained transmission system as well as through alternate means, with primary power backed up by battery power as described.

Based on the above information, the staff finds that the applicant has adequately addressed DCD COL Item 9.5.2.5-2-A, because the design provides for primary and backup communication capability to the grid transmission operator and meets the requirements of 10 CFR 50.47(b)(6).

- EF3 COL 9.5.2.5-3-A Offsite Interfaces (1)

The NRC staff reviewed COL Item EF3 COL 9.5.2.5-3-A related to the offsite interfaces included under Subsection 9.5.2.5 of the Fermi 3 COL FSAR and examined the Emergency Plan Sections II.E and II.F as related to emergency communications.

The DCD COL Item 9.5.2.5-3-A states, "The COL applicant will describe the means of communication between the control room, TSC, EOF, state and local emergency operation centers and radiological field personnel in accordance with NUREG-0696 and NUREG-0654 (Subsection 9.5.2.2)." The applicant addressed EF3 COL 9.5.2.5-3-A in FSAR Subsection 9.5.2.2 and Emergency Plan Sections II.E.1 and II.F.1. EF3 COL 9.5.2.5-3-A states, "The health physics network is described in the Emergency Plan." In Subsection 9.5.2.2 under Emergency Communication Systems EF3 COL 9.5.2.5-3-A states, "The crisis management radio system is part of the plant radio system described in DCD Section 9.5.2.2."

NUREG-0696, in part, specifies the voice and data communication support required for the TSC, operational support center (OSC), and the EOF, and the relationship of these to the MCR. NUREG-0654, Supplement 1, Section II.E in part specifies notification methods and procedures for offsite communications in support of emergency preparedness. NUREG-0654, Supplement 1, Section II.F in part specifies emergency communications for offsite communications in support of emergency preparedness. These requirements are addressed in the Fermi 3 COL Application Part 5: Emergency Plan including Sections II.E and II.F. The Fermi 3 COL Application Part 5: Emergency Plan including Sections II.E and II.F is evaluated in SER Section 13.3, "Emergency Planning" of this SER.

10 CFR Part 50, Appendix E, Section IV.E.9 requires "At least one onsite and one offsite communications system; each system shall have a backup power source." Section 9.5.2 describes the site communications system that is composed of multiple diverse communications subsystems that includes at least one onsite and one offsite communications system with a backup power source as summarized below.

Section 9.5.2 identified site communication subsystems that made up the communications system as follows:

- Plant page/party-line subsystem;
- Private automatic branch exchange subsystem;
- Plant sound-powered telephone subsystem;
- Plant radio subsystem;
- Evacuation alarm and remote warning subsystem;
- Emergency offsite communication subsystem; and
- Completely independent radio communications subsystem for security purposes.

Subsection 9.5.2.1 provides the safety design basis and the power generation design basis while Subsection 9.5.2.2 provides a summary system description for these site communications except for the completely independent radio subsystem for security purposes that is described in ESBWR DCD, Section 13.6. More description of these communication systems is found in the applicant's COL application Part 5: (Emergency Plan), Sections II.E and II.F. The detailed review of the completely independent radio subsystem for security purposes is reflected in SER Section 13.6, "Physical Security" of this SER.

The communications system is considered a nonsafety system, because it serves no safety-related function and the reactor can be shut down without the communications system. However, an adequate communications system is both required by regulation and considered important to overall safety as well as power generation. The subsystems identified above are independent of one another such that a failure in one subsystem does not adversely affect the performance of the other subsystems.

Based on the capability of these communications described in Section 9.5.2, the staff finds the design of the communications system adequately meets the requirements of 10 CFR Part 50, Appendix E, Section IV.E.9, because the multiple communication subsystems provide at least one onsite and one offsite communications system with each system having a backup power source.

10 CFR 50.47(b)(5) requires that, "Procedures have been established for notification, by the licensee, of state and local response organizations and for notification of emergency personnel by all organizations; the content of initial and follow-up messages to response organizations and the public has been established; and means to provide early notification and clear instruction to the populace within the plume exposure pathway Emergency Planning Zone have been established." The COL application Part 5: Emergency Plan, Sections II.E, describes the Fermi 3 notification methods and procedures which are evaluated in Section 13.3 of this SER.

10 CFR 50.47(b)(6) requires that, "Provisions exist for prompt communications among principal response organizations to emergency personnel and to the public." Section 9.5.2, "Communications System," lists communications subsystems that are to provide the means to conveniently and effectively communicate between various parts of the nuclear power plant and with offsite company, governmental, support agencies, and other locations during normal operations, testing and drills, and during maintenance, transient, fire, emergency, and accident conditions under maximum potential noise levels. Based on the capability of these communications described in Section 9.5.2, the staff finds the design of the communications system adequately meets the requirements of 10 CFR 50.47(b)(6) because the multiple communication subsystems provide acceptable means of communication between the control room, TSC, EOF, state and local emergency operation centers, and radiological field personnel communications system as well as alternate independent means of communication in case of the failure of the primary planned subsystem, many with a backup power source.

In the Fermi 3 COL Application Part 5: Emergency Plan Section II.E, the applicant states that Detroit Edison, in cooperation with state, county, and provincial authorities, has established mutually agreeable methods and procedures for notification of offsite response organizations consistent with the emergency classification and action level scheme. Furthermore, Part 5: Emergency Plan, Section II.E describes the methods and procedures needed to provide the capability for 24-hour per day prompt notification and mobilization of emergency response organizations including plant personnel, offsite emergency response organizations, the State of Michigan, adjacent Counties of Monroe and Wayne, the NRC, the Canadian Province of Ontario, Detroit Edison corporate offices including the Detroit Edison Nuclear Information Department, and the others as needed.

In the Fermi 3 Emergency Plan, Section II.F describes the provisions for a diverse set of systems for communication (see Figure II.F-1 of the Emergency Plan) between the Fermi 3 site and principal response organizations, including state, local, and federal agencies as stated above, and communications between the emergency response facilities. In case of the failure of the primary communication system or loss of normal power, either battery backup or alternate systems are available. For example, backup notification and communication can be made through the commercial telephone network system or the Detroit Edison-owned microwave system routed from the Fermi site to the General Offices in Detroit then to any desired location.

The Emergency Plan implementing procedures describe use of communications systems during an emergency, and the Emergency Plan administrative procedures provide additional details describing testing and maintenance of communications systems. Message content and verification methods are established in advance in implementing procedures. Communication systems that allow communications between the site and fixed and mobile medical support facilities are maintained and include both commercial telephone communications with fixed facilities and radio communications to ambulances. Equipment, methods, and procedures for communication are tested and evaluated on a periodic basis through test and drills. For example, Fermi 3 conducts periodic testing of communications systems at the site consistent with communications drill requirements. Communications between the Fermi 3 emergency response facilities and the state/county warning points are tested monthly. Communications between the state/local emergency operation centers and field assessment teams are tested consistent with the requirements of the affected state and county plans. The Fermi 3 COL Application Part 5: Emergency Plan lists the requirements and the corresponding COL application Emergency Plan provision where the requirement is addressed.

Based on the above information, the staff finds that the applicant has adequately addressed DCD COL Item 9.5.2.5-3-A because the communication system design described provides means to meet the requirements of 10 CFR Part 50, Appendix E, Section IV.E.9, 10 CFR 50.47(b)(5), 10 CFR 50.47(b)(6); in addition to the standards/criteria/guidance in NUREG-0696, and NUREG-0654, Supplement 1, Section II.E and II.F.

- EF3 COL 9.5.2.5-4-A Offsite Interfaces (2)

The NRC staff reviewed COL Item EF3 COL 9.5.2.5-4-A related to the offsite interfaces included under Subsection 9.5.2.5 of the Fermi 3 COL FSAR and examined Fermi 3 Emergency Plan Sections II.E and II.F. The DCD COL Item 9.5.2.5-4-A states, “The COL applicant will describe the communication method from the control room, TSC, and EOF to NRC headquarters, including establishment of Emergency Response Data Systems (ERDS) in accordance with NUREG-0696 (Subsection 9.5.2.2).” The applicant addressed this Item with EF3 COL 9.5.2.5-4-A stating, “This COL item is addressed in Subsection 9.5.2.2 and Emergency Plan Sections II.E.1 and II.F.1.” EF3 COL 9.5.2.5-4-A also states, “Communication from the Control Room, TSC, and EOF to NRC headquarters including establishment of Emergency Response Data System (ERDS) is described in the Emergency Plan.” The Fermi 3 COL Application Part 5: Emergency Plan including Sections II.E and II.F is evaluated in SER Section 13.3, “Emergency Plan” of this SER.

NUREG-0696 in part specifies the voice and data communication support required for the TSC, OSC, and the EOF, and the communication of these with the MCR. Section 9.5.2 identifies site communication subsystems that made up the communications system and these subsystems are listed in “Offsite Interfaces (1)” above. These requirements are addressed in the Fermi 3 Emergency Plan including Sections II.E and II.F which are summarized below.

In the Fermi 3 COL Application Part 5: Emergency Plan Section II.F.1, the applicant states that Fermi 3 maintains the capability to make initial notifications to the designated offsite agencies on a 24-hour per day basis. The offsite notification ringdown phone system provides communications to state and county warning points, and emergency operation centers from the

MCR, TSC and EOF (see Figure II.F-1 of the Emergency Plan). Backup methods include commercial telephone lines, radios, microwave, and facsimile. Separate telephone lines are dedicated and maintained for communications with the NRC. These include the ENS, the Health Physics Network (HPN), the Reactor Safety Counterpart Link (RSCL), the Protective Measures Counterpart Link (PMCL), an ERDS Channel, the Management Counterpart Link (MCL), and the Local Area Network (LAN) Access. The ENS lines located in the MCR, TSC, and EOF, are used for initial notifications to the NRC, as well as ongoing information about plant systems, status, and parameters. The HPN lines located in the TSC and EOF provide for communication concerning radiological and meteorological matters. The RSCL lines located in the TSC and EOF provide for internal NRC discussions regarding plant and equipment conditions. PMCL lines located in the TSC and EOF provide for internal NRC discussions on radiological releases, meteorological conditions, and protective measures. The ERDS Channel allows transmittal of selected plant data to the NRC Operations Center on a continuing basis in an emergency. The MCL lines located in the TSC and EOF provide for internal discussion between the NRC Executive Team Director and members of the NRC Executive Team Director's team and the NRC site director, or between licensee site management. The LAN Access with jacks in the TSC and EOF provides access to the NRC LAN.

The Fermi 3 COL Application Part 5: Emergency Plan lists the requirements and the corresponding COL application Emergency Plan provisions that address the requirements. The staff finds the design adequately addresses GL 91-14 because the communications system as described contains all of the subsystems indicated for communications with the NRC specified in Enclosure 1 of GL 91-14, including ENS, HPN, RSCL, PMCL, MCL, ERDS, and LAN.

Based on the above under "Offsite Interfaces (1)" and "Offsite Interfaces (2)," the staff finds that the applicant has adequately addressed the DCD COL Item 9.5.2.5-4-A, because the communications system design described provides means to communicate effectively between and among the MCR, TSC, EOF, and NRC headquarters, including establishment of a ERDS and meets the guidance of NUREG-0696.

- EF3 COL 9.5.2.5-5-A Fire Brigade Radio System

The NRC staff reviewed COL Item EF3 COL 9.5.2.5-5-A related to the fire brigade radio system included under Subsection 9.5.2.5 of the Fermi 3 COL FSAR. The DCD COL Item 9.5.2.5-5-A states, "The COL applicant will describe the Fire Brigade Radio System in accordance with RG 1.189, Position 4.1.7." The applicant addressed this item with EF3 COL 9.5.2.5-5-A that states, "This COL item is addressed in Subsection 9.5.2.2." EF3 COL 9.5.2.5-5-A states that, "Compliance of the Fire Brigade Radio System with RG 1.189, Position 4.1.7, is described in DCD Section 9.5.2.2."

RG 1.189, Regulatory Position 4.1.7, acceptance criteria states that the communication system design should provide effective communication between plant personnel in all vital areas during fire conditions under maximum potential noise levels. Furthermore, two-way voice communications devices should provide: (a) fixed emergency communications independent of the normal plant communication system installed at preselected stations and (b) a portable radio communications system for use by the fire brigade and other operations personnel required to achieve safe plant shutdown that should not interfere with the communications capabilities of the plant security. Fixed repeaters installed to permit the use of portable radio communication units should be protected from exposure or fire damage. Preoperational and periodic testing should demonstrate that the frequencies used for portable radio communication will not affect the actuation of protective relays.

The ESBWR DCD, Subsection 9.5.2.2 states that the plant radio system complies with performance guidelines applicable to portable radio communication systems in RG 1.189, Regulatory Position 4.1.7, as described above.

The ESBWR DCD, Subsection 9.5.2.2 also describes the plant radio system for use during normal and emergency communications within the plants. The plant radio system radios are equipped with multiple channels including a fire brigade channel and an emergency channel, each of which can be used as an alternate security channel if required. Portable, hand-held radios provide two-way mobile voice communication between individual members or units of the fire brigade in the plant and satellite buildings and communication from the fire brigade units or individual members to communication consoles in selected plant locations including the MCR and remote shutdown rooms. The radio system includes antennas distributed throughout the plant with a centralized rebroadcast transmitter providing communication within the plant and satellite buildings. The communication consoles are connected by hardwired links, thus providing a means of communication between selected areas of the plant even with the failure of the radio base station, the PA/PL system, and the PABX system.

Lower power portable radios are used with this system to ensure that there is no electromagnetic interference with instrumentation and control circuits, and operate at frequencies that ensure they do not interfere with DCIS functions. By using radio equipment equipped with a feature called "tone-coded squelch", communications can be directed to or limited to a specific individual, directed to all-channels (zoned), or directed to all-system calls. However, the emergency channel is not coded and thus is not blocked by this feature in order to keep it available for general use and in case of an emergency. Capability is provided whereby calls can be made between the telephone system and the in-plant radio system. The power for base stations and consoles is provided by a security system power supply backed up by batteries and a standby generator.

The plant radio system is considered nonsafety, but meets the single failure criteria with redundancy in equipment including the potential use of the completely independent security radio communications system as an alternate. Based on this redundancy in equipment and the design features noted above, the NRC staff concludes that mobile radio communications would still be available even if the MCR had to be evacuated.

Based on the above, the staff finds that the applicant has adequately addressed the DCD COL Item 9.5.2.5-5-A because the fire brigade radio system design as described meets the guidance of RG 1.189, Regulatory Position 4.1.7.

9.5.2.5 *Post Combined License Activities*

There are no post COL activities related to this section.

9.5.2.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the communication systems, and no outstanding information is expected to be addressed in the

COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the communication systems that were incorporated by reference are resolved.

In addition, to the extent that an item addresses that portion of the communications system used in intra-plant and plant-to-offsite communications, the staff concludes that the site specific COL information items discussed in this section of the COL FSAR are acceptable and meet the requirements of 10 CFR Part 50, Appendix E, Section IV.E.9 and 10 CFR 50.47(b)(5) and (b)(6); and guidance in RG 1.189, Regulatory Position 4.1.7. The staff bases its conclusion on the following: (1) The design provides for at least one acceptable onsite and one acceptable offsite communication system, each with a backup power source as described directly through COL application information or information incorporated by reference of the ESBWR DCD; (2) the design provides communications systems with a capability for prompt notification and continuing communication to the NRC; (3) the design provides communications systems with capability for prompt notification and continuing communication with site, local and state response organizations as well as an initial notification to the Province of Ontario, Canada; (4) the design provides a variety of diverse communication systems involving both private links, commercial links, site public address, microwave, facsimiles, and radio with the capability of adequately supporting both normal use and emergency situations; and (5) the nonsafety communication systems do not prevent completion of safety functions.

9.5.3 Lighting System

The plant lighting systems are composed of the normal lighting system, the standby lighting system, and the emergency lighting system. The normal lighting system is used to provide normal illumination under normal plant operating, maintenance, and testing conditions. The standby lighting system is designed to provide a minimum level of illumination to selected areas of the plant to aid in emergencies, safe shut down, or in restoring the plant to normal operation. The emergency lighting system is used to provide acceptable levels of illumination throughout the station upon the loss of the normal lighting system.

Section 9.5.3 of the Fermi 3 COL FSAR incorporates by reference Section 9.5.3, “Lighting System,” of the ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff’s review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to lighting system that were incorporated by reference are resolved.

9.5.4 Diesel Generator Fuel Oil Storage and Transfer System

9.5.4.1 *Introduction*

This FSAR section describes the diesel generator fuel oil storage and transfer system (DGFOSTS) for the diesel engines that provide standby onsite power. The system for each diesel engine includes a fuel oil storage tank, fuel oil day tank, fuel oil transfer pump,

[1] See *“Finality of Referenced NRC Approvals”* in SER Section 1.2.2 for a discussion on the staff’s review related to verification of the scope of information to be included in a COL application that references a design certification.

strainers/filters, oil purifier (or tank connections for tying into a purification system), instrumentation, controls, and the necessary interconnecting piping and valves. The ESBWR design provides two sets of diesel generators (DGs) – standby diesel generators (SDGs) and ancillary diesel generators (ADGs).

9.5.4.2 *Summary of Application*

Section 9.5.4 of the Fermi 3 COL FSAR, Revision 7, incorporates by reference Section 9.5.4 of the certified ESBWR DCD, Revision 10. In addition, in Fermi 3 COLA FSAR, Section 9.5.4, the applicant provides the following:

COL Items

- STD COL 9.5.4-1-A Fuel Oil Capacity

The applicant provided additional information in STD COL 9.5.4-1-A to address DCD COL Item 9.5.4-1-A. The applicant described the procedural controls in place to ensure that sufficient fuel oil is available onsite to allow each DG to operate continuously for seven days at its calculated design load.

- EF3 COL 9.5.4-2-A Protection of Underground Piping

The applicant provided additional information in EF3 COL 9.5.4-2-A to address DCD COL Item 9.5.4-2-A. The applicant stated that the underground piping portion of the DGFOSTS is made of carbon steel and that it is protected with a waterproof coating and an impressed current cathodic protection system to control external corrosion.

9.5.4.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the relevant requirements of the Commission regulations for the DGFOSTS and the associated acceptance criteria are in Section 9.5.4 of NUREG-0800.
The specific regulatory requirements are as follows:

- GDC 17, “Electric power systems,” requires an onsite electric power system to permit functioning of SSCs important to safety. The SDGs and ADGs are not classified as safety-related. However, since the diesels are RTNSS Criterion B and C systems, availability of both SDGs and ADGs is required according to the Availability Controls Manual (Availability Control Limiting Condition for Operation 3.8.1 and 3.8.2).

- RG 1.137, “Fuel-Oil Systems for Standby Diesel Generators,” provides regulatory guidance with respect to maintaining a 7-day supply of fuel oil and for protection of the system from internal and external corrosion.

9.5.4.4 *Technical Evaluation*

As documented in NUREG-1966, the NRC staff reviewed and approved Section 9.5.4 of the certified ESBWR DCD. The staff reviewed Section 9.5.4 of the Fermi 3 COL FSAR, Revision 7, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.[1] The staff's review confirms that the information in the application and the information incorporated by reference address the required information related to the DGFOSTS.

The SDGs and ADGs are not classified as safety-related. However, since the staff reviewed and accepted the diesels as RTNSS Criterion B and C systems in Chapter 19 of NUREG-1966, availability of both SDGs and ADGs is required according to the Availability Controls Manual (Availability Control Limiting Condition for Operations 3.8.1 and 3.8.2).

Section 1.2.3 of this SER discusses the NRC's strategy for performing one technical review for each standard issue outside the scope of the DC and to use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the North Anna application are equally applicable to the Fermi 3 COL application, the staff undertook the following reviews:

- The staff compared the North Anna COL FSAR, Revision 1, to the Fermi 3 COL FSAR. In performing this comparison, the staff considered changes made to the Fermi 3 COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the North Anna SER with open items.

- The staff confirmed that the applicant has endorsed all responses to the RAIs identified in the corresponding standard content (the North Anna SER) evaluation were endorsed.

- The staff verified that the site-specific differences are not relevant to this section.

The staff has completed the review and finds the evaluation performed for the North Anna standard content to be directly applicable to the Fermi 3 COL application. This SER identifies the standard content material with italicized, double-indented formatting.

The staff reviewed the information in the COL FSAR as follows:

COL Items

- STD COL 9.5.4-1-A Fuel Oil Capacity

The following portion of this technical evaluation section is reproduced from Section 9.5.4 of the North Anna SER (ADAMS Accession No. ML091730520):

> *STD COL 9.5.4-1-A Fuel Oil Capacity*
>
> *The NRC staff reviewed STD COL 9.5.4-1-A related to the fuel oil capacity included under Section 9.5.4 of the North Anna 3 COL FSAR. DCD COL Item 9.5.4-1-A in Section 9.5.4.6, "COL Information," of the ESBWR DCD specifies that the COL applicant needs to establish procedural controls to ensure a minimum fuel oil capacity is maintained onsite. In FSAR Section 9.5.4.2, "System Description," the applicant addressed DCD COL Item 9.5.4-1-A (STD COL 9.5.4-1-A) by indicating that procedures will be developed in accordance with the milestone and processes described in FSAR Section 13.5, "Plant Procedures." Those procedures will ensure sufficient diesel fuel oil inventory is available onsite so that the DG*

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

can operate continually for seven days. The procedures will ensure that the quantity of DG fuel oil in the fuel oil storage tanks is monitored on a periodic basis and that the diesel fuel oil usage is tracked against planned deliveries. Regular transport will replenish the fuel oil inventory during periods of high demand and ensure continued supply in the event of adverse weather conditions. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.5.4-1A in that the necessary procedures will be developed in accordance with FSAR Section 13.5.

The applicant stated that the procedures will ensure sufficient fuel oil to operate the DGs continually for seven days. In RAI 09.05.04-02, the staff asked the applicant to verify that enough fuel oil inventory is available to operate the DGs at continuous maximum rating for seven days. In their response dated August 4, 2008, the applicant provided an FSAR markup stating that procedures ensure sufficient diesel fuel oil inventory is available onsite so that the standby diesel generators (SDGs) and ancillary DGs can operate continually for seven days with each operating at its calculated design load, with appropriate margins. The staff finds that the term "appropriate margins" is an ambiguous term for use in the FSAR. Therefore the staff requested the applicant, in supplemental RAI (eRAI 2468, Question 10135), to specify that the margins are in accordance with American Nuclear Society 59.51-1997, "Fuel Oil Systems for Safety-Related Emergency Diesel Generators." This is being tracked as ***Open Item 9.5.4-01.***

In response to supplemental RAI 09.05.04-7 dated August 3, 2009 (ADAMS Accession No. ML092180975), the applicant (Dominion) stated that ANS 59.51-1997, "Fuel Oil Systems for Safety-Related Emergency Diesel Generators," is not applicable to the ESBWR nonsafety-related SDGs and ADGs. The applicant (Dominion) updated the North Anna FSAR to describe the sufficient margin for the 7-day fuel oil inventory requirement that accounts for usable fuel in the tank, level instrument uncertainty, and the potential for future load growth. The staff finds this response acceptable since the 7-day fuel oil inventory is maintained in accordance with RG 1.137 with sufficient margin that is clearly defined in the FSAR. In a letter dated September 21, 2010 (ADAMS Accession No. ML102660145), the applicant (Detroit Edison) stated that it accepted Dominion's response to RAI 09.05.04-7 as part of the Fermi 3 application and revised the FSAR to include the margin description. Therefore, this RAI 09.05.04-7 is closed.

The staff evaluated COL Item STD COL 9.5.4-1-A to the relevant NRC regulations and acceptance criteria in Section 9.5.4of NUREG-0800. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.5.4-1.

- EF3 COL 9.5.4-2-A Protection of Underground Piping

The NRC staff reviewed EF3 COL 9.5.4-2-A related to the protection of underground piping included under Section 9.5.4 of the Fermi 3 COL FSAR. DCD COL Item 9.5.4-2-A in Subsection 9.5.4.6, "COL Information," of the ESBWR DCD specifies that the COL applicant needs to describe the material and corrosion protection for the underground piping portion of the fuel oil transfer system.

In FSAR Subsection 9.5.4.2, "System Description," the applicant addressed DCD COL Item 9.5.4-2-A (EF3 COL 9.5.4-2-A) by describing the DGFOSTS protection for underground piping. The Fermi 3 COL FSAR states that the underground piping of the DGFOSTS is protected by a waterproof protective coating and an impressed current cathodic protection system for external corrosion control in accordance with the applicable guidance in ASME B31.1 API Recommended Practice 1632.

The staff finds the API Recommended Practice acceptable because it refers to National Association of Corrosion Engineers (NACE International) Recommended Practice (RP) 0169, "Control of External Corrosion on Underground or Submerged Metallic Piping Systems," which is the same guideline recommended in RG 1.137 for cathodic protection of buried diesel fuel oil piping[2]. ASME B31.1, Appendix IV is an acceptable industry standard for external corrosion control because it addresses underground piping in a manner consistent with NACE International Recommended Practice 0169. For example, Appendix IV references NACE Recommended Practice 1069 and recommends, in addition to a coating, cathodic protection unless it is shown to be unnecessary.

The NRC staff finds that both the provisions for maintaining a 7-day fuel oil supply and the design for protection against internal and external corrosion are in accordance with the applicable guidance provided in RG 1.137. In addition, the design description provided in the Fermi 3 COL FSAR supports the regulatory requirements for an onsite power supply in GDC 17 to the extent that the requirements apply to nonsafety-related DGs classified as RTNSS Criterion B and C systems.

The staff evaluated EF3 COL 9.5.4-2-A to the relevant NRC regulations and acceptance criteria in Section 9.5.4 of NUREG-0800. The staff finds that the applicant has satisfactorily addressed DCD COL Item 9.5.4-2-A.

9.5.4.5 *Post Combined License Activities*

There are no post COL activities related to this section.

9.5.4.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1966. The NRC staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the diesel generator fuel oil storage and transfer system, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the diesel generator fuel oil storage and transfer system that were incorporated by reference are resolved. In addition, the staff compared the additional COL supplemental information in the application to the relevant NRC regulations, the guidance in Section 9.5.4 of NUREG–0800, and other NRC regulatory guides. The staff's review concludes that the applicant's information in this section of the COL FSAR is acceptable and meets the requirements of GDC 17 and RG 1.137. The staff also finds that the applicant has satisfactorily addressed DCD COL Items 9.5.4-1-A and 9.5.4-2-A.

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[2] NACE International RP0169, "Control of External Corrosion on Underground or Submerged Metallic Piping Systems," was reaffirmed in 2007 as NACE International Standard Practice (SP) 0169, "Control of External Corrosion on Underground or Submerged Metallic Piping Systems"

9.5.5 Diesel Generator Jacket Cooling Water System

Subsection 9.5.5 of the Fermi 3 COL FSAR incorporates by reference Section 9.5.5, "Diesel Generator Jacket Cooling Water System," of the ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to diesel generator jacket cooling water system that were incorporated by reference are resolved.

9.5.6 Diesel Generator Starting Air System

Subsection 9.5.6 of the Fermi 3 COL FSAR incorporates by reference Section 9.5.6, "Diesel Generator Starting Air System," of the ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to diesel generator starting air system that were incorporated by reference are resolved.

9.5.7 Diesel Generator Lubrication System

Subsection 9.5.7 of the Fermi 3 COL FSAR incorporates by reference Section 9.5.7, "Diesel Generator Lubrication System," of the ESBWR DCD, Revision 10,referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to diesel generator lubrication system that were incorporated by reference are resolved.

9.5.8 Diesel Generator Combustion Air Intake and Exhaust System

Subsection 9.5.8 of the Fermi 3 COL FSAR incorporates by reference Section 9.5.8, "Diesel Generator Combustion Air Intake and Exhaust System," of the ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E, with no departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review[1]. The NRC staff's review confirms that no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to diesel generator combustion air intake and exhaust system that were incorporated by reference are resolved.

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.2.2 for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

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10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

This final safety evaluation report (FSER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's technical review of the combined license (COL) application submitted for the Enrico Fermi Unit 3.

In a letter dated September 18, 2008, DTE Electric Company (DTE, formerly Detroit Edison Company) submitted an application to the NRC for a COL to construct and operate an Economic Simplified Boiling-Water Reactor pursuant to the requirements of Section 103 and 185(b) of the Atomic Energy Act of 1954 as Amended (AEA), Title 10 of the Code of Federal Regulations (10 CFR) Part 52, "Licenses, Certifications and Approval for Nuclear Power Plants," and the associated material licenses under 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material"; 10 CFR Part 40, "Domestic Licensing of Source Material"; and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material." By letter dated December 21, 2012, the Detroit Edison Company informed the NRC that effective January 1, 2013, the name of the company would be changed to "DTE Electric Company." The legal entity remains the same. This reactor will be identified as Fermi 3 and will be located on the existing Fermi site in Monroe County, Michigan.

This FSER presents the results of the staff's review of information submitted in conjunction with the COL application.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)	13. AVAILABILITY STATEMENT
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