West Valley Demonstration Project

Doc. ID Number WVNS-SAR-003

Revision Number 8

Revision Date 05/31/2000

Controlled Copy No. 100

SAFETY ANALYSIS REPORT FOR

VITRIFICATION SYSTEM OPERATIONS

AND HIGH-LEVEL WASTE INTERIM STORAGE

HAZARD CATEGORIZATION: 2

APPROVALS:

Tom Kocialski — 5/26/00

T.F. Kocialski, HLW Systems Engineering Manager — Date

PJ Valenti — 5-26-00

P.J. Valenti, High Level Waste Projects Manager — Date

Alley A. Savage, for — 5-26-00

J.L. Little, Chairman, WVNS Radiation and Safety Committee — Date

Westinghouse
Government Services Group

West Valley Nuclear Services Co.
10282 Rock Springs Road
West Valley, NY 14171-9799

NMSS01 Public

WVNS RECORD OF REVISION

Rev. No.	Description of Changes	Revision On Page(s)	Dated
8	Annual SAR Update Per ECN #12655 Changes to system descriptions to reflect current configurations or operation (e.g., ALPHA computer instead of VAX computer, removal of steam supply to tank bubblers located in the Vitrification Cell, hanging of containers from the maintenance station, actual condensate return line valve operation, etc.) Deletion of reference to DOP testing (since DOP is no longer used) Drawings updated to reflect latest available revisions Substantial additions to Chapter 7 to address the Vitrification Expended Materials Processing (VEMP) system, and to address items listed as vitrification expended materials as of March 2000 Changes to reflect historical practice regarding the frequency and means of replacing Off-Gas system HEPA filters, both in-cell and ex-cell Changes to reflect the current WVNS organizational structure Other changes that were driven by the need for completeness; the need to correct or improve the meaning of certain text; the need to provide technical accuracy; editorial in general.	All	05/31/00

WVNS RECORD OF REVISION CONTINUATION FORM

Rev. No.	Description of Changes	Revision On Page(s)	Dated

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Concluded)

LIST OF FIGURES

LIST OF FIGURES
(Continued)

LIST OF FIGURES
(Continued)

LIST OF FIGURES
(Continued)

LIST OF FIGURES
(Concluded)

LIST OF FIGURES
(Concluded)

LIST OF ACRONYMS AND ABBREVIATIONS

A/E	Architect/Engineer
Å	Angstrom (10^{-8} centimeter)
A&PC	Analytical and Process Chemistry
AA	Atomic Absorption
AAC	Assembly Area Coordinator
AADT	Average Annual Daily Traffic
ABA	Authorization Basis Addendum
ACFM	Absolute Cubic Feet Per Minute
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AED	Assistant Emergency Director
AEDE	Annual Effective Dose Equivalent
AES	Atomic Emission Spectrophotometer
AIHA	American Industrial Hygiene Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ALARA	As Low As Reasonably Achievable
ALI	Annual Limit of Intake
ALS	Advanced Life Saving
AMCA	Air Movement and Control Association
AMS	Aerial Measurement System
AMS	Alarm Monitoring Station
ANC	Analytical Cell
ANL	Argonne National Laboratory
ANS	American Nuclear Society
ANSI	American National Standards Institute
AOC	Ashford Office Complex
APOC	Abnormal Pump Operating Condition
AR-OG	Acid Recovery - Off-Gas
ARC	Acid Recovery Cell
ARF	Airborne Release Fraction
ARI	Air-Conditioning and Refrigeration Institute
ARM	Area Radiation Monitor
ARPR	Acid Recovery Pump Room
ARR	Airborne Release Rate
ASCE	American Society of Civil Engineers
ASER	Annual Site Environmental Report
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AU	Alfred University
AWS	American Welding Society
B&P	Buffalo & Pittsburgh
BDAT	Best Demonstrated Available Technology
BDB	Beyond Design Basis
BDBE	Beyond Design Basis Earthquake
BNL	Brookhaven National Laboratory

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

Bq	Becquerel
BRP	Big Rock Point
BSW	Bulk Storage Warehouse
BWR	Boiling Water Reactor
c	Centi, prefix for 10^{-2}
C	Coulomb
CAM	Continuous Air Monitor
CAS	Criticality Alarm System
cc	Cubic Centimeter
CC	Chilled Water System
CC	Communications Coordinator
CCB	Cold Chemical Building
CCDS	Cold Chemical Delivery System
CCR	Chemical Crane Room
CCSR	Cold Chemical Scale Room
CCSS	Cold Chemical Sump Station
CCTV	Closed-Circuit Television
CDDS	Computer Data Display System
CDS	Criticality Detection System
CEC	Cation Exchange Capacity
CEDE	Committed Effective Dose Equivalent
cfm	Cubic feet per minute
CFMT	Concentrator Feed Make-up Tank
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CGA	Compressed Gas Association
CHT	Condensate Hold Tank
Ci	Curie
CLCW	Closed-Loop Cooling Water
cm	Centimeter
CMAA	Crane Manufacturers Association of America
CMP	Construction Management Procedure
CMR	Crane Maintenance Room
COA	Chemical Operating Aisle
CPC	Chemical Process Cell
CPC-WSA	Chemical Process Cell Waste Storage Area
cpm	Counts per minute
CR	Control Room
CRM	Community Relations Manager
CRT	Cathode Ray Tube
Cs	Cesium
CSDM	Cognizant System Design Manager
CSE	Criticality Safety Engineer
CSE	Cognizant System Engineer
CSER	Confined Space Entry Rescue
CSPF	Container Sorting and Packaging Facility
CSR	Confined Space Rescue
CSRF	Contact Size Reduction Facility
CSS	Cement Solidification System
cSv	centi-Sievert
CTS	Component Test Stand

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

CUA	Catholic University of America
CUP	Cask Unloading Pool
Cv	Column Volume
CVA	Chemical Viewing Aisle
CW	Cooling Tower Water
CY	Calendar Year
D&D	Decontamination and Decommissioning
D&M	Dames & Moore
DAC	Derived Air Concentration
DAS	Data Acquisition System
DB	Dry Bulb
DBA	Design Basis Accident
DBE	Design Basis Earthquake
DBT	Design Basis Tornado
DBW	Design Basis Wind
DC	Drum Cell
DCF	Dose Conversion Factor
DCG	Derived Concentration Guide
DCS	Distributed Control System
DEAR	Department of Energy Acquisition Regulation
DF	Decontamination Factor
DGR	Diesel Generator Room
DOE	Department of Energy
DOE-EM	Department of Energy - Environmental Management
DOE-HQ	Department of Energy - Headquarters
DOE-HQ-EOC	Department of Energy - Headquarters - Emergency Operations Center
DOE-ID	Department of Energy - Idaho
DOE-OCRWM	Department of Energy - Office of Civilian Radioactive Waste Management
DOE-PD	Department of Energy - Project Director
DOELAP	Department of Energy Laboratory Accreditation Program
DOSR	DOE On-Site Representative
DOT	Department of Transportation
DP	Differential Pressure
dpm	Disintegrations per minute
DR	Data Recorder
DR	Damage Ratio
DVP	Developmental Procedure
DWS	Demineralized Water System
E-Spec	Equipment Specification
EBA	Evaluation Basis Accident
EBE	Evaluation Basis Earthquake
ECN	Engineering Change Notice
ECO	Environmental Control Officer
ED	Emergency Director
EDE	Effective Dose Equivalent
EDR	Equipment Decontamination Room
EDRVA	Equipment Decontamination Room Viewing Aisle
EDS	Electrical Power Distribution
EG	Evaluation Guideline
EHS	Employee Health Services

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

EID	Environmental Information Document
EIP	Emergency Implementing Procedure
EIS	Environmental Impact Statement
EMC	Emergency Management Coordinator
EMOA	East Mechanical Operating Aisle
EMP	Emergency Management Procedure
EMT	Emergency Medical Technician
EMU	Emergency Medical Unit
EOC	Emergency Operation Center
EP	Engineering Procedure
EPA	Environmental Protection Agency
EPD	Elevation Plant Datum
EPI	Emergency Prediction Information
EPIcode	Emergency Protection Information Code
EPRI	Electric Power Research Institute
EPZ	Emergency Protection Zone
ERO	Emergency Response Organization
ERPG	Emergency Response Planning Guideline
ES&H	Environmental, Safety, and Health
ESA	Endangered Species Act
ESH&QA	Environmental, Safety, Health, and Quality Assurance
ESQA&LO	Environmental, Safety, Quality Assurance, and Laboratory Operations
FACTS	Functional and Checklist Testing of Systems
FBC	Fire Brigade Chief
FBR	Fluidized Bed Reactor
FFCA	Federal Facility Compliance Act
FHA	Fire Hazards Analysis
FM	Factory Mutual
fpm	Feet per minute
fps	Feet per second
FRI	Feed Reduction Index
FRS	Fuel Receiving and Storage
FSAR	Final Safety Analysis Report
FSFCA	Federal and State Facility Compliance Act
FSP	Fuel Storage Pool
ft	Feet
FWCA	Fish and Wildlife Coordination Act
g	Gram
g	Gravitational Acceleration Constant
G	Giga, prefix for 10^9
GAC	Granular Activated Carbon
gal	Gallon
GC	Gas Chromatograph
GCR	General Purpose Cell Crane Room
GCS	Gravelly Clayey Soils
GE	General Electric
GET	General Employee Training
GFE	Government Furnished Equipment
gM	Gravelly mud
GM	Geometric Mean

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

GM	Geiger-Mueller
GOA	General Purpose Cell Operating Aisle
GOALS	General Office Automated Logging System
GOCO	Government-Owned, Contractor-Operated
GPC	General Purpose Cell
gpd	Gallons per day
GPLI	General Purpose LAN Interface
gpm	Gallons per minute
GRS	General Record Schedule
G_s	Specific gravity
GTAW	Gas Tungsten Arc Welding
h	Hour
ha	Hectare
HAC	Hot Acid Cell
HAF	Hot Acid Feed
HAPR	Hot Acid Pump Room
HAZMAT	Hazardous Materials
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDC	High Density Concrete
HEC	Head End Cells
HEME	High Efficiency Mist Eliminator
HEPA	High Efficiency Particulate Air
HEV	Head End Ventilation
HFE	Human Factors Engineering
HIC	High Integrity Container
HLDS	High-Level Drainage System
HLW	High-Level Waste
HLWIS	High-Level Waste Interim Storage
HLWISA	High-Level Waste Interim Storage Area
HLWTS	High-Level Waste Transfer System
hp	Horsepower
HPGe	Hyperpure Germanium
HPLC	High Performance Liquid Chromatography
HPS	High Pressure Sodium
HRA	Human Reliability Analysis
HRM	Human Resources Manager
HV	Heating and Ventilation
HVAC	Heating, Ventilation, and Air Conditioning
HVOS	Heating, Ventilation Operating Station
HWSF	Hazardous Waste Storage Facility
i.d.	Inner Diameter
I&C	Instrumentation and Control
IA	Instrument Air
IC	Incident Commander
ICEA	Insulated Cable Engineers Association
ICP	Inductively Coupled Plasma
ICR	Instrument Calibration Recall
ICRP	International Commission on Radiological Protection
ID	Idaho
IDLH	Immediately Dangerous to Life and Health

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IH&S	Industrial Hygiene and Safety
ILDS	Infrared Level Detection System
in	Inch
INEEL	Idaho National Engineering and Environmental Laboratory
IRTS	Integrated Radwaste Treatment System
ISMS	Integrated Safety Management System
IV&V	Independent Validation and Verification
IWP	Industrial Work Permit
IWSF	Interim Waste Storage Facility
IX	Ion Exchange
JIC	Joint Information Center
JTG	Joint Test Group
k	Neutron Multiplication Factor
k	Kilo, prefix for 10^3
K_d	Partition Coefficient
k_{eff}	Effective Neutron Multiplication Factor
kg	Kilogram
K_h	Horizontal hydraulic conductivity
kN	Kilo-Newton
kPa	Kilo-Pascal
kPag	Kilo-Pascal gauge
kph	Kilometer per hour
kV	Kilo-Volt
K_v	Vertical hydraulic conductivity
kVA	Kilovolt-ampere
kW	kilo-Watt
L	Liter
LAH	Level Alarm High
LAN	Local Area Network
LANL	Los Alamos National Laboratory
LAP	Laboratory Accreditation Program
LAP	Lower Annealing Point
LASL	Los Alamos Scientific Laboratory
lb	Pound
LCO	Limiting Condition for Operation
lfpm	Linear feet per minute
LFR	Live Fire Range
LI	Level Indicate
LIMS	Laboratory Information Management System
LITCO	Lockheed Idaho Technologies Corporation
LLDS	Low-Level Drainage System
LLL	Lawrence Livermore Laboratory
LLNL	Lawrence Livermore National Laboratory
LLRW	Low-Level Radioactive Waste
LLW	Low-Level Waste
LLW2	Low-Level Waste Treatment Replacement Facility
LLWTF	Low-Level Waste Treatment Facility

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

LLWTS	Low-Level Waste Treatment System
LM	Liaison Manager
LMITCO	Lockheed-Martin Idaho Technologies Corporation
LOS	Level of Service
LOVS	Loss of Voltage Signal
LPF	Leak Path Factor
LPG	Liquid Propane Gas
lpm	Liters per minute
LPM	Liters per minute
LPS	Liquid Pretreatment System
LR	Level Record
LSA	Lag Storage Area
LUNR	Land Use and Natural Resources
LWA	Lower Warm Aisle
LWC	Liquid Waste Cell
LWTS	Liquid Waste Treatment System
LXA	Lower Extraction Aisle
m	Meter
m/s	Meters per second
m	Milli, prefix for 10^{-3}
M	Mega, prefix for 10^{6}
M&O	Maintenance and Operations
M&O	Management and Operating
M&TE	Maintenance and Test Equipment
MAR	Material at Risk
m_b	Earthquake Magnitude
MBtu	Mega-British Thermal Units
MC	Miniature Cell
MCC	Materials Characterization Center
MCC	Motor Control Center
MCE	Maximum Credible Earthquake
mCi	milli-Curie
MEOSI	Maximally Exposed Off-Site Individual
MeV	Mega-electron Volt
MFHT	Melter Feed Hold Tank
mG	Muddy gravels
mi	Mile
MMI	Modified Mercalli Intensity
MOA	Mechanical Operating Aisle
MOI	Maximally Exposed Off-Site Individual
mol	Mole
MOU	Memorandum of Understanding
MPag	Mega-Pascal gauge
MPC	Maximum Permissible Concentration
MPFL	Maximum Possible Fire Loss
mph	Miles per hour
MPO	Main Plant Operator
MPOSS	Main Plant Operations Shift Supervisor
mR/hr	Milli-Roentgen per hour
MRC	Master Records Center
mrem	Millirem

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

MRR	Manipulator Repair Room
MSDS	Material Safety Data Sheet
msG	Muddy Sandy Gravels
MSM	Master-Slave Manipulator
mSv	milli-Sievert
MT	Metric Ton
MTIHM	Metric Tons Initial Heavy Metal
MTU	Metric Tons Uranium
MUF	Material-Unaccounted-For
MW	Mega-Watt
MWD	Mega-Watt-Day
n	Nano, prefix for 10^{-9}
Na	Sodium
NAD	Nuclear Accident Dosimeter
NARA	National Archives and Records Administration
NDA	NRC-Licensed Disposal Area
NDA-LPS	NRC-Licensed Disposal Area - Liquid Pretreatment System
n_e	Effective porosity
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NESHAP	National Emission Standard for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NFS	Nuclear Fuel Services, Inc.
NGVD	National Geodetic Vertical Datum
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
NMC	News Media Center
NMPC	Niagara Mohawk Power Corporation
NOAA	National Oceanic and Atmospheric Administration
NP	North Plateau
NPH	Natural Phenomena Hazard
NPPS	North Plateau Pump System
NPPTS	North Plateau Pump and Treatment System
NQA	Nuclear Quality Assurance
NR	Nonconformance Report
NRC	Nuclear Regulatory Commission
NRRPT	National Registry of Radiation Protection Technology
NWS	National Weather Service
NY	New York
NYCRR	New York Code of Rules and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSERDA	New York State Energy Research and Development Authority
NYSGS	New York State Geological Survey
o.d.	Outer Diameter
OAAM	Operational Accident Assessment Manager
OAM	Operational Assessment Manager
OB	Office Building

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

OBE	Operating Basis Earthquake
OEP	On-Site Evaluation Point
OGA	Off-Gas Aisle
OGBR	Off-Gas Blower Room
OGC	Off-Gas Cell
OGMR	Off-Gas Monitoring Room
OGTS	Off Gas Treatment System
OH	DOE, Ohio Field Office
OH/WVDP	Ohio Field Office, West Valley Demonstration Project
OJT	On-the-Job Training
OM	Operations Manager
OOS	Out-of-Service
ORNL	Oak Ridge National Laboratory
ORR	Operational Readiness Review
ORRB	Operational Readiness Review Board
ORT	Operations Response Team
OSC	Operations Support Center
OSHA	Occupational Safety and Health Act
OSHA	Occupational Safety and Health Administration
OSR	Operational Safety Requirement
oz	Ounce
p	Pico, prefix for 10^{-12}
P	Peta, prefix for 10^{15}
P&ID	Piping and Instrument Diagram
Pa	Pascal
PAG	Protective Action Guideline
PAH	Pressure Alarm High
PBT	Performance-Based Training
PC	Partition Coefficient
PCB	Polychlorinated Biphenyl
PCDOCS	Personal Computer Document Organization and Control Software
pcf	Pounds per cubic foot
PCH	Pressure Control High
PCM	Personal Contamination Monitor
PCR	Process Chemical Room
PD	Project Director
PDAH	Pressure Differential Alarm High
PDAL	Pressure Differential Alarm Low
PDCH	Pressure Differential Control High
PDCL	Pressure Differential Control Low
PDR	Pressure Differential Record
PEL	Permissible Exposure Limit
PF	Personnel Frisker
PGA	Peak Ground Acceleration
PGSC	Pasquill-Gifford Stability Class
PHA	Process Hazards Analysis
PHA	Product Handling Area
PID	Public Information Director
PLC	Programmable Logic Controller
PM	Preventive Maintenance
PMC	Process Mechanical Cell

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

PMCR	Process Mechanical Cell Crane Room
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PMP	Project Management Plan
PNL	Pacific Northwest Laboratory
PNNL	Pacific Northwest National Laboratory
PPB	Parts Per Billion
PPC	Product Purification Cell
ppm	Parts Per Million
PPM	Parts Per Million
PPS	Product Packaging and Shipping
PRC	Pressure Record Control
PRM	Process Radiation Monitor
PSAR	Preliminary Safety Analysis Report
psf	Pound per square foot
psi	Pound per square inch
psig	Pound per square inch gauge
PSO	Plant Systems Operations
PSO	Plant Systems Operator
PSR	Process Safety Requirement
Pu	Plutonium
PVC	Polyvinyl chloride
PVS	Permanent Ventilation System
PVU	Portable Ventilation Unit
PWR	Pressurized Water Reactor
PWS	Potable Water System
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Program
QAP	Quality Assurance Plan
QAPD	Quality Assurance Program Description
QARD	Quality Assurance Requirements Document
QCN	Qualification Change Notice
QM	Quality Management
R	Roentgen
R/hr	Roentgen per hour
R&S	Radiation and Safety
R&SC	Radiation and Safety Committee
RAP	Radiological Assistance Plan
RCO	Radiological Control Operations
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
RCTC	Radiological Control Team Commander
RCTL	Radiation Control Team Leader
REAAM	Radiological and Environmental Accident Assessment Manager
REAM	Radiological and Environmental Assessment Manager
REG	Robert E. Ginna
rem	Roentgen Equivalent Man
RER	Ram Equipment Room
RESL	Radiological and Environmental Sciences Laboratory

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

RF	Respirable Fraction
RID	Records Inventory and Disposition Schedule
RMW	Radioactive Mixed Waste
RP	Radiation Protection
rpm	Revolutions per minute
RPM	Revolutions Per Minute
RPM	Radiation Protection Manager
Rt	Route
RTS	Radwaste Treatment System
RWI	Radiological Worker I
RWII	Radiological Worker II
RWP	Radiation Work Permit
s	Second
S&EA	Safety and Environmental Assessment
SA&I	Safety Analysis and Integration
SAA	Satellite Accumulation Area
SAI	Science Applications International
SAR	Safety Analysis Report
SBS	Submerged Bed Scrubber
SCBA	Self-Contained Breathing Apparatus
scfm	Standard cubic feet per minute
SCR	Selective Catalytic Reduction
SCS	Soil Conservation Service
SCSSCs	Safety-Class Structures, Systems, and Components
SDA	New York State-Licensed Disposal Area
SEAM	Safety and Environmental Assessment Manager
sec	Second
SFCM	Slurry-Fed Ceramic Melter
SFPE	Society of Fire Protection Engineers
SFR	Secondary Filter Room
SGN	Society Generale pour les Techniques Nouvelles
SGR	Switch Gear Room
SI	International System of Units
SIP	Special Instruction Procedure
slpm	Standard liter per minute
SM	Security Manager
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SMS	Sludge Mobilization System
SMT	Slurry Mix Tank
SMWS	Sludge Mobilization and Wash System
SNF	Spent Nuclear Fuel
SNL	Sandia National Lab
SNM	Special Nuclear Material
SO	Security Officer
SOG	Seismic Owner's Group
SOP	Standard Operating Procedure
SPDES	State Pollutant Discharge Elimination System
SPO	Security Police Officer
Sr	Strontium
SR	Surveillance Requirement
SRL	Savannah River Laboratory

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

SRR	Scrap Removal Room
SRSS	Square-root-of-the-sum-of-the-squares
SS	Stainless Steel
SSC	Sample Storage Cell
SSCs	Structures, Systems, and Components
SSE	Safe Shutdown Earthquake
SSS	Security Shift Supervisor
SSS	Slurry Sample System
SSWMU	Super Solid Waste Management Unit
STC	Sample Transfer Cell
STD	Standard
STP	Standard Temperature and Pressure
STS	Supernatant Treatment System
Sv	Sievert
SVS	Scale Vitrification System
SWC	Surge Withstand Capability
SWMU	Solid Waste Management Unit
T	Tera, prefix for 10^{12}
TBP	Tri-butyl phosphate
TE	Test Exception
TEDE	Total Effective Dose Equivalent
TEEL	Temporary Emergency Exposure Limit
Ti	Titanium
TID	Tamper-Indicating Device
TIG	Tungsten Inert Gas
TIP	Test Implementation Plan
TIP	Test In-Place
TIP	Test Instruction Procedure
TLD	Thermoluminescent Dosimeter
TLV	Threshold Limit Value
TN	Transnuclear, Inc.
TPC	Test Procedure Change
TPL	Test Plan
TR	Technical Requirement
TRG	Technical Review Group
TRMS	Training Records Management System
TRR	Test Results Report
TRU	Transuranic
TSB	Test and Storage Building
TSC	Technical Support Center
TSCS	Technical Support Center Staff
TSD	Technical Support Document
TSR	Technical Safety Requirement
TVS	Temporary Ventilation System
UA	Utility Air
UAP	Upper Annealing Point
UBC	Uniform Building Code
UCRL	University of California Research Laboratory
UDF	Unit Dose Factor
UL	Underwriters Laboratories, Inc.

LIST OF ACRONYMS AND ABBREVIATIONS
(Concluded)

ULO	Uranium Load Out
UPC	Uranium Product Cell
UPS	Uninterruptible Power Supply
UR	Utility Room
USDOE	U. S. Department of Energy
USDOI	U. S. Department of the Interior
USDOL	U. S. Department of Labor
USDOT	U. S. Department of Transportation
USEPA	U. S. Environmental Protection Agency
USGS	U. S. Geological Survey
USNRC	U. S. Nuclear Regulatory Commission
USQ	Unreviewed Safety Question
USQD	Unreviewed Safety Question Determination
UWA	Upper Warm Aisle
UWS	Utility Water Supply
UXA	Upper Extraction Aisle
V	Volt
VA	Volt-Ampere
VAC	Volt Alternating Current
VDC	Volt Direct Current
V&S	Ventilation and Service Building
VEC	Ventilation Exhaust Cell
VEM	Vitrification Expended Materials
VEMP	Vitrification Expended Materials Processing
VF	Vitrification Facility
VFFCP	Vitrification Facility Fire Control Panel
VIV	Variable Inlet Vane
VL	Vitrification Liaison
VOG	Vessel Off-Gas
VOSS	Vitrification Operations Shift Supervisor
VPP	Voluntary Protection Program
VS	Vitrification System
VSR	Ventilation Supply Room
VTF	Vitrification Test Facility
VWR	Ventilation Wash Room
W	Watt
WAPS	Waste Acceptance Product Specifications
WC	Water Column
WCC	Warning Communications Center
WCCC	Warning Communications Center Communicator
WDC	Waste Dispensing Cell
WDV	Waste Dispensing Vessel
WHC	Westinghouse Hanford Company
WHSE	Warehouse
WIPP	Waste Isolation Pilot Plant
WMO	Waste Management Operation
WMO	Westinghouse Maintenance Operation
WMOA	West Mechanical Operating Aisle
WNYNSC	Western New York Nuclear Service Center
WO	Work Order

LIST OF ACRONYMS AND ABBREVIATIONS
(Concluded)

WQR	Waste Qualification Report
WRPA	Waste Reduction and Packaging Area
wt%	Weight percent
WTF	Waste Tank Farm
WTFVS	Waste Tank Farm Ventilation System
WVDP	West Valley Demonstration Project
WVNS	West Valley Nuclear Services Co., Inc.
WVPP	West Valley Policies and Procedures
WVVHC	West Valley Volunteer Hose Company
XC-1	Extraction Cell 1
XC-2	Extraction Cell 2
XC-3	Extraction Cell 3
XCR	Extraction Chemical Room
XSA	Extraction Sample Aisle
y	Year
Y_d	Dry density
YOY	Young of Year
yr	Year
Y2K	Year 2000
°C	Degrees Celsius
°F	Degrees Fahrenheit
μ	Micro, prefix for 10^{-6}
χ/Q	Relative concentration

C.1.0 INTRODUCTION AND GENERAL DESCRIPTION OF VITRIFICATION FACILITY

C.1.1 Introduction

The Western New York Nuclear Service Center (WNYNSC) in West Valley, New York was the site of the first commercial nuclear reprocessing operation in the United States. It was operated by Nuclear Fuel Services, Inc. (NFS), beginning in the early 1960s and was discontinued in the early 1970s. The reprocessing operation resulted in the generation of approximately 2,271 m^3 (600,000 gal) of high-level radioactive waste (HLW) that was stored in underground tanks.

In 1980, Congress passed the West Valley Demonstration Project Act (U.S. Congress, 1980), directing the U.S. Department of Energy (DOE) to carry out a high-level waste (HLW) management demonstration project at the site (without taking title to the facilities or the wastes) to demonstrate solidification techniques for preparing the HLW for disposal. Through a contractual agreement with New York State, DOE operates the Project in conjunction with the New York State Energy Research and Development Authority (NYSERDA). DOE and NYSERDA have contracted with Westinghouse Electric Company to manage the Project through a wholly-owned Westinghouse subsidiary, West Valley Nuclear Services Co., Inc. (WVNS). Westinghouse Electric Company was acquired in March 1999 by Morrison Knudsen Corporation and BNFL Inc. (a U.S. subsidiary of British Nuclear Fuels).

The WVDP is located on approximately 89 hectares (220 acres) within the 1,354-hectare (3,345-acre) WNYNSC in rural Cattaraugus County, about 55 km (35 mi) south of Buffalo, New York. The Project facilities include the former NFS plant and related facilities, most of which have been decontaminated and are now in use by the WVDP, and several buildings and facilities constructed by the WVDP.

The WVDP Act directs the Secretary of Energy to undertake five major activities, as follows:

- Solidify the liquid HLW stored at the WNYNSC into a form suitable for transportation and disposal.

- Develop containers for the solidified HLW suitable for permanent disposal of the HLW.

- Transport the waste to a federal repository for disposal.

- Dispose of low-level radioactive waste (LLW) and transuranic (TRU) waste produced by the Project.

- Decontaminate and decommission the HLW storage tanks, the HLW solidification facilities, and any material and hardware used in connection with the Project.

C.1.2 General Vitrification Facility Description

The Vitrification Facility (VF) consists of several associated structures, including the Transfer Trench, Vitrification Building (which includes the Vitrification Cell, operating aisles, and Control Room), Cold Chemical Building, 01-14 Building, Transfer Tunnel, Load-In/Load-Out Area, Equipment Decontamination Room (EDR), High-Level Waste Interim Storage (HLWIS), Off-Gas Trench, and Diesel Fuel Oil Storage Tank Building. See Figure C.1.2-1.

The Transfer Trench contains pipes that are used to transfer waste between the Vitrification Building and Waste Tank Farm. After the HLW has been vitrified in the Vitrification Cell and sealed into stainless steel canisters, the canisters are transported on rails through the Transfer Tunnel and EDR to the HLWIS. The Load-In/Load-Out Area adjoins the west wall of the existing EDR. In conjunction with the Load-In/Load-Out Area, the EDR is also instrumental in the load-in of empty canisters and replacement equipment and materials. In the future, the EDR and Load-In/Load-Out Area will be involved in the load-out of canisters and replaced contaminated equipment that are located in the HLWIS. The HLWIS is located in the Chemical Process Cell (CPC) and is now used to store failed or faulty contaminated equipment and the filled canisters on an interim basis until a permanent HLW repository is made available.

The Off-Gas Trench contains piping that directs process off-gases from various Vitrification Cell process tanks and the melter to portions of the Off-Gas system located in the 01-14 Building. Process off-gases and the Vitrification Cell atmospheric gases are filtered through High Efficiency Particulate Air (HEPA) filters prior to leaving the Vitrification Cell. Both of these gas streams also receive HEPA filtering after leaving the Vitrification Cell. Ex-Cell HEPA filtering equipment for the Vitrification Cell atmospheric gases is located in the Vitrification Building. Ex-Cell HEPA filtering and NO_x removal equipment for the process off-gases is located in the 01-14 Building.

For additional descriptive information about the VF, see Chapters 5 and 6 of this Final Safety Analysis Report (FSAR). The pump pits in the Waste Tank Farm and ventilation systems that service these pits are discussed in Chapter 5.

C.1.3 General Process Description

The process mission of the VF is to convert the HLW from its initial sludge/liquid form into borosilicate glass in stainless steel canisters. The filled canisters are stored temporarily in the HLWIS, until they can be shipped to an approved federal repository.

The VF operates on a continuous basis (24 hours per day, 7 days per week). Feed preparation for the vitrification operation is done on a batch basis. The total vitrification campaign, producing glass at a nominal rate of 30 kg/hour (66 lb/hour), is expected to produce approximately 500,000 kg (1.1E+06 lb) of glass (about 250 canisters). The total vitrification campaign, which was initiated in June of 1996, was expected to take approximately 30 months. In June of 1998, "Phase I" of high-level waste vitrification was completed "by feeding 9.32 million curies of Cs-137/Sr-90 to the melter."

The VF includes all of the structures, systems, and components (SSCs) that are necessary to safely perform the following functions:

- HLW transfer from the Waste Tank Farm to the Vitrification Cell.

- Preparation of cold (i.e., nonradioactive) chemicals in the Cold Chemical Building.

- Melter feed preparation in the Concentrator Feed Make-up Tank (CFMT).

- Feed transfer from the CFMT to the Melter Feed Hold Tank (MFHT).

- Transfer from the MFHT to the Slurry-Fed Ceramic Melter (SFCM).

- SFCM operation and transfer of molten HLW glass to canisters.

- Filled canister welding, decontamination, and transfer to the HLWIS.

- Process equipment off-gas collection, treatment, filtering, and monitoring prior to stack release.

- Heating, Ventilation, and Air Conditioning (HVAC) system exhaust air filtering and monitoring before stack release of all areas potentially containing airborne radioactive materials.

C.1.4 Identification of Agents and Contractors

The state of New York is the site owner. Through an agreement with New York State, the DOE is operating the WVDP in conjunction with the state's on-site representative, the New York State Energy Research and Development Authority (NYSERDA). A Cooperative Agreement, dated October 1980, between the DOE and the state specifies Project funding contributions of the DOE and the state. The DOE Ohio Field Office (OH) is responsible for implementing the objectives of the WVDP, and has established the DOE West Valley Area Office (OH/WVDP) for on-site administration of the Project.

The WVDP Act requires the DOE to consult with the U.S. Nuclear Regulatory Commission (NRC) concerning substantive aspects of the Project. The NRC must also approve the final decontamination and decommissioning (D&D) criteria to be implemented upon completion of the Project. The relationship between the DOE and the NRC has been outlined in a memorandum of understanding (MOU) between the two agencies (FR Vol. 46, No. 223 November 19, 1981). In addition, the WVDP Act requires the DOE to consult with the U.S. Department of Transportation (DOT), the U.S. Environmental Protection Agency (EPA), and the U.S. Geological Survey (USGS) in matters relating to their respective areas of expertise and concern.

DOE and NYSERDA have contracted with Westinghouse Corporation to manage the Project through a wholly owned Westinghouse subsidiary, West Valley Nuclear Services Co., Inc. (WVNS). Dames & Moore joined with WVNS in the original procurement to provide geotechnical, environmental, and safety assessment services for the Project. Ebasco Services, Inc., Pacific Northwest Laboratories (PNL), and the Societe Generale pour les Techniques Nouvelles (SGN) have been retained for design services, with Ebasco Services, Inc. serving as the lead architect-engineer firm for the VF. Bell Power was the firm responsible for construction of the VF. WVNS is the operator.

The Project also consults with and is engaged in technology transfer on a national level by means of the Commercial Waste Treatment Program, Defense Waste Processing Facility, and other DOE government-owned contractor-operated (GOCO) facilities, and on an international level with German, French, and Japanese nuclear program organizations.

C.1.5 Structure of the Safety Analysis Report

The purpose of a Safety Analysis Report is to document the adequacy of safety analyses to ensure that a given facility, activity, or operation can be constructed, operated, maintained, shutdown, and decommissioned safely and in compliance with applicable laws and regulations. This FSAR has been developed to comply with the requirements of DOE Order 5480.23, *Nuclear Safety Analysis Reports* (U.S. Department of Energy April 30, 1992), and WVNS Policy and Procedure WV-365, *Preparation of WVDP Safety Documents*. The guidance contained in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, has also been utilized (U.S. Department of Energy July 1994).

These DOE documents provide direction with respect to the content of an FSAR, but do not mandate the use of any particular format. This FSAR uses the twelve chapter format/outline suggested in NRC Regulatory Guide 3.26, *Standard Format and Content of*

Safety Analysis Reports for Fuel Reprocessing Plants (U.S. Nuclear Regulatory Commission 1975). The informational requirements from Regulatory Guide 3.26 were carefully considered during development of this FSAR. Decisions were made on a case-by-case basis as to whether a given informational requirement from Regulatory Guide 3.26 should or should not be included in this FSAR. The topics listed in DOE Order 5480.23 can be found in this FSAR through use of the correlative information shown in Table C.1.5-1.

C.1.6 Technical Safety Requirements

Consistent with the definition of a safety class SSC provided in DOE-STD-3009-94, no active SSCs associated with the VF have been designated as safety class based on the accident analyses provided in Chapter 9 of this FSAR. Based on "engineering judgment of possible effects and the potential added value of safety-significant SSC designation," no VF SSCs have been designated as safety-significant SSCs (even though they may contribute to defense in depth). Since no VF SSCs that are active or under an operator's direct control have been designated as safety class or safety-significant based on DOE-STD-3009-94 guidance and other rationale presented in Chapter 11 of this FSAR, no safety limits, operating limits (including limiting control settings and limiting conditions for operation), or surveillance requirements, as described in DOE Order 5480.22, *Technical Safety Requirements*, are established for the VF.

In its discussion of worker safety, DOE Order 5480.22 acknowledges that "The impact from the release of hazardous materials is also reduced through industrial hygiene and radiation protection oversight (e.g., monitoring of worker exposures, use of personnel protective equipment [PPE] and emergency evacuation planning), as well as the use of TSRs." This statement indicates that formal measures other than TSRs are recognized by the DOE as being acceptable for ensuring worker safety. DOE-STD-3009-94 reinforces this position, stating: "It is important to develop TSRs judiciously. TSRs should not be used as a vehicle to cover the many procedural and programmatic controls inherent in any operation." Consistent with relevant DOE Orders and federal and state regulations with which WVNS is currently contractually obligated to comply, the control of the levels of hazardous and radioactive materials to which workers may, at any time, be exposed, is addressed in WVDP safety and health programs.

Furthermore, worker exposure to hazardous materials and/or conditions is regulated under the provisions of the Occupational Safety and Health Act administered by the Occupational Safety and Health Administration (OSHA).

DOE Order 5480.22 and DOE-STD-3009-94 both indicate that, with the exception of safety class SSCs, there is significant latitude as to the content of a given facility's TSRs. This is consistent with the statement in DOE Order 5480.22 that "DOE's first safety responsibility must be the protection of the public." This latitude, in conjunction with the specifics discussed above and existing contractual health and safety related commitments that the incumbent WVDP M&O contractor has to the DOE, provide adequate justification for there not being TSRs (including administrative TSRs) associated with the VF.

C.1.7 DOE Order 6430.1A Compliance

WVNS used DOE Order (Draft) 6430.1, *General Design Criteria,* DOE-Idaho (ID), *Architectural Engineering Standards,* DOE Order 5481.1A, *Safety Analysis and Review System,* and ID-12044, *Operational Safety Design Criteria Manual* (U.S. Department of Energy April 1985), as general guidelines to develop the VF principal design criteria. Principal design criteria include the following:

- WVNS-DC-022 - *Vitrification of High-Level Wastes*
- WVNS-DC-045 - *Cold Chemical System*
- WVNS-DC-046 - *Sludge Mobilization Waste Removal System*
- WVNS-DC-048 - *High-Level Waste Interim Storage System*
- WVNS-DC-066 - *Vitrification Load-In Facility.*

The DOE Idaho Field Office (DOE-ID), OH/WVDP, and WVNS agreed that DOE Order 6430.1A would not apply to existing facilities but would apply to new facilities and modifications to existing facilities then in design or to be designed (Bixby July 17, 1989). OH subsequently concurred with the design basis.

WVNS was designing to the above design criteria when DOE Order 6430.1A was received for evaluation and implementation. DOE Order 6430.1A is dated April 6, 1989. The WVDP site status at that time was as follows: 1) The existing plant and the Integrated Radwaste Treatment System (IRTS) were operating; and 2) The basic designs and interfaces for the Vitrification System, Sludge Mobilization System (SMS) and Cold Chemical System (CCS) were complete. The High-Level Waste Interim Storage (HLWIS) uses an existing building and Heating, Ventilation, and Air Conditioning (HVAC) system that predate DOE 6430.1, hence the HLWIS is considered an "existing facility." The existing plant and operations and the facilities that comprise the IRTS are discussed in other DOE-approved WVDP safety documentation. The Vitrification Load-In Facility has been designed to comply with the applicable requirements of DOE Order 6430.1A.

WVNS evaluated the above principal design criteria against DOE Order 6430.1A using a three-phased approach: 1) A review of DOE Order 6430.1A to determine which paragraphs were applicable to the WVDP site and in particular to the VF; 2) A complete review of DOE Order 6430.1A of the codes and standards to determine which were applicable to the WVDP and in particular to the VF; and 3) A review of every paragraph that contained the words environment, environmental, fire, health, and safe/safety.

The completion of these reviews established that the Vitrification System, SMS, CCS, and HLWIS designs met DOE Order 6430.1A, Section 7, "Policy and Objectives," paragraph (4), "All Department facilities are to be designed and constructed to be reasonable and adequate for their intended purpose and consistent with health, safety, security, and environmental protection requirements."

REFERENCES FOR CHAPTER C.1.0

Bixby, W.W. July 17, 1989. DOE Order 6430.1A. West Valley Project Office (DW:89:0365). Letter to R.A. Thomas.

Cooperative Agreement between the U.S. Department of Energy and the New York State Energy Research and Development Authority. October 1, 1980.

Memorandum of Understanding between the U.S. Department of Energy and the U.S. Nuclear Regulatory Commission: Implementation of the West Valley Demonstration Project Act of 1980. November 19, 1981. FR Doc. 81-33439. Vol. 46, No. 223.

U.S. Congress. October 1, 1980. West Valley Demonstration Project Act Public Law 96-368.

U.S. Department of Energy. April 30, 1992. DOE Order 5480.23: *Nuclear Safety Analysis Reports*.

__________. February 15, 1992. Change 2 (January 23, 1996). DOE Order 5480.22: *Technical Safety Requirements*. Washington, D.C.: U.S. Department of Energy.

__________. DOE Order 5481.1A: *Safety Analysis and Review System.* Washington, D.C.: U.S. Department of Energy.

__________. April 6, 1989. DOE Order 6430.1A: *General Design Criteria*. Washington, D.C.: U.S. Department of Energy.

__________. April 1985. DOE-ID 12044: *Operational Safety Design Criteria Manual*. Rev. 4. U.S. Department of Energy, Operational Safety Division. (See also Hannum, W.H. May 28, 1985. DW:85:0266.)

__________. July 1994. DOE-STD-3009-94: *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*. Washington, D.C.: U.S. Department of Energy.

REFERENCES FOR CHAPTER C.1.0
(Concluded)

U.S. Nuclear Regulatory Commission. 1975. Regulatory Guide 3.26: *Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants*. Washington, D.C.: U.S. Department of Energy.

West Valley Nuclear Services Company, Inc. Policy and Procedure WV-365: *Preparation of WVDP Safety Documents*. (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-022: *Design Criteria, Vitrification of High-Level Wastes*. (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-045: *Design Criteria, Cold Chemical System*. (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-046: *Design Criteria, Sludge Mobilization Waste Removal System*. (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-048: *Design Criteria, High-Level Waste Interim Storage System*. (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-066: *Design Criteria, Vitrification Load-In Facility*. (Latest Revision.) West Valley Nuclear Services Co., Inc.

C.2.0 SUMMARY SAFETY ANALYSIS

This Final Safety Analysis Report (FSAR) has been developed in accordance with U.S. Department of Energy (DOE) Order 5480.23, *Nuclear Safety Analysis Reports*, and DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (U.S. Department of Energy April 30, 1992; December 1992). In accordance with page 16 of Attachment 1 of DOE Order 5480.23, the level of analysis and documentation presented in this FSAR is commensurate with the magnitude of the hazards being addressed; the complexity of the Vitrification Facility (VF) and VF systems being relied on to maintain an acceptable level of risk; and the stage in the life cycle of the VF for which DOE approval is sought (i.e., conduct of radiological operations). Consistent with guidance contained in DOE-STD-1027-92, the VF is classified as a Category 2 facility. Page 13 of DOE Order 5480.23 states that for a Category 2 facility "the hazard analysis shows the potential for significant on-site consequences." Using the "facility segmentation" guidance contained in Attachment 1 of DOE-STD-1027-92, certain structures within the VF (as defined in Section C.1.2) are less than Hazard Category 2. Specifically, consistent with the guidance contained in DOE-EM-STD-5502-94, *Hazard Baseline Documentation,* the 01-14 Building is a Radiological Facility, and the Load-In/Load-Out Area and the Cold Chemical Building are Industrial Facilities.

Consequences from evaluated events (i.e., anticipated, unlikely, and extremely unlikely events as defined in Section C.9.3 of this FSAR) were compared to select criteria that are referred to as Evaluation Guidelines (EGs). To facilitate the development of EGs, several distinctions have been made. These distinctions are as follows:

- Whether the event (accident) is manmade or natural phenomena induced;
- Whether the hazard is radiological or toxicological; and
- Whether the population at risk is the public or on-site workers.

These distinctions lead to eight different situations for which an EG is required. The justification and related precedents for these EGs (which are presented below) are provided in Chapter 9 of this FSAR.

Public Radiological EGs

(Internal or external) manmade Evaluation Basis Accidents (EBAs) shall not cause doses to the maximally exposed off-site individual (MOI) greater than (1) 0.5 rem (0.005 Sv) for accidents with estimated frequencies < 0.1 event per year but ≥ 0.01 event per year; (2) 5 rem (0.05 Sv) for accidents with estimated frequencies < 1 E-2 event per year but ≥ 1 E-4 event per year; and (3) 25 rem (0.25 Sv) for accidents with estimated frequencies < 1 E-4 event per year but > 1 E-6 event per year. Manmade EBAs with estimated frequencies ≤ 1 E-6 event per year are not considered credible. Natural phenomena induced Design Basis Accidents (DBAs) or EBAs shall not cause doses to the MOI > 25 rem (0.25 Sv). See Figure C.2-1.

Public Toxicological EGs

For manmade EBAs with an estimated frequency of < 0.1 event per year but ≥ 1 E-4 event per year, the risk to an average individual in the vicinity of the WVDP for prompt fatalities that might result from accidents shall not exceed one-tenth of one percent (0.1%) of the sum of prompt fatalities resulting from other accidents to which members of the population are generally exposed. For evaluation purposes, individuals are assumed to be located within one mile of the site boundary. Consequences of natural phenomena induced DBAs or EBAs with initiating frequencies defined by applicable design criteria documents shall be compared against this same criteria. This EG is based on Secretary of Energy Notice (SEN) 35-91 (U.S. Department of Energy September 9, 1991).

On-Site Radiological EGs

Manmade EBAs shall not result in calculated doses at the on-site evaluation point (OEP) (640 meters [2,100 ft]) greater than (1) 5 rem (0.05 Sv) for accidents with estimated frequencies < 0.1 event per year but ≥ 0.01 event per year; (2) 25 rem (0.25 Sv) for accidents with estimated frequencies < 1 E-2 event per year but ≥ 1 E-4 event per year; and (3) 100 rem (1.0 Sv) for accidents with estimated frequencies < 1 E-4 event per year but > 1 E-6 event per year. Manmade EBAs with estimated frequencies ≤ 1 E-6 event per year are not considered credible. See Figure C.2-2. On-site numerical EGs shall not be required for safety assurance in natural phenomena accident analysis.

On-Site Toxicological EGs

On-site numerical EGs shall not be required for safety assurance in natural phenomena or manmade accident analysis.

C.2.1 Site Analysis

C.2.1.1 Natural Phenomena

Natural phenomena that could impact facilities at the WVDP include earthquakes, tornadoes, tornado-generated missiles, lightning, and snow loadings. As documented in Section A.3.4 of WVNS-SAR-001, *Project Overview and General Information,* even the hypothetical probable maximum flood is not a hazard to the VF. The design basis earthquake (DBE) for the WVDP has a 0.1g acceleration which has an associated annual frequency of occurrence of 5.0E-04. (See Figure A.3.6.E.6 of the Technical Support Documentation to WVNS-SAR-001.) The design basis tornado (DBT) for the WVDP was developed based on detailed analyses of tornado occurrences in Western New York State. The characteristics of the DBT are:

Maximum wind speed	260 km/hr (160 mph)
Rotational speed	180 km/hr (110 mph)
Translational speed	80 km/hr (50 mph)
Radius of maximum rotational wind	45.7 m (150 ft)
Peak pressure differential	2.4 kPa (0.35 psi)
Rate of pressure drop	1.0 kPa/sec (0.15 psi/sec)

The DBT has an associated annual frequency of occurrence of 1.0E-06. Tornado-generated missiles are based on these DBT parameters and therefore have the same annual frequency of occurrence. WVNS-SAR-001, Section A.4.2.4, discusses characteristics of tornado-induced missiles used in analyses at the WVDP. In accordance with WVNS-DC-022, *Design Criteria Vitrification of High-Level Wastes*, the VF is designed to withstand two types of tornado-generated missiles, namely a "wooden plank 0.10 meters x 0.30 meters x 3.65 meters (4 in x 12 in x 12 ft), 63 kilograms (139 lbs) weight at a velocity of 38 m/s (85 mph)" and a "steel pipe 0.076 meters (3 in) diameter by 3.05 meters (10 ft), 33.4 kilograms (76 lb) weight at a velocity of 22.35 m/s (50 mph)."

Lightning is a relatively common occurrence. The VF has lightning protection equipment/devices consistent with the requirements of applicable industry standards, including National Fire Protection Association (NFPA) requirements. The most likely adverse effect from lightning is postulated to be a loss of off-site power, which is addressed in Chapter 9 of this FSAR.

WVNS-SAR-001, Section A.4.2.6, discusses estimated snow loadings used at the WVDP. WVNS-DC-022 requires that buildings and outside structures be designed for a snow load of 1.9 kPa (40 lb/ft^2).

C.2.1.2 Site Characteristics Affecting the Safety Analysis

This FSAR assesses the hazards associated with accomplishing the vitrification process. Factors such as snowfall, wind, temperature, precipitation, tornadoes, earthquakes, and near-surface groundwater were considered in designing the VF. As a result, none of these natural phenomena are expected to pose a threat to the integrity of key structures, systems, and components (SSCs) associated with vitrification operations.

Accidents analyzed in Chapter 9 assess the impacts due to severe natural phenomena. As documented in Chapter 9, the VF is capable of withstanding a WVDP DBE or DBT without a significant release of radioactive and/or hazardous materials to the environment.

Other site-specific loads (e.g., high winds and snow loading) are bounded by more controlling loads and their associated margins of safety. The effect of high winds and snow loadings are incorporated in the design and do not provide a mechanism for off-site safety-related concerns. The site's topographic setting renders the likelihood of major flooding not credible, and local run-off and flooding is adequately accommodated by natural and manmade drainage systems in and around the WVDP.

C.2.1.3 Effect of Nearby Industrial, Transportation and Military Facilities

Nearby industrial and transportation facilities are not considered to pose an undue risk to WVDP activities due to the distance of these facilities from the site and the nature of the operations at these facilities. See Section A.2.1.3 of WVNS-SAR-001 for a further discussion of nearby industrial, transportation, and military facilities. Section B.8.2.1.2 and Table B.9.1-1 of WVNS-SAR-002 address on-site hazards such as diesel, gasoline, and fuel oil tanks. Table C.5.1.2.5-1 and Figure C.5.1.1-3 of this FSAR contain pertinent information in this regard. Since it can be ascertained from these information sources that the subject on-site hazards cannot pose a credible threat to releasing radiological and/or hazardous materials associated with the VF, these hazards are not included in the process hazard analysis (PHA) provided in Chapter 9 of this FSAR. Other than the VF, the primary radiological facilities or operations at the WVDP are part of the Integrated Radwaste Treatment System (IRTS). The IRTS includes the Supernatant Treatment System (STS), Liquid Waste Treatment System (LWTS), Cement Solidification System (CSS), and Drum Cell. It is somewhat evident from the nomenclature of these systems, and can be further determined from a review of other DOE approved WVDP safety documentation, that there are no radiological facilities or operations at the WVDP that have sufficient energetics so as to pose a hazard to the VF, and, more specifically, lead to the breaching of the Vitrification Cell, tanks in the Cold Chemical Building, or ammonia storage tank.

C.2.2 Impact of Normal Operations

On-site and off-site dose assessments have been performed to determine the impact of normal operations. (See Chapter 8.) Occupational exposures are minimized at the WVDP through strict adherence to as low as reasonably achievable (ALARA) principles. The analyses provided in Chapter 8 show that consequences of normal VF operations to all on-site and off-site receptors are well within acceptable limits, and in fact are essentially negligible. As documented in WVDP-010, *WVDP Radiological Controls Manual*, the WVDP administrative control level for a radiological worker is 0.5 rem (0.005 Sv) per annum. Hence, no VF worker is expected to ever receive an annual dose in excess of 0.5 rem (0.005 Sv).

C.2.3 Impact from Abnormal Operations

Abnormal events could occur from hardware malfunctions or operator error. Abnormal events are of consequence when they affect systems in facilities that process, control, or confine radioactive and/or hazardous materials. Abnormal events considered in the PHA posed very small or negligible risk to workers or the public. The PHA is a qualitative analysis, and is provided in Tables C.9.3-1 through C.9.3-7 of this FSAR. These tables discuss the hazard, cause, protective and mitigative features, consequences, frequency, and "action item" for various SSCs associated with the VF. Chapter 8 of this FSAR identifies hazards associated with the vitrification process; design features and programs that are in place to ensure that workers and the public are adequately protected from those hazards; an occupational and off-site receptor dose assessment; and a discussion on ensuring that exposures to radiological and hazardous materials are kept ALARA. Events in the PHA that were considered to pose a significant risk (or where additional analysis was considered necessary to more accurately determine if a significant frequency and/or consequence exists) were analyzed as EBAs.

C.2.4 Accidents

A discussion of defense-in-depth as it applies to the VF is provided in Chapter 8 of this FSAR. Some of the more important measures that exist at the VF to eliminate, control, or mitigate the consequences of accidents are as follows:

- Administrative procedures/controls
- Controlled maintenance activities performed in accordance with approved procedures

- Design and construction of design basis natural phenomenon event confinement structures
- Design and installation of redundant and diverse HVAC system components
- Extensive and diversified communication mechanisms
- Fire detectors and associated local and remote alarms
- Fire/security watch
- Good housekeeping practices
- Multiple barriers
- Personnel trained in responding to incipient fires
- Procurement and installation of electrical equipment to industry electrical standards
- Prohibiting smoking except for designated areas
- Sprinkler systems
- Standby power system
- Training program
- West Valley Fire Department
- WVDP Emergency Response Organization.

Accident scenarios are quantitatively evaluated in Chapter 9 of this FSAR. The scenarios evaluated include events that are natural phenomena induced. A summary of the EBAs analyzed in Chapter 9 is provided in Table C.2.4-1. A DBT is included in

Table C.2.4-1 because of a tornado's potential to generate a missile that could hypothetically breach a Vitrification Cell window. A DBE is not included in Table C.2.4-1 because it could not generate similar/analogous phenomena. The Vitrification Cell is designed to withstand a DBT and DBE.

There are no EBAs analyzed in Chapter 9 of this FSAR that have consequences associated with them that exceed the EGs previously stated. The consequence analyses developed for comparison with Evaluation Guidelines only took credit for passive confinement barriers such as the Vitrification Cell, Transfer Tunnel, and Crane Maintenance Room roof, walls, hatches, and shield windows. These analyses did not take credit for High Efficiency Particulate Air (HEPA) filtration of releases. The EBA consequence assessments provided in Chapter 9 that are intended to portray risk (i.e., realistically expected outcomes), as opposed to "worst plausible scenario" for comparison to Evaluation Guidelines, reveals that the VF, even under accident conditions, is a relatively benign facility in terms of potential health and safety impacts to on-site and off-site populations.

For example, the accident analyses indicate that several key systems (i.e., Power, Process Off-Gas, and HVAC) can be lost simultaneously with essentially negligible consequences. Additionally, since the radiological and hazardous materials in the Vitrification Cell are enclosed/confined by the formidable and seismically qualified in-cell process systems and components, it is very likely that in nearly all accident scenarios the vast majority of radiological and hazardous materials would remain contained in the subject process systems and components.

In general, it can be stated that the VF is benign in terms of potential health and safety impacts if (1) one or more of the in-cell or ex-cell HEPA filters associated with the Process Off-Gas system and Vitrification Cell HVAC system remain functional (assuming that the ex-cell flowpaths are not breached), and (2) the passive confinement barriers such as the Vitrification Cell, Transfer Tunnel, and Crane Maintenance Room roof, walls, hatches, and shield windows maintain their structural integrity. Regarding nonradiological EBAs, Table C.2.4-1 indicates that risk from nonradiological hazards associated with the VF is very small.

Accident scenarios beyond the EBAs shown in Table C.2.4-1 are evaluated in Chapter 9 because DOE Order 5480.23 states that "the likelihood and consequences of accidents beyond the design basis accidents should be evaluated to provide a complete documented rationale for acceptance or rejection of the operation of the facility, and to estimate the residual risk associated with facility accidents." Consistent with this stipulation from DOE Order 5480.23, various beyond EBA events are examined, including an evaluation of the contents of the Slurry-Fed Ceramic Melter (SFCM) and Concentrator Feed Makeup Tank (CFMT) intermixing due to a beyond DBE. The consequences of a breach of the ammonia tank are also analyzed. (Ammonia is used in the Process Off-Gas system in the abatement of NO_x.) The radiological and nonradiological beyond design basis scenarios evaluated in Chapter 9 have consequences associated with them that are below the EGs. It is not a requirement for beyond design basis accidents to have consequences associated with them that are below the EGs. In the context of the text provided above from DOE Order 5480.23, DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, states that "Such beyond DBAs are not required to provide assurance of public health and safety. Accordingly, they serve as bases for cost-benefit considerations if ..." (U.S. Department of Energy July 1994).

C.2.5 Conclusions

The analyses and information provided in this FSAR demonstrate that the design of the VF is satisfactory in regard to safety concerns for the operations that are performed there. Normal operations and postulated accident scenarios do not pose an undue risk to VF workers, WVDP personnel, off-site populations, or the environment. VF design attributes such as extensive use of shielding materials and applicable industry codes and standards, and WVDP administrative controls such as the formally established WVDP administrative control for radiation exposure to a radiological worker, provide a significant measure of confidence that the VF does not pose an undue risk to VF workers. The accident analyses provided in Chapter 9 of this FSAR demonstrate that other WVDP site personnel and off-site populations are adequately protected from exposure to radiation and radiological and hazardous materials during accident conditions at the VF. As previously stated and made evident by a review of Table C.2.4-1, the VF, even under accident conditions, is a relatively benign facility in terms of potential health and safety impacts to on-site and off-site populations.

REFERENCES FOR CHAPTER C.2.0

U.S. Department of Energy. September 9, 1991. Secretary of Energy Notice 35-91: *Nuclear Safety Policy.*

__________. April 30, 1992. Change 1 (March 10, 1994). DOE Order 5480.23: *Nuclear Safety Analysis Reports.*

__________. December 1992. Change 1 (September 1997). DOE STD-1027-92: *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports.*

__________. July 1994. DOE STD-3009-94: *Preparation Guide For U.S. Department Of Energy Nonreactor Nuclear Facility Safety Analysis Reports.*

__________. August 1994. DOE-EM-STD-5502-94: *Hazard Baseline Documentation.*

West Valley Nuclear Services Company, Inc. Safety Analysis Report WVNS-SAR-001: *Project Overview and General Information.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. Technical Safety Document for Safety Analysis Report WVNS-SAR-001: *Project Overview and General Information Technical Safety Document.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. Safety Analysis Report WVNS-SAR-002: *Safety Analysis Report for Low-Level Waste Processing and Support Activities.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-022: *Design Criteria, Vitrification of High-Level Wastes.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVDP-010: *WVDP Radiological Controls Manual.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

C.3.0 SITE CHARACTERISTICS

Characteristics of the West Valley Demonstration Project (WVDP) site are discussed in WVNS-SAR-001, *Project Overview and General Information*, Chapter A.3.0, and in accompanying *Technical Support Documents (TSDs) for WVNS-SAR-001*. The TSDs are a compilation of the data and results of numerous past studies and evaluations of site characteristics like meteorology and geology. The influence of these site characteristics on the design and operation of the Vitrification Facility (VF) is described below.

C.3.1 Geography and Demography

WVNS-SAR-001, Section A.3.1, contains a comprehensive description of the geographic and demographic features of the WVDP and surrounding areas. Neither geography nor demography affect the design and operation of the VF.

C.3.2 Nearby Industrial, Transportation, and Military Facilities

A detailed discussion of the effects on the WVDP from these nearby sources is provided in WVNS-SAR-001, Section A.3.2. There are no direct effects on the VF from these facilities.

C.3.3 Meteorology

The meteorology of the WVDP and surrounding areas is described in WVNS-SAR-001, Section A.3.3. As discussed in other chapters of this Final Safety Analysis Report (FSAR), particularly Chapters 4, 5, and 9, meteorological characteristics of the region have been considered in the design of the VF. Weather is not expected to affect the operation of the VF.

C.3.4 Surface Hydrology

WVNS-SAR-001, Section A.3.4, describes the surface hydrology at and in the vicinity of the WVDP. Design and operation of the VF are not affected by surface hydrology.

C.3.5 Subsurface Hydrology

WVNS-SAR-001, Section A.3.5, describes the subsurface hydrology at and in the vicinity of the WVDP. The design of the VF included consideration of the local subsurface hydrology; therefore, operation is not expected to be affected by subsurface hydrology.

C.3.6 Geology and Seismology

A general discussion of geology and seismology is provided in WVNS-SAR-001, Section A.3.6. As indicated in Chapters 4, 5, and 9 of this FSAR, regional soil characteristics and seismological factors have been considered in the design of the VF.

Soil characteristics associated with the Waste Tank Farm (WTF) and the area around the Vitrification Building are discussed in the *Design Criteria - Sludge Mobilization Waste Removal System* (WVNS-DC-046), Section 4.1.4, Soil Pressure Load.

Settlement may occur due to the differential movement caused by the presence of new structures next to existing structures, the variation in soil properties for long structures, or the variation in soil loading of different portions. The design criteria to address differential settlement is found in the *Design Criteria - Sludge Mobilization Waste Removal System* (WVNS-DC-046), Section 4.1.5, Differential Settlement.

Seismic displacement effects associated with wave propagation aspects during the postulated occurrence of a seismic event are addressed in the *Design Criteria - Sludge Mobilization Waste Removal System* (WVNS-DC-046), Section 4.1.7.5, Seismic Displacement.

C.3.7 Summary of Conditions Affecting Construction and Operating Requirements

WVNS-SAR-001, Section A.3.8, provides a tabular summary of site characteristics that impact design of facilities. Factors such as snowfall, wind, temperature, precipitation, tornadoes, earthquakes, and near-surface groundwater were considered in designing the VF. As a result, none of these natural phenomena are expected to pose a threat to the structural integrity of the VF or vitrification operations.

REFERENCES FOR CHAPTER C.3.0

West Valley Nuclear Services Co., Inc. July 24, 1992. WVNS-DC-046: *Design Criteria, Sludge Mobilization Waste Removal System.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. *Safety Analysis Report WVNS-SAR-001: Project Overview and General Information.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. *WVDP Technical Support Documents for Safety Analysis Report SAR-001: Project Overview and General Information.* WVNS-SAR-001 TSD. (Latest Revision.) West Valley Nuclear Services Co., Inc.

C.4.0 PRINCIPAL DESIGN CRITERIA

This chapter identifies and discusses the principal engineering design criteria and design bases for the structures, systems, and components (SSCs) of the Vitrification Facility (VF).

The Western New York Nuclear Service Center (WNYNSC) was originally located at West Valley because the area is suitable in several ways for nuclear materials handling and disposal. WVNS-SAR-001, *Project Overview and General Information*, Section A.4.0, elaborates on the siting attributes of West Valley and states that "other than the natural phenomena described earlier, there are no site features requiring special consideration in terms of design." Section A.4.0 also discusses the approach used in the design safety evaluation of the original WNYNSC facilities.

As stated in WVDP-028, *West Valley Demonstration Project (WVDP) Plan*, "the overall approach to the project was to make the maximum use of existing technology, facilities, and equipment while minimizing new development and new construction. The objective of the WVDP is to develop a system that will vitrify the High-Level Waste (HLW) in a safe, environmentally sound, and cost-effective manner."

The West Valley Nuclear Services Company, Inc. (WVNS) used the U.S. Department of Energy (DOE) Order (Draft) 6430.1, *General Design Criteria*, DOE-Idaho (ID) *Architectural Engineering Standards*, DOE Order 5481.1A, *Safety Analysis and Review System*, and ID-12044, *Operational Safety Design Criteria Manual* (U.S. Department of Energy April 1985), as general guidelines to develop the VF principal design criteria. Principal design criteria include the following:

- WVNS-DC-022 - *Vitrification of High-Level Wastes*
- WVNS-DC-045 - *Cold Chemical System*
- WVNS-DC-046 - *Sludge Mobilization Waste Removal System*
- WVNS-DC-048 - *High-Level Waste Interim Storage System*
- WVNS-DC-066 - *Vitrification Load-In Facility*.

The DOE Idaho Field Office (DOE-ID), DOE West Valley Area Office (OH/WVDP), and WVNS agreed that DOE Order 6430.1A would not apply to existing facilities but would apply to new facilities and modifications to existing facilities then in design or to be designed (Bixby July 17, 1989). The DOE Ohio Field Office (OH) subsequently concurred with the design basis.

WVNS was designing to the above design criteria when DOE Order 6430.1A was received for evaluation and implementation. DOE Order 6430.1A is dated April 6, 1989. The WVDP site status at that time was as follows: 1) The existing plant and the Integrated Radwaste Treatment System (IRTS) were operating; and 2) The basic designs and interfaces for the Vitrification System, Sludge Mobilization System (SMS) and Cold Chemical System (CCS) were complete. The High-Level Waste Interim Storage (HLWIS) uses an existing building and Heating, Ventilation, and Air Conditioning (HVAC) system that predate DOE Order 6430.1, hence the HLWIS is considered an "existing facility." The existing plant and operations are discussed in other DOE-approved WVDP safety documentation, and the facilities that comprise the IRTS are discussed in other DOE approved WVDP safety documentation. The Vitrification Load-In Facility has been designed to comply with the applicable requirements of DOE Order 6430.1A.

WVNS evaluated the above principal design criteria against DOE Order 6430.1A using a three phased approach: 1) A review of DOE Order 6430.1A to determine what paragraphs were applicable to the WVDP site and in particular to the VF; 2) A complete review of DOE Order 6430.1A of the codes and standards to determine which were applicable to the WVDP and in particular to the VF; and 3) A review of every paragraph that contained the words "environment," "environmental," "fire," "health," "safe," and/or "safety."

The completion of these reviews established that the Vitrification System, SMS, CCS, and HLWIS designs met DOE Order 6430.1A, Section 7, "Policy and Objectives," paragraph (4), "All Department facilities are to be designed and constructed to be reasonable and adequate for their intended purpose and consistent with health, safety, security, and environmental protection requirements."

C.4.1 Purpose of the Vitrification Facility

The purpose of the VF is to solidify the radioactive constituents and hazardous waste components of the HLW stored in underground tanks at the WVDP site into a borosilicate glass waste form that will be encased in stainless steel canisters and to provide interim storage for filled, sealed, and decontaminated canisters until shipment off-site to a federal repository.

C.4.2 Preparation of Slurry Fed Ceramic Melter (SFCM) Feed

C.4.2.1 HLW Tanks 8D-2 and 8D-4 Content

The HLW currently being stored at the WVDP site resulted from the reprocessing of about 640 metric tons (1.4E+06 lb)of nuclear reactor fuel from 1966 to 1972. The HLW generated during the reprocessing was stored in underground steel tanks, which was consistent with the method of HLW storage practiced at federal installations at that time.

The initial waste that resulted from the reprocessing was contained in Tanks 8D-2 and 8D-4. The initial radionuclide content of the HLW stored in Tanks 8D-2 and 8D-4 is given in Table C.4.2.1-1. The dominant radionuclides are cesium-137 (Cs-137) and its short-lived decay product barium-137m (Ba-137m) and strontium-90 (Sr-90) and its short-lived decay product yttrium-90 (Y-90).

The largest volume of HLW (approximately 2,271 m^3 [600,000 ga]), produced from the reprocessing of the uranium fuel using the PUREX process, was highly acidic and was neutralized by the addition of sodium hydroxide before transferring it to Tank 8D-2 for storage. The neutralization process caused most of the radionuclides (with the exception of the Cs isotopes) to precipitate and form a layer of sludge on the bottom of Tank 8D-2 beneath the supernatant. The sludge layer was about 483 mm (19 in) in depth and was composed of oxides and hydroxides of iron, aluminum, manganese, chromium, uranium, and nickel.

The supernatant initially contained about 40 weight percent total salts and 60% (w/w) water. The salts consisted of about 97% nitrates, nitrites, sulphate, bicarbonates, and carbonates. Most of the cations were sodium and potassium.

The chemical compositions of the initial supernatant and sludge in Tank 8D-2 are provided in Tables C.4.2.1-2 and C.4.2.1-3 respectively.

Acidic THOREX waste resulted from reprocessing batches of thorium-uranium fuel using the THOREX process and produced an initial volume of approximately 31 m^3 (8,189 gal), which was stored in Tank 8D-4. The Tank 8D-4 waste consisted of about 71% (w/w) salts and 29% (w/w) water. The Tank 8D-4 waste was largely a single-phase liquid and was not neutralized because the thorium would have precipitated out of the solution. The initial chemical composition of Tank 8D-4 is provided in Table C.4.2.1-4.

C.4.2.2 HLW Pretreatment

The initial pretreatment of Tank 8D-2 supernatant was accomplished using the IRTS, which consisted of the Supernatant Treatment System (STS), in which the cesium-laden supernatant flows through columns of zeolite to remove the cesium; the Liquid Waste Treatment System (LWTS), an evaporative concentration process; the Cement Solidification System (CSS), in which Low-Level Waste (LLW) was solidified in cement in steel drums; and the Drum Storage Facility. The sludge in Tank 8D-2 was then washed to remove as much of the soluble material as possible. Water was added to

Tank 8D-2, the sludge was mixed and allowed to settle and then the supernatant was processed through the IRTS. This step was repeated several times.

The supernatant sent to the IRTS was filtered to prevent process contamination by sludge particulates suspended in the wash solution. The solution was then processed through ion exchange columns designed to remove the cesium, plutonium, and strontium dissolved in the sludge wash solution. Exhausted ion exchange zeolite was sluiced from the ion exchange column to the bottom of Tank 8D-1, until it was ultimately transferred to Tank 8D-2. Following discharge, the ion exchange column was recharged with fresh zeolite.

After the Tank 8D-2 sludge washing was completed, the THOREX waste from Tank 8D-4 was transferred to Tank 8D-2 and neutralized. The neutralization was done in Tank 8D-2 (rather than Tank 8D-4) because the tank has design features for removal of solids. Tank 8D-4 does not have these solids retrieval features. The neutralized mixture of PUREX and THOREX wastes was then washed to remove as much soluble material as possible. After the washing of the mixture was completed, the spent zeolite was transferred to Pump Pit 8Q-2 where a grinder reduces the size of the zeolite and discharges it into Tank 8D-2. The initial curie inventory and volume of the HLW stored in Tanks 8D-1, 8D-2 and 8D-4 prior to mixing in Tank 8D-2 are shown in Table C.4.2.2-1.

The final mixture of the contents of the three tanks is mobilized in Tank 8D-2 and transferred to the Concentrator Feed Make-up Tank (CFMT) in the VF for further processing. The description of the above process is covered in Section C.6.1 of this Final Safety Analysis Report (FSAR).

C.4.2.3 Feed Preparation

The feed preparation cycle consists of those processes necessary to prepare the HLW, glass formers and chemicals, and other additives into an acceptable feed for introduction into the SFCM for vitrification. The feed preparation cycle is a batch operation that takes place in the CFMT. The waste from Tank 8D-2 and the Submerged Bed Scrubber (SBS) effluent (containing demineralized water and particulates removed from the melter off-gas stream and some dilute nitric acid and cerium transferred from the Canister Decontamination Station) are mixed in the CFMT, sampled, and analyzed. Based on the analytical results the CFMT content is concentrated to produce the proper weight percent solids in the waste. Acceptable ranges of the CFMT feed mixture are given in Chapter 6, Table 6.2.2-1. The cold chemicals and glass formers are prepared in the CCS and added to the CFMT to form an SFCM feed slurry. The vitrification mass balance (Nixon, 1995) contains the chemical and radionuclide mass balance information for the vitrification campaign.

When the SFCM feed is confirmed by analysis and/or calculation as acceptable, it is transferred to the Melter Feed Hold Tank (MFHT) to continuously feed the SFCM. The vitrification process systems, waste transfer system, and in-cell handling are discussed in Section C.6.1. The CCS is discussed in Section C.6.5.1.

C.4.3 Vitrification Facility Product and By-Products

C.4.3.1 Glass Product and Storage

The VF product is a radioactive borosilicate glass waste form contained in stainless steel canisters. The canisters' dimensions are 610 mm (24 in) outside diameter by 3,000 mm (118 in) high and are filled to a minimum of 80% of their volume as required in *Waste Acceptance Product Specifications* (WAPS) established by the DOE Office of Environmental Restoration and Waste Management (U.S. Department of Energy 1993). Each canister contains approximately 1,900 kg (4,189 lb) of waste glass with a density of approximately 2.7 g/cm^3 (169 lb/ft^3) and a waste loading of about 15% (w/w) solids.

The molten glass is poured at a temperature of about 1,150°C (2,102°F) into a canister positioned under the SFCM pour spout by the Canister Turntable. The Canister Turntable can accommodate four canisters: one under the melter pour spout, two in cooling positions, and one in the load in/out position. Canister glass inventory during canister fill operations is monitored (e.g., mass balance and ILDS). After the canister has been confirmed filled, the canister is rotated to one of the cooling positions, then to the load in/out position where the canister is removed and taken to either the Canister Storage Rack for temporary storage or directly to the Canister Weld Station for further processing.

The Canister Weld Station is designed to place and remotely weld the lids on filled-product canisters. Glass shard sampling and measuring of the level of glass in a given canister with a customized depth gauge are also done at this station. The Canister Weld Station provides capability to record the automated welder parameters during welding operations and to visually inspect the weld to ensure that the weld meets quality assurance requirements. Defective welds are reworked at the station. The welding equipment is remotely operated. As much of the electrical/electronic equipment as possible is located outside the cell to protect personnel and equipment from radiation and to provide easy maintenance access to the equipment. The in-cell welding equipment can be repaired or replaced remotely.

Glass shard samples are removed from each canister at the Canister Weld Station. Approximately 10% of the samples are analyzed, and all are retained in-cell for future storage in the HLWIS.

The canisters are decontaminated at the Canister Decontamination Station inside the Vitrification Cell to minimize the spread of contamination. Nitric acid and ceric nitrate solution are staged outside the hot cell. The two solutions are blended in-line when transferred to the Canister Decontamination Tank. Decontamination of the 304 stainless steel product filled canisters involves dissolution of a thin layer from the canister surface using ceric ion (Ce^{+4}) in an approximately 0.9 molar nitric acid solution.

The decontamination reaction is achieved by soaking the canister in the decontamination solution at 65°C (149°F) for 6 hours while agitating the solution with a gentle air sparge. The thickness of the stainless steel that is removed from the surface of the canister is limited to approximately 10 microns (3.9E-04 in) by the amount of reactant (Ce^{+4}) available in the decontamination solution, the temperature of the solution, and the residence time in the solution (Bray June 1988). The chemical "milling" process of the canister is easily controlled because the chemical reaction rate slows as the Ce^{+4} is spent in the decontamination operation.

The spent decontamination fluid is transferred to the Neutralization Tank where the unreacted Ce^{+4} is reduced to Ce^{+3} with hydrogen peroxide (H_2O_2), thereby making the solution non-reactive with stainless steel components in the downstream process. Neutralized decontamination solution and acid rinse water contained in the Neutralization Tank are transferred via steam jet to the SBS. Used rinse water can also be directed to Tank 8D-4 via the waste header. To monitor the decontamination process, a smear sample is collected from the decontaminated canister and analyzed.

After decontamination, the canisters are placed in a transfer cart and transferred through the Transfer Tunnel and Equipment Decontamination Room (EDR) to the HLWIS where the canisters are stored in two-tier high racks.

In support of the vitrification process and the operation of the VF, provisions have been made for the introduction of the empty canisters and miscellaneous equipment that will require replacement during the course of the vitrification campaign. These provisions include modifications to an existing plant structure (i.e., EDR) and addition of a handling area to the west of the EDR (i.e., the Load-In/Load-Out Area).

Table C.4.3.1-1 presents the major chemical components of the glass waste form, and Table C.4.3.1-2 presents the radionuclide content of the glass waste form. Estimates have been completed for canister surface dose rates, thermal power generated by decay heat, neutron and photon source terms per canister, and the neutron multiplication factor (K-effective) for a typical product canister (Yuan January 1994) using these nominal canister content values. The results of this analysis are presented in Table C.4.3.1-3, along with corresponding maximum allowable limits from the WAPS. The table shows that the typical WVDP waste canister characteristics for the above-listed parameters are at least an order of magnitude below the maximum acceptable repository criteria established in the WAPS.

C.4.3.2 Waste By-Products

By-products of the operation of the VF include radioactive or contaminated decontamination solutions, flush solutions, spent roughing and High-Efficiency Particulate Air (HEPA) filters, contaminated swipes, hardware, sample bottles, and sample solutions, vessels and melter off-gases, and miscellaneous trash.

The liquid waste streams are recycled back to the CFMT or to the tank farm and to the LWTS or VF for processing, depending on the level of radioactivity. LLW and transuranic wastes are handled per existing WVDP procedures. The details for gaseous, liquid, and solid radioactive wastes are discussed in Sections C.7.4, C.7.5, and C.7.6, respectively.

C.4.3.3 Vitrification Facility Functions

A general description of the VF is provided in Section C.1.2. A general description of the vitrification process is provided in Section C.1.3. A more detailed description of the VF and the processes are provided in Chapters 5 and 6.

C.4.4 Structural and Mechanical Safety Criteria

The safety class and quality level of VF SSCs are assigned in WVDP-204, *WVDP Quality List "Q-List"*. This "Q-List" is the "primary source for establishing, identifying, revising, and maintaining an up-to-date listing of safety classes and quality levels" of all facilities and their systems that are under the purview of the WVNS Quality Assurance (QA) Program.

C.4.4.1 Structural Criteria

The structures and components in the VF fall into two different design categories based on their confinement requirements. They are confinement structures or nonconfinement structures.

C.4.4.1.1 Confinement Structures

A structure required to confine radioactive or hazardous material that could affect the health and safety of the public or site personnel was designed to withstand the effects of natural hazards and still perform its safety function(s) and confine the radioactive or hazardous material to acceptable levels. The structures that are in this category are identified in Section C.5.2.1.1, and the design criteria, codes, and standards are provided in Section C.5.2.2.

C.4.4.1.2 Nonconfinement Structures

Structures that are not required to confine radioactive or hazardous material have been designed to the *New York State Code Manual for the State Building Construction Code*, and incorporated seismic considerations from the *Uniform Building Code (UBC)*. These structures are not required to survive extreme environmental loads (natural hazard phenomena) without loss of function. However, these structures should survive without collapse to satisfy minimum life safety requirements under less severe environmental loadings. These criteria apply to both new construction and to modifications to existing structures. The structures that are in this category are provided in Sections C.5.2.1.2 and C.5.2.1.3. The design criteria are provided in Sections C.5.2.2.2 and C.5.2.2.3.

C.4.4.1.3 Natural Hazard Phenomena

Natural hazard phenomena include the following: Design Basis Earthquake (DBE), Design Basis Tornado (DBT), Design Wind Forces, Design Snow Loading, and Reference Design Flooding. The bases for these loads are provided in Section C.5.2.2.1.3.

C.4.4.2 Process Equipment and Components

C.4.4.2.1 Confinement Components and Equipment

Components and equipment required to confine radioactive or hazardous material that could affect the health and safety of the public or site personnel were designed to withstand the effects of natural hazards and still perform their safety function(s) and contain the radioactive or hazardous material within acceptable levels.

The equipment located within the Vitrification Cell is protected against wind, tornado, and tornado-generated missiles by the reinforced concrete vault, special doors, and shield windows. Therefore, only seismic loading is considered in the design of components and equipment and their structural supports or anchorage. The equipment and components that constitute a potential seismic hazard to other components have been structurally designed for seismic loads.

C.4.4.2.2 Nonconfinement Components and Equipment

The mechanical safety criteria associated with VF components and equipment that do not provide confinement of radioactive or hazardous materials are stipulated in

WVDP-204, and are often simply the criteria established by the manufacturer of a given component or piece of equipment.

C.4.5 Safety Protection Systems

C.4.5.1 General

The VF processes radioactive HLW. Special design considerations are required to ensure that: 1) HLW is properly contained, and 2) the process off-gases and ventilation air are properly filtered and/or treated. In addition, doses to operating and maintenance personnel from radiation and airborne contamination are maintained As Low As Reasonably Achievable (ALARA).

WVNS-SAR-001, Section A.4.3.2, provides a discussion of standard practices used in the nuclear industry to protect individuals from external radiation and inhalation or ingestion of radioactive materials. Chapter 8 of this FSAR also contains pertinent information in this regard.

Confinement barriers and systems associated with the VF are designed to maintain doses to on-site and off-site personnel during normal and accident conditions below DOE established limits. To ensure that exposures to radiological and nonradiological materials are maintained within safe limits, the facility is operated in compliance with the requirements of WVDP-010, *WVDP Radiological Controls Manual*, WVDP-011, *WVDP Industrial Hygiene and Safety Manual*, and WVDP-177, *WVDP Fire Protection Plan*.

Design criteria associated with specific safety protection systems are discussed in the following subsections.

C.4.5.2 Protection by Multiple Confinement Barriers and Systems

C.4.5.2.1 General

WVNS-DC-022, *Design Criteria, Vitrification of High-Level Waste*, stipulates three primary design principles for the confinement of radioactive materials: 1) use sufficiently air-tight physical boundaries to keep contamination as close to the source as practical; 2) use multiple barriers, such as cells, walls, and double-wall piping; and 3) maintain pressure differentials between each confinement zone so that air flow travels from zones of lesser contamination potential to zones of greater contamination potential.

C.4.5.2.2 Vitrification Cell

The method of confinement for a given substance depends on several factors such as the physical form, mobility, and degree of hazard associated with the substance. In the Vitrification Cell:

- The first confinement barrier for the HLW slurry and molten glass consists of process vessels, piping, or containers in direct contact with the HLW. All process tanks and piping are connected to the Vessel Vent and Melter Off-Gas system, which maintains a negative pressure within these confinements to form one contiguous confinement barrier for process gases and airborne particulates. Since the process vessels and piping are maintained at a lower pressure than the cell, all air leakage is into the process and not into the cell.

- The second confinement barrier is the Vitrification Cell which has a stainless steel liner up to 6,706-mm (22-ft) level. This liner contains any potential liquid and solid spills from the process vessels and piping. The Vitrification Cell is continually kept at a negative pressure and wall penetrations are sealed to ensure confinement of airborne particulates and gases. The Vitrification Cell is constructed of reinforced concrete and designed to withstand the effects of the DBE or DBT and provides radiation shielding for workers in the operating aisles.

- The third confinement barrier consists of the following: 1) the Vitrification Drain system, which has three sumps into which the HLW waste can be drained and then jetted to the Waste Header system for recycling and reprocessing; 2) the HVAC system, which maintains the proper environmental conditions for the cell as well as a negative pressure in the cell to ensure confinement of airborne radioactive particulates and gases; and 3) all nonprocess fluids (lines) that leave the Vitrification Cell and have the potential for becoming contaminated (e.g., cooling water, steam condensate) are instrumented to detect any cross-contamination. All process and non-process lines that penetrate the cell walls are capable of being isolated with isolation valves. Three-way air solenoid valves are designed such that any backflow through the system is directed back into the cell.

C.4.5.2.3 HLW Slurries External to the Vitrification Cell

The multiple barrier approach is also used externally to the Vitrification Cell. In the Sludge Mobilization and Transfer system, the pumps, vessels, and piping are the first barrier. The pumps and vessels are located in vaults and pits that are ventilated and can be drained. The piping between the wall of Pit 8Q-2 and the Vitrification Building is double-walled, except for where it passes through diversion Pit 8Q-5. Return piping from the Vitrification Building to HLW tank vaults is also double-walled. All of the subject double-walled piping is housed in a concrete trench.

C.4.5.2.4 Transfer of Canisters

The waste/glass product is in canisters that are decontaminated and transferred to the HLWIS. The primary confinement barrier is the glass matrix itself. The second barrier is the sealed stainless steel canister. Additional confinement barriers are provided by: 1) the Transfer Tunnel and EDR that the canisters pass through on their way to the HLWIS, and 2) the Vitrification Building and Main Plant HVAC systems.

C.4.5.2.5 Main Plant Confinement

The Main Plant uses the same confinement techniques to confine radioactive material as is used in the VF. The first barrier consists of the process equipment and piping that contains the HLW. The second barrier consists of concrete cells with their stainless steel liners and sumps. The third barrier consists of the drain system to remove the liquids and the HVAC system to ensure the proper environmental condition, to maintain the differential pressure zones, and to filter the gases prior to release to the environment.

C.4.5.3 Ventilation and Process Off-Gas

C.4.5.3.1 General

Process off-gas and potentially hazardous atmospheres of cells/rooms/areas are processed through equipment so that releases to the environment are below all applicable DOE, U.S. Environmental Protection Agency (EPA), and New York State Department of Environmental Conservation (NYSDEC) limits. The safety class and quality level of the Process Off-Gas system components and components of the HVAC systems are assigned in WVDP-204.

C.4.5.3.2 Process Off-Gas System

The Process Off-Gas system (which includes vessel vent and melter off-gas and ex-cell off-gas equipment) provides two primary services:

- The motive force to maintain the in-cell waste vitrification equipment at a slight vacuum compared to the Vitrification Cell pressure for purposes of contamination control;

- Environmental atmospheric protection by removing radioactive particulates and destroying the acidic oxides of nitrogen (NOx).

Off-gas from the SFCM passes through the SBS and mist eliminator before merging with noncondensible off-gases from the CFMT and MFHT. The combined off-gases are then directed through a High-Efficiency Mist Eliminator (HEME), preheater, and HEPA filters, and through an entrainment separator while in route to the 01-14 Building, where they are directed through a reheater, HEPA filters, blowers and NOx abatement equipment, prior to being released from the 60-m (197-ft) Main Plant stack to the environment.

C.4.5.3.3 Ventilation Systems

HVAC systems have three primary functions: to provide pressure differential and direction of air flow to aid in confinement, to environmentally protect the equipment and components, and to provide human comfort.

The Vitrification Building has three differential pressure zones designed to direct the flow of air from the zone with the least potential for contamination to the zone with the greatest potential for contamination. The use of controlled zones is a common practice when handling or treating radioactive or hazardous material. Generically, Zone I consists of those areas that are expected to contain a significant amount of airborne activity during normal operations. Zone II generally consists of those areas immediately surrounding Zone I that provide a buffer to Zone I and could contain airborne activity on a very infrequent basis. Zone III designates areas that are expected to remain free of any contamination, such as a main control room.

The Vitrification Building HVAC system has chilled water and refrigerant systems, as well as steam and electrical heating systems to control the temperature and humidity to protect the equipment and components, and to provide human comfort.

Design criteria for, and a description of, the HVAC for the EDR, HLWIS, and 01-14 Building are provided in other DOE approved WVDP safety documentation. The safety class and quality level of select HVAC related components associated with these structures are provided in WVDP-204.

HLW in Tank 8D-2 is discharged from a pump located in pit 8Q-2 and directed to the Vitrification Building via diversion pit 8Q-5. Ventilation for these pits is provided by the Waste Tank Farm Ventilation system which is discussed in other DOE approved WVDP safety documentation and Section C.5.4.1.8 of this FSAR.

C.4.5.4 Protection by Equipment and Instrument Selection

A fundamental concept is that select SSCs in the VF must provide confinement of radioactive and hazardous materials. The basic design approach for the equipment and instrumentation is: 1) it must perform its operational function and if required, its safety functions, and 2) if possible be located in a nonradioactive area. If the equipment and instrumentation must be located in a radioactive area then: 1) take appropriate measures to ensure a high degree of reliability, 2) use redundancy where continuous operations is required, and 3) make the equipment and instrumentation easy to maintain or replace remotely.

C.4.5.4.1 Design and Quality Requirements for Equipment

The safety class and quality level of VF SSCs are assigned in WVDP-204, the *"Q-List"*. This "Q-List" is the "primary source for establishing, identifying, revising, and maintaining an up-to-date listing of safety classes and quality levels" of all facilities and their systems that are under the purview of the WVNS QA Program. The design codes and standards associated with each quality level are stated in WVDP-204.

C.4.5.4.2 Redundancy of Components and Equipment

To provide continuous operation and safety during normal operations there are; redundant operator stations in the control room, redundant process trains and fans for the process off-gas system, and redundant filter trains and fans in the HVAC systems.

During off-normal incidents, the normal electrical power is backed up with uninterruptible power supplies for the instrumentation and controls, diesel generators to support the confinement system and the melter, and the instrument air is backed up with high pressure bottled air to support operations of the confinement equipment.

C.4.5.4.3 Equipment Remote Maintenance and Replacement

Sections 4.1.2 and 4.2.8 of WVNS-DC-022 specify the design criteria for remote maintenance and cell cranes. Section 4.1.2 of WVNS-DC-022 lists specific design criteria for features associated with maintenance in the Vitrification Cell. Section 4.1.2.1 of WVNS-DC-022 states "The basic plan for maintenance of the Vitrification System shall be remote removal and replacement. Systems and components in contaminated areas shall be designed to be either remotely maintainable in place, or remotely removable and replaceable." Systems and components associated with the VF and not located in the Vitrification Cell, Transfer Tunnel, EDR, and HLWIS are generally accessible for hands-on maintenance. Though not formally invoked in the VF design documents, much of the guidance contained in UCRL-15673, *Human Factors Design Guidelines for Maintainability of Department of Energy Nuclear Facilities,* has been incorporated into the design and construction of the VF (Lawrence Livermore National Laboratory June 18, 1985).

Little to no maintenance is anticipated in the Transfer Trench. The need to perform hands-on maintenance or remote maintenance in the Transfer Trench is made on a case-by-case basis. WVNS-DC-046, *Design Criteria Sludge Mobilization Waste Removal System,* provides remote maintenance and replacement design criteria for the Transfer Trench and associated hardware.

C.4.5.5 Nuclear Criticality Safety

WVNS Policy and Procedure WV-923, *Nuclear Criticality Safety,* and WVDP-162, *WVDP Nuclear Criticality Safety Program Manual,* set forth the safety requirements and administrative controls associated with the WVDP nuclear criticality safety program. The program was developed to satisfy the requirements of DOE Order 420.1, *Facility Safety* (U.S., Department of Energy October 13, 1995).

WVDP-162 contains criteria for nuclear criticality safety at the WVDP. For example, criteria are provided for establishing process specifications for processes or activities involving fissionable materials. Process specifications, which are derived from subcritical limits and appropriately selected margins of safety, ensure that a subcritical configuration is maintained under all normal and credible abnormal operating conditions.

The VF processes and activities that pose nuclear criticality issues are presented in Section C.9.4.11 of this FSAR covering the basic elements, control parameters, and issues for nuclear criticality safety as covered in DOE Order 420.1.

C.4.5.6 Radiological Protection

VF radiological protection design criteria are provided in Section 4.3 of WVNS-DC-022. This section of WVNS-DC-022 commits to implement the principle of ALARA in the design of the VF and to limit on-site personnel exposure levels to less than one tenth of the 10 CFR 835, *Occupational Radiation Protection,* (U.S. Department of Energy) dose equivalent limits as a design objective (U.S. Department of Energy December 21, 1988).

All VF operation, maintenance, and access control are performed in compliance with the latest revision of WVDP-010. Shield walls, confinement and containment structures, and ventilation systems; as well as, administrative controls, procedures, training and technical safety requirements, are used to maintain radiation doses to occupationally exposed personnel ALARA. Protective clothing (e.g., anti-c and respiratory protection) is worn when required by radiological conditions, as prescribed by WVDP-010.

The VF control of radiation exposure is largely accomplished through the use of shielding (for direct penetrating radiation), time of exposure (full-time occupancy, full-time access, and restricted), and the HVAC systems (for airborne contamination). The above radiation controls are discussed in Section C.8.1 of this FSAR.

Continuous air monitors (CAMs) and area radiation monitors (ARMs) are provided in the VF and audibly alarm if set points are exceeded. The alarm set points for CAMs and ARMs are in accordance with guidance provided in WVDP-010.

C.4.5.7 Fire and Explosion Protection

The WVDP fire protection program has been developed to meet the requirements for a comprehensive fire protection program as delineated in WVDP-177, *WVDP Fire Protection Manual*, which is based on the requirements in DOE Order 420.1, *Facility Safety*. WVNS-DC-022 specifically requires that the VF be designed in accordance with the National Fire Protection Association (NFPA) codes and DOE-ID 12044. Administrative controls, procedures, and training to prevent fires and explosions are presented in WVDP-177.

The potential for a fire is kept low by minimizing the amount of combustible material. Electrical insulation is made of a fire-resistant material. The Vitrification Cell, Crane Maintenance Room, Transfer Tunnel, EDR, and HLWIS contain essentially no combustible materials during normal operations. The process slurry inputs, decontamination solutions, and canister weld components contain no flammable components and cellulosic (e.g., paper, wood, natural fibers) type materials are not stored within the process cells. Hence, the potential for a fire is considered to be minimal.

The potential of generation and possible accumulation of combustible NH_4NO_3 downstream of the NO_x Selective Catalytic Reduction (SCR) reactor has been addressed by Pacific Northwest Laboratories (Ross February 1990). The study concluded that: "SCR operations in support of the WVDP will not create any identifiable off-gas safety hazards or exhaust system difficulties resulting from NH_4NO_3 production which would require any special operations or attention so long as nominal operating conditions are not grossly altered or exceeded." Since the NO_x SCR reactor is carefully controlled, monitored, and alarmed through the Distributed Control System (DCS), no hazards concerning ammonium nitrate will be present in the VF.

Section C.5.4.9 of this FSAR states the design basis of the Fire Protection system, and cites various reports, assessments and procedures that have been developed to address specific areas of fire protection in detail.

C.4.5.8 Fuel and Radioactive Waste Handling and Storage

No spent nuclear fuel handling or storage is associated with the VF.

The VF product will be approximately 270 to 300 canisters of solidified HLW. These canisters are decontaminated and transferred to the HLWIS for interim storage until shipped to a federal repository. Pertinent design criteria are provided in WVNS-DC-048, *Design Criteria, High-Level Waste Interim Storage System.*

Radioactive liquids generated during the processing of the HLW are recycled to the CFMT or sent back to the Tank Farm for treatment as either LLW and run through the IRTS or HLW and returned to the VF. Solid radioactive wastes (e.g., contaminated swipes, paper, tools) are managed per existing WVDP procedures. Waste minimization is achieved at the WVDP by following the principles outline in WVDP-087, *Waste Minimization/Pollution Prevention Awareness Plan.*

C.4.5.9 Industrial and Chemical Safety

The DOE has complete responsibility and authority to control all aspects of occupational safety and health and environmental protection at government owned-contractor operated (GOCO) facilities governed by the Atomic Energy Act of 1954, as amended. To ensure safety, DOE has prescribed a set of directives to be used in conjunction with those of the Occupational Safety and Health Administration (OSHA) and other agencies. The DOE directives that are applicable to WVNS are listed in the contract between DOE and WVNS. WVNS-DC-022 also requires OSHA 29 CFR 1910 be applied to the WVDP to address "industrial/occupational safety" and provides a listing of typical areas for occupational safety review.

The *WVDP Industrial Hygiene and Safety Manual* (WVDP-011) establishes the policies used to control chemical and industrial hazards for all West Valley operations. Safety is controlled by use of:

- Proper facility and equipment design,
- Proper protective clothing and equipment,

- Personnel training,
- Safe disposal practices,
- Operating procedures, and
- Industrial Work Permits.

Industrial and chemical hazards for vitrification activities are routinely controlled by techniques prescribed in DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities* (U.S. Department of Energy July 9, 1990). Good work practices are required for plant operations such as orderly shift turnover, required reading lists, facility surveillances and walk-downs, and use of logbooks. Routine operations (including such operations as nitric acid handling and anhydrous ammonia handling) are governed by formal procedures. An Industrial Work Permit (IWP) is required whenever non-routine handling operations, such as maintenance, are conducted on equipment with safety hazards. Lockout/tagout procedures are inherently used in conjunction with the IWP and craftsmen and operators are trained in the use of locks and tags. WVNS-SAR-001, Section A.4.3.8, addresses established WVDP industrial and chemical safety measures.

Fabrication, installation, and testing of the ammonia storage tank and supply subsystem and Cold Chemical Building has been performed in accordance with the following standards, as applicable:

- ASME Section VIII - Division I, *Boilers and Pressure Vessels Codes.*
- ASME B31.3, *Chemical Plant and Petroleum Refinery Piping.*
- ASME SA-516-70, *Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate and Lower Service.*
- ASME-NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities.*
- 29 CFR 1910.111, *Storage and Handling of Anhydrous Ammonia.*
- Compressed Gas Association (CGA) Pamphlet G-2, *Anhydrous Ammonia.*
- ANSI Pamphlet K61.1-1989, *Storage and Handling of Anhydrous Ammonia.*
- ANSI A58.1-1982, *Minimum Design Loads for Buildings and Other Structures.*

- ANSI B16.5, *Steel Pipe Flanges and Flanged Fittings.*
- ASTM A-36, *Standard Specification for Structural Steel.*
- ASTM A-53, *GR B Standard Specification for Pipe, Steel Blacks and Hot-dipped, Zinc-coated, Welded and Seamless.*
- American Society Nondestructive Testing (ASNT) STN-TC-1A, *Recommended Practice for Nondestructive Testing.*
- American Welding Society (AWS) D1.1, *Structural Welding Code.*
- *Uniform Building Code*, 1988 edition.
- Underwriters Laboratories (UL) 132-84, *Pressure Relief Valves for Anhydrous Ammonia and LP-Gas.*
- New York State Department of Environmental Control (NYS/DEC) 6NYRR Part 596, *Chemical Bulk Storage.*
- Customer Manual by the Ammonia National Co., Bower Ammonia Co., and North eastern Ammonia Co., *Storage and Handling of Anhydrous Ammonia*, Revision 2-89.
- ACI 318, *Building Code Requirements for Reinforced Concrete.*
- ACI 349, *Code Requirements for Nuclear Safety Related Concrete Structures.*
- National Fire Protection Association (NFPA) National Fire Codes, Standards, Recommended Practices, and Manuals.
- NFPA 70, *National Electrical Code.*
- NFPA 101®, *Life Safety Code.*
- IEEE, Standards Class 1E.

C.4.6 Classification of Structures, Systems, and Components

The safety class and quality level of VF SSCs are listed in WVDP-204. This "Q-List" is the primary source for establishing, identifying, revising, and maintaining an up-to-date listing of WVDP safety classes and quality levels of all facilities and their systems that are under the purview of the WVNS QA Program.

Although WVDP-204 was developed well after WVNS-DC-022, the safety class and quality level assigned to VF SSCs in WVDP-204 are, in the vast majority of instances, the same as those assigned in WVNS-DC-022. The primary difference between the two documents is that WVDP-204 lists and assigns a quality level and safety class to approximately three dozen more VF SSCs than does WVNS-DC-022. For VF SSCs that are listed in both documents, there are only four instances where the safety class or quality level in WVDP-204 is lower than that specified in WVNS-DC-022.

- The heat exchanger in the Closed-Loop Cooling Water (CLCW) system changed from quality level "B" to "C".
- The pumps in the CLCW system changed from quality level "B" to "C".
- The Process Off-Gas system back-up blowers in the 01-14 Building changed from quality level "B" to "C".
- The VF Process Off-Gas system ducting changed from safety class "C" to "N".

With two exceptions, other changes raise the safety class or quality level from an "N" or blank entry in WVNS-DC-022 to a "C" in WVDP-204. The storage racks in the HLWIS and the canister welding station welder changed from a quality level "N" in WVNS-DC-022 to a "B" in WVDP-204.

The definitions of safety class and quality level that are contained in WVDP-204 were developed by WVNS personnel and were chosen for reasons stated in WVDP-204. The WVDP-204 definition of safety class (and VF SSCs that have been designated as safety class in WVDP-204) are to be completely disassociated with safety class SSCs as defined in DOE-STD-3009-94 (U.S. Department of Energy 1994). Safety class SSCs per DOE-STD-3009-94 generally have Technical Safety Requirements (TSRs) associated with them. DOE-STD-3009-94 defines safety class SSCs as follows: "Systems, structures, or components including primary environmental monitors and portions of process systems, whose failure could adversely affect the environment, or safety and health of the public as identified by safety analyses. For the purposes of implementing this Standard, the phrase "adversely affect" means Evaluation Guidelines are exceeded. Safety class SSCs are systems, structures, or components whose preventive or mitigative function is necessary to keep hazardous material exposure to the public below the offsite Evaluation Guidelines. This definition would typically exclude items such as primary environmental monitors and most process equipment."

C.4.7 Decommissioning

The VF was designed in accordance with the decommissioning policies of both 10 CFR Part 50, Appendix F, *Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities* and the guidance provided in DOE Order 6430.1 (Draft), *General Design Criteria*. These regulations require the design to facilitate decontamination and removal of all significant radioactive wastes at the time the facility is permanently decommissioned.

Decontamination is also a requirement of the WVDP Act (U.S. Congress October 1, 1980), the Memorandum of Understanding (MOU), and the Cooperative Agreement. The MOU requires the DOE to decontaminate and decommission (D&D) the nuclear facilities, at Project end, to criteria developed by the U.S. Nuclear Regulatory Commission (NRC). Decommissioning of the VF will be performed in accordance with both the NRC criteria and guidelines established in DOE Order 435.1, *Radioactive Waste Management* (U.S. Department of Energy July 9, 1999).

After completion of the WVDP decommissioning activities, operational control of the Project premises will revert back to the State of New York for continued monitoring and maintenance.

C.4.7.1 Design Philosophy

The decommissioning of any nuclear facility is controlled by the operational considerations of removing radioactive contamination and hazardous materials from the facility and treating and packaging them for disposal as required by governing radioactive and hazardous material regulations. The VF systems and structures are designed for ease of facility decontamination and decommissioning after all high-level waste inventory is solidified. This includes decontamination of the structures and equipment, and removal of sources of toxic, hazardous, and radioactive materials to acceptable levels or concentrations.

The VF design includes a decontamination process capability with a dedicated chemical makeup area, process piping, and remote handling equipment to perform the internal and external decontamination of process vessels and equipment upon completion of their mission. The design of the VF includes those decontamination and decommissioning design features suggested in DOE Order 6430.1 (Draft), which are appropriate for a "Special" (as designated in the order) nonreactor nuclear facility. Examples of these provisions include:

- Location of exhaust filtration components of the ventilation systems at or near individual enclosures so as to minimize long runs of internally contaminated ductwork.

- Equipment, including effluent decontamination equipment, that precludes, to the extent practicable, the accumulation of radioactive or other hazardous materials in relatively inaccessible areas including curves and turns in piping and ductwork. Accessible, removable inspection covers are provided where feasible to allow visual inspection.

- Designs that ease cut-up, dismantling, removal, and packaging of contaminated equipment from the facility (e.g., removal and dismantling of gloveboxes, air filtration equipment, large tanks, vessels, equipment, and ductwork).

- Fully drainable piping systems that carry contaminated or potentially contaminated liquids.

The VF has the remotely operated equipment necessary to perform operations and maintenance tasks during the facility operation. This equipment will also aid in D&D activities. Systems and components in contaminated areas are designed to be either remotely maintainable in place, or remotely removable and replaceable. Components which may require relatively frequent routine preventive or corrective maintenance (e.g., valve packing replacement or valve stem lubrication) are located outside of Zone I areas to the maximum extent practicable.

All vessels are designed to be remotely washed down internally or filled with suitable decontaminating solution to accomplish decontamination of the internal surfaces. Piping from each vessel is provided to route the decontamination solutions to an appropriate liquid waste treatment and/or storage system.

The design provides capabilities for the receipt, storage, and makeup of decontamination chemicals and for the treatment, solidification, and packaging for disposal of radioactive chemical solutions.

C.4.7.2 Plant Design Criteria for Decommissioning

WVNS-DC-022 establishes the criteria used to design the facility decommissioning and decontamination features and equipment. This document requires the VF design to incorporate features that facilitate future decommissioning of the facility. The VF facilities and structures are designed in accordance with ANSI N300, *Design Criteria for Decommissioning of Nuclear Fuel Reprocessing Facilities* (American National Standards Institute, Inc. 1975).

The VF systems and structures are designed to facilitate post solidification decontamination. This includes decontamination of the structure and equipment, and removal of sources of toxic, hazardous, and radioactive materials to acceptable levels or concentrations.

C.4.7.2.1 Process Cell Decontamination and Decommissioning

The equipment located in the vitrification process cells will be highly contaminated and will have radiation fields which are prohibitively high for direct personnel handling, until significant decontamination of the equipment exterior and interior surfaces is accomplished. The VF decontamination system is designed to permit flooding the inside surfaces of equipment in contact with contaminated process liquids and solids. Equipment installed in the VF include features to minimize time and flushing required for decontamination efforts. Examples of these features are provided below:

- Process piping design minimizes nondraining low points or pockets. Where low points or pockets are unavoidable, provisions are made to drain or flush the low point.
- Vessels are designed to enhance the complete removal of process and decontamination solutions. Interior and exterior crevices are minimized.
- Horizontal surfaces are avoided. Sloped surfaces are utilized to facilitate drainage of decon solutions.
- Process valves and associated piping are provided with flushing and draining capabilities.
- Cell floors are stainless steel lined. Cell walls are also stainless steel lined to the 37.5-m (123-ft) level. Surfaces not stainless steel lined are protected with Ameron 400 epoxy coatings to facilitate decontamination.
- Cell floors are sloped for drainage and include a means of emptying and decontaminating sump areas.
- A high pressure (i.e., approximately 6,895 kPag [1,000 psig]) hose is provided in-cell to facilitate decontamination activities.

The facility is designed for remote maintenance and operation while the VF is in operation. These remote operating requirements are accomplished by use of the facility crane, impact wrench, or local overhead remote manipulators. Bails, lifting rigs, and grapples are provided to augment the basic crane capabilities.

Thus, the design inherently provides features and equipment that aid in accomplishing the final facility dismantling and decommissioning. Contaminated in-cell process equipment can be disassembled and removed from the cell using design features of the facility. Examples of these features are provided below:

- Remotely removable valves, pumps, etc., on jumper assemblies are used to enhance remote changeout. Remote handling equipment is provided in the facility design to handle these remotely removable fixtures.
- Equipment such as, tanks, vessels, columns, and airlifts located in the shielded cell are designed to permit remote replacement. Space is provided for equipment removal with reasonable disassembly and removal of adjacent equipment.
- Shielded windows are provided for viewing of routine remote operations. Where viewing through a window is not feasible, closed-circuit TV with movable in-cell support assemblies is provided.
- All in-cell filter banks can be remotely changed.
- Connectors, bolts, flanges, wrenches, sockets, extensions, etc., are standardized to the maximum extent practical to reduce the need for multiple tools and frequent tool changes.
- In-cell lights are remotely replaceable.
- Cell access is provided through ceiling hatches as far as practicable.
- Bridge cranes provide complete cell coverage.
- In-cell remote handling equipment is provided with redundant features and/or retrieval systems to facilitate recovery from failure.
- A shielded maintenance cell is provided for parking and decontaminating the crane, and hands-on maintenance. Hatches are provided in the roof of the room so that crane trolleys and components can be removed from the facility.

Rails are provided between the Vitrification Cell and EDR/HLWIS for removal of equipment from the cell. The rail dimensions, location, and spacing match the existing rails in the HLWIS and EDR cells. A transfer cart is provided for removal of components, vessels, and jumpers.

Equipment such as the melter, the turntable and canisters are capable of being removed through the EDR. An area is specifically designed for wall removal to provide egress in the EDR for removal of these large components. Access to the special opening is provided to the Melter and Turntable by the in-cell rail cart transfer system.

In-cell off-gas vessels have remotely removable jumper assemblies and can be removed with only limited cutting required. There are no provisions for remote removal of the Vessel Vent Header. It is "permanently" installed on a ledge where there is no access by either crane hooks or remote manipulators. Therefore, after the Vitrification Cell has been decontaminated and all equipment that can be remotely removed has been removed, manned entries will likely be required to remove the Vessel Vent Header. The Waste Header System can be remotely cut into manageable pieces at the expansion loops and remotely removed from the Vitrification Cell.

Radioactive ventilation systems, off-gas treatment systems, and HEPA filter housings are constructed of stainless steel and are designed to be decontaminated to levels acceptable for removal from the facility.

First stage roughing and primary filters on these systems are located as close to the inlet as possible to minimize the amount of contamination deposited on downstream ducting and filtering components. First stage filters are remotely changeable since this is where the majority of contamination, in the ventilation system air, will be captured.

Once the sources of high radiation are removed from the cell by remote means, the cell radiation fields will eventually be lowered to the point which will allow personnel entry to the cell. Final cell decontamination will be performed using manual cleanup methods in accordance with ALARA principles and under the provisions of industrial work permits and radiation work permits.

C.4.7.2.2 Decontamination Support Area

The CCS provides for the addition of decontamination chemicals to the vitrification process vessels. Operation of the system is performed by both hands-on chemical handling into the makeup vessels and remote (control room) control and monitoring of feed to the process vessels. An exhaust system is provided to remove chemical makeup vessel fumes and dust.

Process reagents and decontamination solutions such as acids, caustics, metal salt solutions, and oxidizing solutions will be prepared and used in the facility. Chemical handling will be in accordance with existing site and plant chemical standards. Adequate chemical receipt, storage, and makeup areas are provided as a part of the facility design.

C.4.7.3 Future Isolation of Radioactive Materials to Protect the Public

After completion of the WVDP decommissioning activities, operational control of the Project premises will revert back to the state of New York for continued monitoring and maintenance.

Solid radiological wastes will be generated during D&D activities. These wastes will consist of spent roughing and HEPA filters, equipment, piping, conduit, instrumentation, tools, contaminated clothing, and other miscellaneous wastes. These wastes will be decontaminated as appropriate, packaged, and disposed of in accordance with existing WVDP policies and procedures (e.g., WVDP-010).

The Project does not dispose of radiological waste on-site. Pending completion of the WVDP Phase II Environmental Impact Statement (EIS), a decision will be made regarding on-site versus off-site disposal of low-level radioactive waste currently stored on-site. Transuranic waste will be stored on-site until it can be treated and/or shipped to a transuranic waste storage or disposal facility. The Project will not dispose of transuranic waste on-site. Project-generated, nonradioactive, nonhazardous solid wastes are disposed of off-site in a licensed sanitary landfill. High-level waste will be stored on-site until it can be shipped to an approved disposal (i.e., final repository) facility. Nonradioactive hazardous waste will be shipped to a licensed Resource Conservation and Recovery Act (RCRA) facility for treatment and final disposal.

C.4.8 Human Factors Engineering

The VF is designed to be comfortable and natural for humans to operate and maintain. Human factors have been considered in the positioning of equipment, switches, valves, and instruments, both from an operating and a maintenance viewpoint. The following are examples of how human factors engineering has been incorporated into the design of the VF.

- Instrument readouts are located at an average eye elevation for ease of reading, and controls for such instruments are located to permit visual monitoring without large shifts of body position.
- Equipment is accessible for ease of operation and maintenance.
- Manipulators and viewing equipment are properly located for ease of remote operation.

- Equipment is designed for male and female operators.

- Operations that require special skills or attention have been minimized or automated.

- Audible and visual alarms are provided that warn operators in advance of exceeding process limits.

- Instrument failure warning lights are provided to avoid use of or reliance on incorrect indications.

- Communications systems are provided that allow for rapid reporting of abnormal conditions.

- Human factors considerations associated with system control, display devices, component arrangement, vibration, noise, lighting, emergency lighting, ventilation, temperature, humidity, human dimensions, protective equipment, warning and annunciator systems, and maintainability are incorporated into the VF control room design and layout.

REFERENCES TO CHAPTER C.4.0

American Concrete Institute. 1990. *Code Requirements for Nuclear Safety Related Concrete Structures.* ACI 349-90.

__________. 1980. *Building Code Requirements for Reinforced Concrete.* ACI 318-80. (Revised 1992.)

American National Standards Institute. 1975. *Design Criteria for Decommissioning of Nuclear Fuel Reprocessing Facilities.* ANSI N300. New York: American Institute of Chemical Engineers.

American Society of Mechanical Engineers. 1970. *Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate and Lower Service.* ASME SA-516-70.

__________. September 1989. *Quality Assurance Program Requirements for Nuclear Facilities.* ASME-NQA-1. New York: American Society for Mechanical Engineers.

American Society of Mechanical Engineers/American National Standards Institute. 1987. *Chemical Plant and Petroleum Refinery Piping.* ASME B31.3-1987. New York: American Society of Mechanical Engineers.

__________. 1992. *ASME Boiler/Pressure Vessel (B/PV) Code. Section VIII, Division I.* New York: American Society for Mechanical Engineers.

__________. 1982. *Minimum Design Loads for Buildings and Other Structures (NRC Adopted).* ANSI A58.1. New York: American National Standards Institute, Inc.

__________. October 1988. *Steel Pipe Flanges and Flanged Fittings.* ANSI B16.5-88. New York: American National Standards Institute, Inc.

__________. 1989. *Safety Requirements for the Storage and Handling of Anhydrous Ammonia.* ANSI K61.1-1989. New York: American National Standards Institute, Inc.

American Society for Nondestructive Testing. December 1992. *Recommended Practice for Nondestructive Testing.* SNT-TC-1A.

American Society for Testing and Materials. 1993. *Standard Specification for Structural Steel.* ASTM A-36.

__________. 1993. *GR B Standard Specification for Pipe, Steel Blacks and Hot-dipped, Zinc-coated, Welded and Seamless.* ASTM A-53.

REFERENCES FOR CHAPTER 4.0
(Continued)

American Welding Society. 1994. *Structural Welding Code.* AWS D1.1-94. Thirteenth Edition.

Ammonia National Co., Bower Ammonia Co., and North Eastern Ammonia Co. February 1989. *Storage and Handling of Anhydrous Ammonia, Customer Manual.*

Atomic Energy Act of 1954, as amended.

Bixby, W.W. July 17, 1989. DOE Order 6430.1A. West Valley Project Office (DW:89:0365). Letter to R.A. Thomas.

Bray, L.A. June 1988. *Development of a Chemical Process Using Nitric Acid-Cerium (IV) for Decontamination of High-Level Waste Canisters.* WVST 87/263A. Richland, WA: Pacific Northwest Laboratory. (See also Carrell, J.R. September 30, 1987 BW:87:0231).

Compressed Gas Association. 1984. Pamphlet G-2, *Anhydrous Ammonia.*

International Conference of Building Officials. 1988 Edition. *Uniform Building Code (UBC).*

Lawrence Livermore National Laboratory. June 18, 1985. *Human Factors Design Guidelines for Maintainability of Department of Energy Nuclear Facilities.* UCRL-15673. Prepared for U.S. Department of Energy.

National Fire Protection Association. 1993. NFPA 70: *National Electrical Code.*

__________. 1994. *National Fire Protection Association Manual.*

__________. February 11, 1994. NFPA 101®: *Code for Safety to Life from Fire in Buildings and Structures.* (See also *Life Safety Code® Handbook.*)

New York State Code Manual for State Building Construction Code. New York State.

New York State Department of Environmental Control. *Chemical Bulk Storage,* 6 NYCRR, Part 596, as amended.

Nixon, Justina. May 1, 1995. *Vitrification Mass Balance,* Rev. 8. Memo No. CC:95:0031. Letter to V.S. Arakali, et al. West Valley Nuclear Services Co. Inc.

REFERENCES FOR CHAPTER 4.0
(Continued)

Occupational Safety and Health Administration. *Storage and Handling of Anhydrous Ammonia*, 29 CFR 1910.111, as amended.

Ross, Wayne A., Battelle Project Manager. February 28, 1990. *Milestone 0407A - Submit Ammonium Nitrate Safety Evaluation*. Letter to Dr. James M. Pope.

Underwriters Laboratories, Inc. 1984. *UL Standard for Safety Relief Valves for Anhydrous Ammonia and LP-Gas.* UL 132-84.

U.S. Congress. October 1, 1980. West Valley Demonstration Project Act. Public Law 96-368.

U.S. Department of Energy. December 12, 1983. Draft DOE Order 6430.1: *General Design Criteria*. Washington, D.C.: U.S. Department of Energy.

__________. April 1985. DOE-ID 12044: *Operational Safety Design Criteria Manual*. Rev. 4. U.S. Department of Energy, Operational Safety Division. (See also Hannum, W.H. May 28, 1985. DW:85:0266.)

__________. October 13, 1995. Change 2 (October 24, 1996). DOE Order 420.1: *Facility Safety*. Washington, D.C.: U.S. Department of Energy.

__________. July 9, 1999. DOE Order 435.1: *Radioactive Waste Management*. Washington, D.C.: U.S. Department of Energy.

__________. April 6, 1989. DOE Order 6430.1A: *General Design Criteria*. Washington, D.C.: U.S. Department of Energy.

__________. July 9, 1990. Change 1 (May 18, 1992). DOE Order 5480.19: *Conduct of Operations Requirements for DOE Facilities*. Washington, D.C.: U.S. Department of Energy.

__________. February 15, 1992. Change 2 (January 23, 1996). DOE Order 5480.22: *Technical Safety Requirements*. Washington, D.C.: U.S. Department of Energy.

__________. 1993. EM-WAPS, *Office of Environmental Restoration and Waste Management: Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms*. Rev. 0.

REFERENCES FOR CHAPTER 4.0
(Continued)

__________. July 1994. DOE STD-3009-94: *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports.* Washington, D.C.: U.S. Department of Energy.

__________. DOE Order 5481.1A: *Safety Analysis and Review System.* Washington, D.C.: U.S. Department of Energy.

__________. 10 CFR 835: *Occupational Radiation Protection.*

U.S. Department of Energy, Idaho Field Office. October 1986. *INEL Architectural Engineering Standards.* Idaho National Engineering Library. Rev. 6.

U.S. Department of Labor. *Occupational Safety and Health Standards,* 29 CFR 1910, as amended.

U.S. Nuclear Regulatory Commission. *Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities.* 10 CFR 50, Appendix F, as amended.

West Valley Nuclear Services Company, Inc. Policy and Procedure WV-905: *Radiation Protection.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. Policy and Procedure WV-923: *Nuclear Criticality Safety.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. Policy and Procedure WV-988: *Employee "Right-to-Know" Program-Hazard Communication.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVDP-010: *WVDP Radiological Controls Manual.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVDP-011: *WVDP Industrial Hygiene and Safety Manual.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVDP-028: *West Valley Demonstration Project Plan.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVDP-087: *Waste Minimization/Pollution Prevention Awareness Plan.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

REFERENCES FOR CHAPTER C.4.0
(Concluded)

__________. WVDP-162: WVDP *Nuclear Criticality Safety Program Manual.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVDP-177: *WVDP Fire Protection Plan.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVDP-204: *WVDP Quality List "Q-List".* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-022: *Design Criteria, Vitrification of High-Level Wastes.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-045: *Design Criteria, Cold Chemical System.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-046: *Design Criteria, Sludge Mobilization Waste Removal System.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-048: *Design Criteria, High-Level Waste Interim Storage System.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-066: *Design Criteria, Vitrification Load-In Facility.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. *Safety Analysis Report WVNS-SAR-001: Project Overview and General Information.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

Yuan, Y.C. January 1994. *WVDP High-Level Waste Nuclear Characteristics: An Independent Study.* (See also Yuan, Y.C. January 31, 1994 D&M:OP:YCY:99:0001).

Table C.4.2.1-1
Radionuclide Content in Curies of HLW
(Fission and Activation Products Decay Corrected to July 1987)

Radionuclide	Tank 8D-2 Supernatant	Tank 8D-2 Sludge	Tank 8D-4	Total
H-3	9.5E+01	~0	<2.0	9.5E+01
C-14	1.4E+02	~0	... 1.4E+02	
Fe-55	~0	1.0E+03	... 1.0E+03	
Ni-59	~0	8.2E+01	... 8.2E+01	
Ni-63	8.9E+02	6.4E+03	... 6.5E+03	
Co-60	~0	4.7	1.2E+03	1.2E+03
Se-79	3.7E+01	~0	... 3.7E+01	
Sr-90	2.9E+03	6.9E+06	5.0E+05	7.4E+06
Y-90	2.9E+03	6.9E+06	5.0E+05	7.4E+06
Zr-93	~0	2.3E+03	... 2.3E+02	
Nb-93m	~0	2.3E+02	... 2.3E+02	
Tc-99	1.6E+03	~0	... 1.6E+03	
Ru-106	~0	1.3E+02	<3.1E-01	1.3E+02
Rh-106	~0	1.3E+02	<3.1E-01	1.3E+02
Pd-107	~0	1.2	... 1.2	
Sb-125	4.8E+01	4.5E+03	... 4.5E+03	
Te-125m	1.1E+01	1.0E+03	... 1.0E+03	
Sn-126	~0	4.0E+01	... 4.0E+01	
Sb-126m	~0	4.0E+01	... 4.0E+01	
Sb-126	~0	5.6E+01	... 5.6E+01	
I-129	2.1E-01	~0	<1.5E-01	<3.6E+01
Cs-134	1.4E+04	~0	2.9E+02	1.4E+04
Cs-135	1.6E+02	~0	... 1.6E+02	
Cs-137	7.3E+06	~0	5.1E+05	7.8E+06
Ba-137m	6.8E+06	~0	4.8E+05	7.3E+06
Ce-144	2.9E-05	1.4E+01	<2.0E-02	1.4E+01
Pr-144	2.9E-05	1.4E+01	<2.0E-02	1.4E+01
Pm-147	1.7E+02	3.1E+05	4.5E+03	3.1E+05
Sm-151	1.1	2.1E+05	1.5E+01	2.1E+05
Eu-152	4.2E-02	4.2E+02	5.8	4.2E+02
Eu-154	1.4E+01	1.3E+05	2.6E+03	1.3E+05
Eu-155	2.3	2.3E+04	3.1E+02	2.3E+04

Table C.4.2.1-1 (Concluded)
Radionuclide Content in Curies of HLW

	Radionuclide	Tank 8D-2 Supernatant	Tank 8D-2 Sludge	Tank 8D-4	Total
(Actinides)	Th-232	~0	~0	1.7	1.7
	U-233	4.9E-01	6.9	2.6	1.0E+01
	U-234	2.9E-01	4.0	3.0E-01	4.6
	U-235	6.4E-03	8.9E-02	4.9E-03	1.0E-01
	U-236	1.9E-02	2.7E-01	1.0E-02	3.0E-01
	U-238	5.7E-02	7.9E-01	6.1E-04	8.5E-01
	Np-237	~0	1.1E+01	...	1.1E+01
	Np-239	~0	2.4E+03	...	2.4E+03
	Pu-238	1.3E+02	6.5E+03	5.3E+02	7.2E+03
	Pu-239	2.5E+01	1.7E+03	1.7E+01	1.7E+03
	Pu-240	1.9E+01	1.3E+03	9.0	1.3E+03
	Pu-241	1.5E+03	8.5E+04	9.3E+02	8.7E+04
	Pu-242	2.5E-02	1.7	1.3E-02	1.7
	Am-241	~0	7.2E+04	2.7E+02	7.2E+04
	Am-242	~0	2.1E+01	...	2.1E+01
	Am-242m	~0	2.1E+01	...	2.1E+01
	Am-243	~0	2.4E+03	8.8	2.4E+03
	Cm-242	~0	2.2	<1.1E-03	2.2
	Cm-243	~0	1.7E+02	5.0E-02	1.7E+02
	Cm-244	~0	2.2E+04	1.6E+01	2.2E+04
	Cm-245	~0	1.0E+01	1.2E-03	1.0E+01
	Cm-246	~0	4.3	...	4.3

Table C.4.2.1-2

Chemical Composition of Tank 8D-2 Supernatant

Compound	% (w/w) Wet Basis	% (w/w) Dry Basis	Total Kg in Supernatant
$NaNO_3$	21.10	53.38	602,659
$NaNO_2$	10.90	27.57	311,326
Na_2SO_4	2.67	6.76	76,261
$NaHCO_3$	1.49	3.77	42,557
KNO_3	1.27	3.21	36,274
Na_2CO_3	0.884	2.24	25,249
$NaOH$	0.614	1.55	17,537
K_2CrO_4	0.179	0.45	5,113
$NaCl$	0.164	0.42	4,684
Na_3PO_4	0.133	0.34	3,799
Na_2MoO_4	0.0242	0.06	691
Na_3BO_3	0.0209	0.05	597
$CsNO_3$	0.0187	0.05	534
NaF	0.0176	0.04	503
$Sn(NO_3)_4$	0.00859	0.02	245
$Na_2U_2O_7$	0.00808	0.02	231
$Si(NO_3)_4$	0.00806	0.02	230
$NaTcO_4$	0.00620	0.02	177
$RbNO_3$	0.00416	0.01	119
Na_2TeO_4	0.00287	0.007	82
AlF_3	0.00271	0.007	77
$Fe(NO_3)_3$	0.00152	0.004	43
Na_2SeO_4	0.00054	0.001	15
$LiNO_3$	0.00048	0.001	14
H_2CO_3	0.00032	0.0008	9
$Cu(NO_3)_3$	0.00022	0.0005	6
$Sr(NO_3)_2$	0.00013	0.0004	4
$Mg(NO_3)_2$	0.00008	0.0002	2
TOTAL	39.53	100.00	1,129,038
H_2O (by difference)	60.47		1,727,164

Data from Eisenstatt 1986

Table C.4.2.1-3
Chemical Composition of Tank 8D-2 Sludge

Compound	Kg in Sludge
$Fe(OH)_3$	66,040
$FePO_4$	6,351
$Al(OH)_3$	5,852
AlF_3	536
MnO_2	4,581
$CaCO_3$	3,208
$UO(OH)_2$	3,087
$Ni(OH)_2$	1,088
SIO_2	1,263
$Zr(OH)_4$(a)	159
$MgCO_3$	826
$Cu(OH)_2$	376
$Zn(OH)_2$	128
$Cr(OH)_3$	65
$Hg(OH)_2$	23
Fission Products	
$SrSO_4$	217
$Y(OH)_3$	103
$Zr(OH)_4$	805
$Ru(OH)_4$	458
$Rh(OH)_4$	79
$Pd(OH)_2$	34
AgOH	0.7
$Cd(OH)_2$	1.7
$In(OH)_3$	0.3
$Sn(OH)_4$	2.5
$Sb(OH)_3$	0.7
$BaSO_4$	303
$La(OH)_3$	185
$Ce(OH)_3$	354
$Pr(OH)_3$	170
$Nd(OH)_3$	621

Table C.4.2.1-3 (Concluded)
Chemical Composition of Tank 8D-2 Sludge

Compound	Kg in Sludge
$Pm(OH)_3$	1.5
$Sm(OH)_3$	143
$Eu(OH)_3$	7.5
$Gd(OH)_3$	1.7
Transuranics	
NpO_2	35
PuO_2	37
AmO_2	28
CmO_2	0.4
Total:	97,172 (Excludes fission product zirconium)

Data from Eisenstatt 1986

Table C.4.2.1-4
Chemical Composition of Tank 8D-4 Waste

Compound	% (w/w)	Total kg in Tank
$Th(NO_3)_4$	26.69	12,997
$Fe(NO_3)_3$	19.41	9,452
$Al(NO_3)_3$	9.57	4,660
HNO_3	4.88	2,376
$Cr(NO_3)_3$	4.40	2,143
$Ni(NO_3)_2$	1.81	881
H_3BO_3	1.10	536
$NaNO_3$	0.759	370
Na_2SO_4	0.414	202
$KN0_3$	0.294	143
Na_2SiO_3	0.290	141
K_2MnO_4	0.281	137
$Nd(NO_3)_3$	0.146	71
$Mg(NO_3)_3$	0.131	64
NaCl	0.115	56
Na_2MoO_4	0.114	56
$Ca(NO_3)_2$	0.0700	34
$Ba(NO_3)_2$	0.0697	34
$Ru(NO_3)_4$	0.0643	31
$CsNO_3$	0.0502	24
Na_2TeO_4	0.0410	20
$Sr(NO_3)_2$	0.0407	20
$Ce(NO_3)_3$	0.0387	19
$Zr(NO_3)_4$	0.0288	14
$Sm(NO_3)_3$	0.0286	14
$La(NO_3)_3$	0.0269	13
$Pr(NO_3)_3$	0.0267	13
$Zn(NO_3)_2$	0.0226	11
$Rh(NO_3)_4$	0.0222	11
Na_2TcO_4	0.0206	10
$UO_2(NO_3)_2$	0.0156	8
$Y(NO_3)_3$	0.0134	7
Na_2SeO_4	0.00767	4
$RbNO_3$	0.00619	3
$Co(NO_3)_2$	0.00505	2
$Pd(NO_3)_4$	0.00469	2

Table C.4.2.1-4 (Concluded)
Chemical Composition of Tank 8D-4 Waste

Compound	% (w/w)	Total kg in Tank
NaF	0.00244	1
$Cu(NO_3)_2$	0.00177	0.9
$Pu(NO_3)_4$	0.00152	0.7
$Eu(NO_3)_3$	0.00142	0.7
$Gd(NO_3)_3$	0.00037	0.2
$X(NO_3)_4$(a)	0.00035	0.2
$Pm(NO_3)_2$	0.00034	0.2
Total	71.02	34,583
H_2O (by diff.)	28.98	14,114
Solids		
$Th(NO_3)_4$	-	18,958
Insolubles	-	39

(a) X = Am-241, Am-243, Cm-242, Cm-243, Cm-244, Cm-245
Data from Eisenstatt 1986

Table C.4.2.2-1
WVDP HLW Inventories

Tank #	Contents	Curies*	Nominal Tank Capacity (gal)	Representative Volume (gal)	Service Date
8D-1	Spent Zeolite	13 Million	750,000	247,000	1988**
8D-2	Neutralized PUREX Waste	13 Million	750,000	439,000	1966
8D-4	Acidic THOREX Waste	2 Million	15,000	13,000	1968

* Total activity in HLW tank, including radioactive decay daughters, at end of processing supernatant and sludge wash.

** Prior to 1988, condensate from Tank 8D-2 was stored in Tank 8D-1.

Table C.4.3.1-1
Chemical Composition of Glass Waste Form

Component	Nominal % (w/w)	Range % (w/w)	
AgO	0.0001	-	-
Al_2O_3	2.8295	1.19	7.15
AmO_2	0.0073	-	-
BaO	0.0540	0.04	0.08
B_2O_3	9.9516	9.33	10.66
CaO	0.5993	0.39	0.93
CdO	0.0003	-	-
CeO_2	0.0670	0.04	0.10
CmO_2	0.0001	-	-
CoO	0.0002	-	-
Cr_2O_3	0.3112	0.21	0.48
Cs_2O	0.0826	0.05	0.13
CuO	0.0001	-	-
Eu_2O_3	0.0014	-	-
Fe_2O_3	12.1573	8.32	18.50
Gd_2O_3	0.0003	-	-
In_2O_3	0.0001	-	-
K_2O	3.5733	3.36	3.84
La_2O_3	0.0337	0.02	0.05
Li_2O	3.0315	2.84	3.25
MgO	1.3032	1.22	1.39
MnO_2	1.3107	0.84	1.96
MoO_3	0.0088	-	0.01
NaCl	0.0183	0.01	0.03
NaF	0.0013	-	-
Na_2O	10.9335	10.25	11.71
Nd_2O_3	0.1209	0.08	0.19
NiO	0.3358	0.22	0.52
NpO_2	0.0224	0.01	0.03
P_2O_5	2.5084	0.21	3.16
PdO	0.0062	-	-
Pm_2O_3	0.0003	-	-
Pr_6O11	0.0321	0.02	0.05
PuO_2	0.0076	-	-
Rb_2O	0.0005	-	-
RhO_2	0.0136	0.01	0.02
RuO_2	0.0759	0.05	0.12
SO_3	0.2164	0.14	0.33
Sb_2O_3	0.0001	-	-
SeO_2	0.0005	-	-
SiO_2	44.8770	42.08	48.10
Sm_2O_3	0.0267	0.02	0.04

Table C.4.3.1-1 (Concluded)
Chemical Composition of Glass Waste Form

Component	Nominal % (w/w)	Range % (w/w)	
SnO_2	0.0006	-	-
SrO	0.0269	0.02	0.04
Tc_2O_7	0.0021	-	-
ThO_2	3.5844	1.83	6.56
TeO_2	0.0028	-	-
TiO_2	0.9800	0.92	1.05
UO_2	0.5605	0.37	0.87
Y_2O_3	0.0177	0.01	0.03
ZnO	0.0010	-	-
ZrO_2	0.2943	0.19	0.45
Insolubles	0.0080	-	-

Data from Eisenstatt 1986

Table C.4.3.1-2
Reference Radionuclide Content of a Canister of WVDP HLW (in 1990)

Radionuclide	Radioactivity (Ci) Nominal	Range	
55-Fe	1.9E+0	1.7E+0	2.1E+0
59-Ni	3.2E-1	2.9E-1	3.6E-1
63-Ni	2.5E+1	2.3E+1	2.7E+1
60-Co	3.2E+0	2.8E+0	3.6E+0
79-Se	1.5E-2	1.3E-2	1.6E-2
90-Sr	2.7E+4	2.4E+4	3.0E+4
90-Y	2.7E+4	2.4E+4	3.0E+4
93-Zr	9.5E-1	8.5E-1	1.1E+0
93m-Nb	7.8E-1	7.0E-1	8.6E-1
99-Tc	6.7E+0	6.0E+0	7.4E+0
106-Ru	3.2E-2	2.9E-2	3.6E-2
106-Rh	3.2E-2	2.9E-2	3.6E-2
107-Pd	4.7E-3	4.2E-3	5.3E-3
125-Sb	8.4E+0	7.5E+0	9.3E+0
125m-Te	1.9E+0	1.7E+0	2.1E+0
126-Sn	1.6E-1	1.4E-1	1.8E-1
126m-Sb	1.6E-1	1.4E-1	1.8E-1
126-Sb	2.2E-1	2.0E-1	2.5E-1
134-Cs	1.5E+1	1.3E+1	1.6E+1
135-Cs	6.3E-1	5.6E-1	7.0E-1
137-Cs	2.9E+4	2.5E+4	3.2+4
137m-Ba	2.7E+4	2.4E+4	3.0E+4
144-Ce	3.8E-3	3.4E-3	4.3E-3
144-Pr	3.8E-3	3.4E-3	4.3E-3
147-Pm	5.4E+2	5.0E+2	6.3E+2
151-Sm	8.1E+2	7.2E+2	9.0E+2
152-Eu	1.5E+0	1.3E+0	1.6E+0
154-Eu	4.0E+2	3.6E+2	4.5E+2
155-Eu	5.9E+1	5.3E+1	6.5E+1
232-Th	6.3E-3	4.7E-3	8.0E-3
233-U	3.8E-2	3.4E-2	4.2E-2
234-U	1.7E-2	1.6E-2	1.9E-2
235-U	3.9E-4	3.5E-4	4.4E-4
236-U	1.1E-3	9.9E-4	1.2E-3
238-U	3.1E-3	2.8E-3	3.5E-3
237-Np	4.3E-2	2.0E-2	6.9E-2
239-Np	9.4E+0	4.4E+0	1.5E+1
238-Pu	2.7E+1	2.4E+1	3.0E+1
239-Pu	6.8E+0	6.1E+0	7.6E+0
240-Pu	1.5E+1	8.7E+0	1.9E+1
241-Pu	3.0E+2	2.6E+2	3.3E+2

Table C.4.3.1-2 (Concluded)
Reference Radionuclide Content of a Canister of WVDP HLW (in 1990)

	Radioactivity (Ci)		
Radionuclide	Nominal	Range	
242-Pu	6.8E-3	6.0E-3	7.5E-3
241-Am	3.4E+2	1.7E+2	5.0E+2
242-Am	8.3E-2	3.8E-2	1.3E-1
242m-Am	8.3-2	3.8E-2	1.3E-1
243-Am	9.4E+0	4.4E+0	1.5E+1
242-Cm	8.3E-2	3.8E-2	1.3E-1
243-Cm	6.2E-1	3.0E-1	1.0E+0
244-Cm	7.8E+1	3.7E+1	1.2E+2
245-Cm	3.9E-2	1.9E-2	6.3E-2
246-Cm	1.7E-2	8.0E-3	2.7E-2

Data from Eisenstatt 1986.

C.5.0 VITRIFICATION FACILITY DESIGN

This chapter presents information on the design and engineering of structures, systems, and components (SSCs) that support safe and efficient operation of the Vitrification Facility (VF).

C.5.1 Summary Description

C.5.1.1 Location and Facility Layout

The VF is part of the West Valley Demonstration Project (WVDP), which is located on approximately 89 hectares (220 acres) within the Western New York Nuclear Service Center (WNYNSC). The WNYNSC occupies an area of approximately 1,354 hectares (3,345 acres) in the Town of Ashford, Cattaraugus County, New York, approximately 5.6 km (3.5 mi) south of the Village of Springville, Erie County. The coordinates for the center of the main stack are 42.450° North latitude 78.545° West longitude. The location of the WNYNSC with respect to major natural and manmade features in Western New York is shown in Figure C.5.1.1-1. A WNYNSC site map is provided in Figure C.5.1.1-2. A WVDP site map is provided in Figure C.5.1.1-3. Further details are provided in WVNS-SAR-001, *Project Overview and General Information*.

The VF consists of several associated structures including the Transfer Trench, Vitrification Building (which includes the Vitrification Cell, operating aisles, and Control Room), Cold Chemical Building, 01-14 Building, Transfer Tunnel, Load-In Building, Equipment Decontamination Room (EDR), High-Level Waste Interim Storage (HLWIS), Off-Gas Trench, and Diesel Fuel Oil Storage Tank Building. See Figure C.1.2-1.

C.5.1.2 Principal Features

C.5.1.2.1 Site Boundary

The boundaries of the WNYNSC are shown on Figure C.5.1.1-2, and the boundaries of the WVDP site are shown on Figure C.5.1.1-3. The New York State Energy Research and Development Authority (NYSERDA) holds title to the WNYNSC on behalf of the state of New York.

C.5.1.2.2 Exclusion Area

The WNYNSC area is the project exclusion area. Access is controlled primarily by a boundary fence.

C.5.1.2.3 Restricted Area

The WVDP site is the "Property Protection Area." Access is controlled by a chain-link fence and an electronic card security system at the designated entries. Access is monitored by closed-circuit television and security guards.

C.5.1.2.4 Site Utilities Used by the Vitrification Facility

Utilities available on the WVDP site include electricity, water, and natural gas. The electric feed is routed on overhead lines from two Niagara Mohawk Power Corporation sources. The on-site lines and transformers are shown in Figure C.5.1.1-3. The VF Electrical Distribution system is discussed further in Section C.5.4.2. Water is transported to the WVDP site from two reservoirs on the WNYNSC, southeast of the WVDP, via underground pipes. The locations of the reservoirs are shown on Figure C.5.1.1-2, and the locations of storage tanks are shown on Figure C.5.1.1-3. Natural gas is supplied to the WVDP site via an underground National Fuel Gas Supply Corporation line. However, natural gas is not utilized within the VF, as detailed in Section C.5.4.13.

C.5.1.2.5 Storage Facilities

The location of storage facilities, including impoundments, is shown on Figure C.5.1.1-3. A listing of outside storage facilities and impoundments is provided in Table C.5.1.2.5-1. The table is provided to compliment Figure C.5.1.1-3 by identifying the location, volume, and type of materials stored at facilities adjacent to the VF.

C.5.1.2.6 Stacks

The VF Heating, Ventilating, and Air Conditioning (HVAC) exhaust release points, including the Vitrification Building stack, are discussed in Section C.5.4.1. Radioactive process off-gas, which is filtered and treated prior to release from the Main Plant stack, is discussed in Section C.7.4. Interfaces with the existing Main Plant are also discussed in these sections.

C.5.2 Design of Structures

C.5.2.1 Introduction

The VF is composed of different types of structures primarily because of different radiological confinement functional requirements. VF structures may be classified into one of three categories, based on their design. These categories are:

1) Confinement barriers required to remain functional under site-specific design basis events.

2) Modified existing structures not required to remain functional under site-specific design basis events.

3) New structures not required to remain functional under site-specific design basis events.

In addition to these basic structures, there are equipment, vessels, and components that have the potential of becoming seismic hazards to the confinement barriers because of their shape, size, and/or mass. Interaction of these elements, primarily in the Vitrification Cell, could lead to accident release scenarios.

This section of this Final Safety Analysis Report (FSAR) discusses the structural integrity of primary structures and vessels that serve as passive confinement. The integrity of confinement systems is also discussed in Section C.5.5.

C.5.2.1.1 Confinement Barrier Structures

The VF design philosophy is that the following SSCs must be designed to maintain structural integrity during and after credible natural phenomena events. The purpose of these requirements is to ensure total or nearly total confinement of radioactive and hazardous materials. The engineered confinement barrier structures relied on during accident scenarios, including natural phenomena induced accident scenarios, are as follows:

- Vitrification Cell
- Crane Maintenance Room (CMR)
- Transfer Tunnel
- Secondary Filter Room (SFR)
- HV Operating Station (HVOS)
- Diesel Generator Room (DGR)
- High-Level Waste Transfer System (HLWTS).

Figures C.5.2.1.1-1 through C.5.2.1.1-10 illustrate the engineered confinement barriers for the VF. These barrier structures have various integral enclosures and components, including special doors, shield windows, pipe penetrations, hatches, trench covers, etc. These components have been engineered to maintain their integrity as confinement barriers. Wherever possible, redundancy of barriers has been incorporated in the design so that radiological releases to the environment would require the failure of more than one barrier.

The Vitrification Cell and Transfer Tunnel were built to mate with the existing EDR and Chemical Process Cell (CPC). (The CPC is now the High Level Waste Interim Storage (HLWIS) facility, as established by this FSAR.) Structures such as the HLWIS are not required to withstand the Design Basis Earthquake (DBE), since their failure would not result in significant environmental releases. For this reason, the Transfer Tunnel is designed and built to be seismically "decoupled" from the EDR and HLWIS (Gates January 25, 1994).

C.5.2.1.2 Modified Existing Structures

The VF is designed to utilize both newly constructed structures and existing structures of the original fuel reprocessing plant. Existing plant structures have been modified to serve as the interim storage and loadout areas for the finished borosilicate glass product within the stainless steel canisters. These structures were designed originally to building codes that have now been superseded. All modifications to these structures are designed to meet current building codes. These original structures include the following:

- Equipment Decontamination Room (EDR)
- Chemical Process Cell (CPC)
- Crane Maintenance Room (CMR)
- 01-14 Building.

Figures C.5.2.1.2-1 and C.5.2.1.2-2 illustrate the CPC and EDR structures of the old processing plant. Figure C.5.2.1.1-5 shows the 76-mm (3-in) seismic separation joint between the EDR (old plant) and the new structures. The seismic joint is designed and provided with shielding to prevent radiation shine paths during normal operations and to accommodate out-of-phase motion between these structures. The 76-mm (3-in) separation joint has been filled with sheets of closed-cell, cross linked, polyethylene (Rodofoam II) that is highly resistant to radiation and chemical attack; will not absorb water and hence cannot freeze or thaw; and has no observable deterioration in physical properties with age, such as stiffening. It has been successfully used as a seismic joint fill material on nuclear power plants for 25 years.

C.5.2.1.3 New General Construction

Building structures, which are not required as engineered confinement barriers for the processing of high-level waste (HLW), have been designed as conventional structures. These structures are, thus, not required to survive extreme environmental loads (natural phenomena hazards) without loss of function. However, these structures should survive without collapse to satisfy minimum life safety requirements under less severe environmental loadings. These structures include:

- Sheet metal building surrounding the Vitrification Cell
- Cold Chemical Building
- Diesel Fuel Storage Tank Building
- New Portion of 01-14 Building
- Load-In Building

Figure C.5.2.1.1-1 illustrates the sheet metal enclosures and exterior special doors associated with the Vitrification Building and the Cold Chemical Building.

C.5.2.2 Design Criteria, Codes, and Standards

Principal design criteria, including criteria stipulated by applicable DOE Orders and nuclear and commercial industry codes and standards, are discussed in Chapter 4.

C.5.2.2.1 Vitrification Confinement Structures

C.5.2.2.1.1 Introduction

The Vitrification Cell confines the majority of the dispersible radioactive waste inventory and houses confinement systems and components necessary to maintain confinement under accident conditions. The CMR and Transfer Tunnel are included as part of the confinement structure because they communicate with the Vitrification Cell environment during transfer of canisters to storage, and crane maintenance.

The SFR and HVOS are necessary to maintain the cell air filtration function. The DGR is designed to withstand natural phenomena events so that back-up electrical power would be available to run the active HVAC confinement system components such as the exhaust fans that service the Vitrification Cell.

A failure of these structures and/or confinement equipment (such as doors, shield windows, and HVAC filter units) could result in an airborne radiological release. Liquid spills are contained by the stainless steel-lined pit and sumps within the reinforced concrete walls and floor of the Vitrification Cell.

The HLWTS provides for the pumping of HLW, in slurry form, from Tank 8D-2 to the Concentrator Feed Makeup Tank (CFMT), through a series of jumpers and double-walled steel piping systems supported in transfer pits and trenches.

C.5.2.2.1.2 Basis For Design

The basis for design of key confinement structures is found in design criteria WVNS-DC-022 and WVNS-DC-046. These documents derived their site-specific design basis events from the VF Preliminary Safety Analysis Report (PSAR [West Valley Nuclear Services Co., Inc. December 1986]). Table C.5.2.2.1.2-1 shows specific design codes and standards used for VF confinement barriers. Table C.5.2.2.1.2-2 shows the governing engineering codes and standards used in the confinement barriers' general design.

WVNS-DC-046, *Design Criteria, Sludge Mobilization Waste Removal System,* provides the basis for the design of the HLWTS. Codes and standards used in the design and fabrication of the HLWTS are given in Table C.5.2.2.1.2-3. Table C.5.2.2.1.2-4 shows the governing engineering codes and standards used in the HLWTS general design.

C.5.2.2.1.3 Design Basis Loads

The loads used for structural design and analysis include the following:

- Dead load (D)
- Live load (L)
- Thermal load (T_o)
- Internal pressure (P_o)
- Differential settlement (Δ)
- Snow load (S)
- Soil pressure load (H_{static}, $H_{hydrostatic}$, $H_{dynamic}$)
- Wind load (W)

- Tornado load (W_t)
- Seismic load (E_{DBE}).

Specific values used for design and analysis of these loads may be found in references discussed in subsequent sections discussing important structural confinement components.

The key natural phenomena hazards design basis loads used for the confinement barrier design include the following:

- Design Basis Earthquake (DBE) - Confinement structures are designed for a peak horizontal ground acceleration of 0.1g with design spectra and structural damping in accordance with U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.60 and 1.61 (1973), respectively. The vertical component of peak ground acceleration was taken as 0.067g, using scaled horizontal design spectra, specified in NRC Regulatory Guide 1.60. The DBE, so defined, has an annual frequency of occurrence of 5E-04 based on a median hazard curve from a site-specific probabilistic analysis (Dames & Moore August 17, 1983).

  The former reprocessing building (including the EDR and CPC) is supported on pile foundations, the Vitrification Building is supported on a reinforced concrete mat footing, and the HLWTS piping is supported in partially buried reinforced concrete trenches. A seismic separation joint exists between the former reprocessing building and the Vitrification Building to allow for differential movement and seismic ground wave effects. Differential movement and relative movement due to the passage of seismic ground waves were included in the design of various SSCs associated with the VF.

  The 0.1g DBE was established and accepted by the U.S. Department of Energy (DOE) (Hannum October 20,1983) in accordance with DOE guidance in effect at the time the work was performed.

- Design Basis Tornado (DBT) - Radiological confinement barriers are designed to assure confinement under DBT conditions. In general, confinement barriers may be damaged, but not breached due to DBT conditions. The DBT for the WVDP is established in Nicholas and Eagan (January 1983). The event has an annual frequency of occurrence at the West Valley site of 1E-06. The parameters used for the tornado wind and missile load analysis are:

  - Maximum wind speed 260 kilometers/hour (160 mph)
  - Tornado radius of 45.7 meters (150 ft)
  - Tornado rotational wind velocity of 180 kilometers/hour (110 mph)
  - A translational wind velocity of 80 kilometers/hour (50 mph)

- Peak pressure differential of 2,413 Pa (0.35 psi) from ambient atmospheric pressure.
- A rate of pressure change of 1,034 Pa/sec (0.15 psi/sec).
- Penetration and crushing effects of small, high-velocity missiles. The missiles used in the analysis are typical items that can be found on or near the site and are:

  (1) Wooden plank 0.10 meters x 0.30 meters x 3.65 meters (4 in x 12 in x 12 ft), 63 kilograms (139 lbs) weight at a velocity of 38 meters/second (85 mph).

  (2) Steel pipe 0.076 meters (3 in) diameter by 3.05 meters (10 ft) long, 33.4 kilograms (76 lbs) weight at a velocity of 22.35 meters/second (50 mph).

- Concrete building structures are designed for negative pressures with respect to the outside atmosphere of 746 Pa (negative 3 inch water column).

- <u>Design Wind Loads</u> - Building structures and equipment on the exterior of the buildings are designed for severe environmental conditions to the 100-year wind of 35.8 meters/second (80 mph) with peak gusts of 43.4 meters/second (97 mph). Wind pressure is analyzed using methods specified in ANSI A58.1, Exposure Condition C (American National Standards Institute, Inc. 1982).

- <u>Design Snow Loading</u> - Buildings and structures are designed for severe environmental conditions to a snow of 1,915 Pa (40 lbs/ft^2). Snow loads are relatively small compared to the other design requirement loads such as tornado, earthquake and gravity.

- <u>Reference Design Flooding</u> - A flood is not considered to be a hazard to the VF due to the site elevation above the local flood plain, and will not result in releases of radioactivity to the environment.

Earthquakes and tornadoes are the extreme environmental conditions that form the two critical design basis events that control the safety margins for natural phenomena hazards. These two design basis events meet or exceed DOE Order 6430.1A (U.S. Department of Energy April 6, 1989) and UCRL-15910 guidance for natural phenomena hazards as shown in Pomerening (April 1993).
Three groups of load combinations were used in the design:

a. <u>Normal Operating Load Conditions</u> - these are loads which are encountered during normal plant operations and shutdown and include dead, live, thermal, internal pressure and soil pressure loads.

b. <u>Severe Environmental Load Conditions</u> - these are loads that could infrequently be encountered during the plant life and include wind and snow.

c. <u>Extreme Environmental Load Conditions</u> - these are loads which are credible but are highly improbable and include tornado and earthquake.

Due to differences in the behavior and methods of design of concrete structures, steel structures, and piping systems, a different set of load combinations and acceptance criteria are used for each case.

<u>Concrete Structures</u>

The following nine load combinations have been considered in the design of the reinforced concrete portions (e.g., VF walls and HLWTS pits and trenches) of the confinement barriers:

a. <u>Normal Operating Conditions</u>

1. $U = 1.4\ D + 1.7\ L + 1.7\ H_{static}$
2. $U = 1.4\ D + 1.4\ T_0 + 1.4\ P_0$
3. $U = 1.05\ D + 1.3\ L + 1.05\ T_0 + 1.05\ P_0 + 1.05\ \Delta$

b. <u>Severe Environmental Load Conditions</u>

4. $U = 1.05\ D + 1.3\ L + 1.3\ H_{static} + 1.3\ W + 1.05\ T_0 + 1.05\ P_0$
5. $U = 1.4\ D + 1.7\ L + 1.7\ H_{static} + 1.7\ W$
6. $U = 0.9\ D + 1.3\ W + 0.9\ T_0 + 0.9\ P_0$
7. $U = 1.05\ D + 1.3\ W + 1.3\ H_{static} + 1.05\ T_0 + 1.05\ P_0$

c. <u>Extreme Environmental Load Condition</u>

8. $U = 1.0\ D + 1.0\ L + 1.0\ H_{static} + 1.0\ H_{dynamic} + 1.0\ T_0 + 1.0\ P_0 + 1.0\ \Delta + 1.0\ E_{DBE}$
9. $U = 1.0\ D + 1.0\ L + 1.0\ H_{static} + 1.0\ T_0 + 1.0\ P_0 + 1.0\ W_t$

For concrete structures, "U" is the section strength required to resist the design loads based on the strength design method described in the ACI 318 code. The load combinations used for the reinforced concrete design are based on the ACI 318 load requirements augmented with the ACI 349 load combinations for Design Basis Tornado and Design Basis Earthquake.

Steel Construction

The following six load combinations have been considered in the design of the structural steel portions of the confinement barriers:

a. Normal Operating Load Conditions

1. $D + L$
2. $D + L + T_0$

b. Severe Environmental Load Conditions

3. $D + L + W$
4. $D + L + W + T_0$

c. Extreme Environmental Load Conditions

5. $D + L + T_0 + E_{DBE}$
6. $D + L + T_0 + W_t$

The acceptable stress for the load combinations is as follows:

Load Combination	Stress Limit
1	1.0 S
2	1.5 S
3	1.33 S
4	1.5 S
5 and 6	1.6 S

"S" is the required strength in the steel members based on elastic design methods and allowable stresses defined in Part I of the American Institute of Steel Construction (AISC) Steel Manual (AISC, 1980). The combined stresses are not to exceed the steel yield stress. No increase in allowable stress has been permitted when designing connections including base plates and embedments. Thus, all connections have strengths in excess of the connecting members. Any overload due to extreme environmental conditions will result in ductile yielding of the members or buckling prior to brittle failure of the connections.

Piping

The following four load combinations were used in the design of the HLWTS piping:

a. Normal Operating Conditions

	Allowable Stress
1. $D + P_0$	S_h
2. T_0	S_A
3. $D + P_0 + T_0$	$S_A + S_h$

b. Extreme Environmental Load Conditions

	Allowable Stress
4. $D + P_0 + E_{DBE}$	$1.33\ S_h$

The allowable stresses for the stainless steel piping are in accordance with ASME/ANSI B31.3 with terms defined as follows:

S_h Material allowable stress at design temperature.
S_c Material allowable stress at room temperature.
$S_A = (1.25S_c + 0.25S_h)$

C.5.2.2.1.4 Structural Design Acceptance Criteria

The VF confinement structures are designed to meet the requirements of:

1) Building code standard practices, and

2) Design criteria requirements to withstand the design basis loads from extreme natural hazards without inelastic behavior.

The design is based on dynamic analysis of linear elastic soil-structure models of the primary confinement cells. The analysis used time-history motions for three simultaneous orthogonal directions to compute the earthquake response of the building structure. The time-history earthquake input motions to the model were synthetically generated to envelop the design basis response spectra in accordance with NRC Regulatory Guide 1.60 (NRC, 1973). The damping properties of the model were based on NRC Regulatory Guide 1.61 (NRC, 1973). Spatial attenuation of energy from structure-soil interaction was accounted for in the model.

The results of this dynamic analysis provided forces and floor motions at the various levels of the structure that were used in the design of the confinement structure (walls, roof, floors) and in the functional performance and anchorage requirements for equipment (primary filters, coolers, melter supports, etc.) within the structure designed for the induced loads resulting from the DBE.

Further details on the dynamic analysis performed by EBASCO for design and the independent review analysis by Dames & Moore are available in Gates (August 11, 1989) and in Pomerening (April 1993).

C.5.2.2.1.5 Independent Design Review

After the design was completed, an independent assessment of the structural integrity of the confinement barriers was performed by Dames and Moore. This assessment identified margins of safety and modes of failure under extreme environmental loadings, beyond the DBE and DBT. The results of these structural integrity analyses are summarized in tables that are presented in subsequent sections of this FSAR.

Safety margins reported in this FSAR for structures, tanks, structural supports, and piping represent the factor by which loads produced by the DBE or DBT can be increased before ultimate failure of the component will occur.

For the VF confinement structures, independent analyses were performed using the original models from the design, as well as totally independent models of the structure and supporting soil to validate the seismic analysis and to assess the potential margins of safety. The independent models incorporated detailed three dimensional plate element response for the walls and roof that were not incorporated in the simplified stick models used in the original design. Close agreement was found between the independent models and the simplified stick models, validating the original design analysis.

C.5.2.2.2 Modified Existing Structures

Once the HLW is processed from the liquid slurry form into the borosilicate glass waste form and confined within stainless steel canisters, it is considerably more stable and, therefore, less mobile during accident conditions. Chapter 9 of this FSAR establishes the fact that once the HLW is processed into this containerized glass waste form, substantial release to the public will not occur, even if the concrete structure confining the stored waste is damaged. For this reason, some areas such as the HLWIS need not have as much structural integrity as the Vitrification Cell and other locations containing highly dispersible radioactive materials. The HLWIS has been decontaminated and fitted with canister storage racks to accommodate the filled borosilicate canisters.

Structures that are not required to confine radioactive material, under accident conditions, are designed in conformance with the *New York State Code Manual for the State Building Construction Code* and to the *Uniform Building Code* (UBC) requirements. The original reprocessing plant structures, including the CPC, EDR, and 01-14 Building were built to seismic requirements of the 1961 UBC for Seismic Zone III.

The 1961 UBC Zone III seismic requirements for the reprocessing building produced base shears that were equivalent to design for a peak ground acceleration of 0.3g with possible structural damage but no collapse. To assess the building's earthquake capacity, two independent seismic analyses of the former nuclear fuel reprocessing building were performed in the 1970's for the NRC. One review was performed by Los Alamos National Laboratory (LANL) (1978) and the other by Lawrence Livermore National Laboratory (LLNL) (1977). These analytical reviews were further reviewed by expert consultants for the NRC, who concurred with the conclusions of the LANL and LLNL studies.

The studies by LANL and LLNL have shown that the former reprocessing building, including the CPC, has a margin of safety of > 1 x DBE against structural damage. The margin of safety against structural collapse is significantly > 1 x DBE.

C.5.2.2.3 New Non-Confinement Structures

Structures that are not required to confine radioactive material, under accident conditions, are designed in conformance with the *New York Code Manual for the State Building Construction Code* and to the UBC requirements as well as American Concrete Institute (ACI) and American Institute of Steel Construction (AISC) requirements as applicable.

C.5.2.2.4 Seismically Hazardous Equipment and Components

The seismically hazardous equipment and components have been structurally designed or reviewed for conformance with seismic design codes or DBE loading for the site. (See Table C.5.2.2.4-1.)

Equipment located in the Vitrification Cell is protected against wind, tornado, and tornado-generated missiles by the reinforced concrete cell, special doors, and shield windows. The cell operating conditions and pressures are not capable of generating internal missiles. Thus, only seismic loading is considered for the extreme environmental design of the potentially hazardous components and equipment and their structural supports or anchorage.

C.5.2.2.5 Soil Loads and Foundation Design

The former reprocessing building (including the EDR and CPC) is supported on pile foundations. The Vitrification Cell is supported on a reinforced concrete mat. A seismic separation joint of 76 mm (3 in) exists between the former reprocessing building and the Vitrification Building to allow for differential movement and seismic ground wave effects. The separation is filled with Rodofoam. Differential movement and relative movement due to the passage of seismic ground waves were included in the design. The building surrounding the Vitrification Cell is supported on spread footings and grade beams. The Cold Chemical Building and the Load-In Building are each on separate mats and the HLWTS piping is supported in partially buried reinforced concrete trenches.

Prior to the original reprocessing plant construction, soil investigations were conducted (Dames & Moore May 8, 1963) to determine the general soil conditions at the site and to obtain soil data directly relevant to the foundation design and construction. Piles were selected by Bechtel for the foundation support and 476 steel H piles were driven into the compact glacial till soil stratum which underlies the site and consists of a mixture of sand, gravel, silt and clay. The piles were driven to plant elevations between 9.8 m and 12.8 m (32 ft and 42 ft). Pile load tests and pile driving criteria are summarized in the Dames & Moore (July 19, 1963) report to Bechtel.

A comprehensive subsurface investigation was performed for the design and construction of the Component Test Stand (CTS) (Dames & Moore March 18, 1983). A subsurface investigation was performed (Dames & Moore June 1988) to verify that the conditions beneath select portions of the proposed VF were consistent with those encountered during the previous investigation for the CTS. In particular, there was some concern regarding the possibility of encountering fill near the EDR. The investigation indicated that conditions were consistent to those encountered beneath the CTS and the report recommended that the foundation design be based on the information included in the CTS report. The VF PSAR (Section C.4.2.9) and the HLWTS design criteria (WVNS-DC-046) provide soil and foundation design criteria. A confirmatory geotechnical investigation was performed in 1992 (Dames & Moore August 24,1992).

A description of the geotechnical background, boring locations, soil static and dynamic material properties, and the recommended parameters for foundation design are provided in other DOE-approved WVDP safety documentation (e.g., WVNS-SAR-001, Section A.3.6).

C.5.2.3 Confinement Barrier Structures

Figures C.5.2.1.1-1 through C.5.2.1.1-10 illustrate the primary confinement structures that have been designed to withstand natural phenomena events discussed in Section C.5.2.2.

Gates (January 25, 1994) analyzes the passive barriers provided by the concrete walls, doors, roof hatches, shield windows, etc. of these structures. Table C.5.2.3-1 summarizes the results of these analysis giving failures modes, intensity of the DBE or DBT to cause failure, and estimated frequency of the postulated failure. This table shows that the passive confinement barriers are designed to withstand the DBE and DBT accident conditions and have a low likelihood of failure.

Since the confinement barriers are only as good as their weakest component, it is necessary to consider all potential breach points in the confinement structure. These components are discussed in the following sections. Table C.5.2.3-2 shows the accident design conditions (DBE and/or DBT) that the confinement barriers are designed to withstand without loss of structural integrity. Tables C.5.2.3-1 and C.5.2.3-3 show the analyzed minimum safety margins for the structural confinement components.

C.5.2.3.1 Roof

The 838-mm (33-in) thick composite structural steel and cast-in-place (Q deck) concrete roof structure for the Vitrification Cell vault (shown in Figure C.5.2.1.1-4) has a computed margin against cracking of less than 1.0 due to the thermal gradients in the structure. This means that the underside of the concrete roof slab may have minor hairline cracks induced by thermal stresses in combination with dead load. As illustrated in Table C.5.2.3-1 the steel in the roof at mid-span yields at > 2.7 x DBE. This indicates the typical design margin, anticipated in reinforced concrete construction, has been conservatively maintained by the designers. Flexural failure is estimated to have a margin of safety > 3.5 x DBE. Based on engineering judgement and experience, roof collapse has a margin of safety > 3.5 x DBE.

Tornado generated missile penetration of the roof is estimated to have a margin of safety > 6 x DBT. This is the typical margin of safety, against tornado penetration, in all concrete portions of the structure. Note that Table C.5.2.3-1 also identifies the annual frequency that the extreme natural hazard will cause failure.

C.5.2.3.2 Walls

The 1,219-mm (48-in) thick concrete shield walls of the Vitrification Cell (see Figures C.5.2.1.1-5 and C.5.2.1.1-6) have more than adequate capacity to resist the DBE. Both the upper 660-mm (26-in) section and the 1,219-mm (48-in) sections of the shield wall have margins of safety against out-of-plane flexural failure of at least 3.5 x DBE. In terms of in-plane shear, the walls have very large safety margins, in excess of 6 x DBE.

C.5.2.3.3 Cell Doors

Figure C.5.2.1.1-1 through Figure C.5.2.1.1-3 show the special doors that are designed to maintain confinement integrity under various environmental loads. Table C.5.2.3-2 shows the environmental loads considered for design of the doors and indicates that doors used for confinement are enhanced by the use of an active HVAC confinement system. Not all doors are required to be designed for DBT missiles since they may be protected by outer doors on cell walls.

Failure of the doors is considered to occur when the door is breached by a tornado missile or the door is bent and torn off its hinge supports in response to a tornado missile rebound. Table C.5.2.3-1 indicates all exterior doors have a margin of safety against tornado missile-induced flexural failure of the door leaf > 1 x DBT (Gates August 12, 1992). The controlling missile for the door design was the wooden plank. It should be noted that the pipe missile used in the analysis of the door design was the 45.4-kg (100-lb), 76-mm (3-in) diameter, 3,048-mm (10-ft) long, schedule 80 pipe. This tornado missile was heavier than the 34.5-kg (76-lb) pipe missile specified in WVNS-DC-022.

C.5.2.3.4 Cell Shield Windows

The Vitrification Cell contains six shield windows and the CMR also has a shield window. Typical locations of the shield windows are shown in Figures C.5.2.1.1-5 and C.5.2.1.1-6 and a typical cut-away view of a window is shown in Figure C.5.2.1.1-7. These shield windows are an integral part of the Vitrification Cell confinement structure so their integrity during a DBE and/or DBT has been assessed (Gates January 25, 1994). As shown in Table C.5.2.3-1, the shielded windows have a safety margin > 2 x DBE.

Gates, et al. (August 11, 1989) addresses the resistance of a shield window to a tornado-driven missile. Simple analytical studies using principles of momentum and conservative assumptions on the characteristics of the glass have shown that under worst case assumptions, it is conceivable that the DBT missile could penetrate the glass layers of the window. The resulting penetration would be limited to a 102-mm (4-in) diameter hole due to the loss of momentum in the missile while passing through the layers of glass and oil. The HVAC system would maintain negative pressures in the cell and an inward air flow through the window penetration. Only during the peak negative pressure drop (suction phase) as the tornado passes over the building will local air be drawn out of the cell window. Thus, the release of contaminated cell air through the window penetration would be very limited in volume.

C.5.2.3.5 Cell Hatches

Figure C.5.2.1.1-4 shows the location of the Vitrification Cell hatch and the CMR access cover. As indicated in Table C.5.2.3-2, these items are anchored sufficiently to prevent uplift or rebound due to the DBT missile or during a DBE event. As can be seen from Table C.5.2.3-1, taken from Gates (January 25, 1994), the design of the Vitrification Cell hatch has a margin of safety > 10 x DBE and > 6 x DBT with the hatch cover welded.

C.5.2.3.6 Cell Pipe Penetration Seals

The Vitrification Cell has a series of pipe penetrations through the walls at various locations. There are five types of penetrations:

- Those used for the flow of fluids into the Vitrification Cell. These pipes have valves located on the ex-cell wall to isolate flow, and in-line backflow prevention valves when the process permits their use. The cold chemical slurry addition and the HLW transfer pipes, do not have backflow prevention valves. The frit addition line is plugged with shielding material and capped from the ex-cell wall.

- Those pipes that are used for flow to the in-cell process vessels, and where the process permits, have special backflow valves to prevent the flow of liquids and gases from in-cell to ex-cell.

- Unused pipe penetrations have been capped with a remotely removable cap on the in-cell side, have an isolation valve at the wall, and are sealed on the ex-cell side.

- Straight through penetrations have a shield plug inserted from the ex-cell side. The shield plugs are bolted into place to prevent slide out during a DBE.

- Electrical/instrumentation penetrations are pipes that are sealed on the ex-cell side.

Under DBT missile conditions, a few of the unused penetrations could be sheared off at the ex-cell wall face. This has no consequence since the in-cell side of the penetration has been capped. Further safety is provided by the HVAC system (Kupp August 23, 1989).

Under extreme DBT wind loads, the metal building on the exterior of the Vitrification Cell could be damaged and distorted to the extent that it would shear off some of the valved pipes at the ex-cell face. The resulting ruptured lines carry nonradioactive fluids and thus do not have radiological impact. The in-cell Off-Gas system and/or Vitrification Cell HVAC system will maintain a negative pressure on process vessels and lines carrying process fluids preventing escape of gases through these severed pipes.

C.5.2.3.7 High-Level Waste Transfer System

The HLWTS includes double-walled pipe lines designed to transfer the mobilized and treated wastes between the Tank Farm and the Vitrification Cell. The location of the tanks, pits, etc., is shown in Figure C.5.2.1.1-8. Table C.5.2.3.7-1 shows the function of each component and the primary and support barriers of the HLWTS. Transfer in the trenches is accomplished through double-walled, welded, stainless steel pipe. The single-walled jumpers are welded to PUREX couplers to accommodate remote removal. Any leakage in the pit, when the remote couplers are changed out, is contained by the stainless steel liner of the reinforced concrete transfer pit or pump pit.

Waste transfer operations begin with the transfer pump located in the reinforced concrete pump Pit 8Q-2. This stainless steel lined pump pit is located above Tank 8D-2 as shown in Figure C.5.2.3.7-1. A cutaway drawing of a typical pump and discharge line connection to the double walled transfer pipe is shown in Figure C.5.2.3.7-2. Pump pit jumpers are connected with specially designed "PUREX" connectors which can be removed using special reach rod tools to minimize personnel radiation exposures during maintenance and decontamination and decommissioning activities.

The pit is constructed of 610-mm (2-ft) thick reinforced concrete walls with a 305-mm (1-ft) thick concrete base mat poured on top of the existing tank vault. Each tank pit has a drain, with level detection conductivity probes, which drains back to the tank. The cover of the pit consists of a series of pre-cast reinforced planks that have an epoxy seal on the underside and rubber gaskets between the plank joint surfaces to minimize air flow into the pit and to facilitate decontamination of the surfaces. Other special provisions such as caulking small cracks are taken to seal air leaks into the pits. Holes with special plugs have been provided through the pit covers to permit manual control of the jumper valves. Compression seals are used around valve reach rods to prevent leakage at these penetration points.

Ventilation to the pits is normally supplied by the Tank Farm Ventilation system, which is supplied to the pits via the drain line to the respective tank. Off-gas from this ventilation system exhausts to the Main Plant stack after passing through a filter train, having redundant moisture separators, heaters, and High-Efficiency Particulate Air (HEPA) filters. A slight negative pressure is maintained on the pits due to the tightly sealed pit cover.

During maintenance activities, when the cover is removed and more ventilation air volume is needed, the pits are ventilated to the Permanent Ventilation System (PVS) via a nominal size 203-mm (8-in) schedule 10, 304L stainless steel line that is routed in the transfer trench to each pit. This line connects to the 610-mm (2-ft) stainless steel PVS vent line which normally provides ventilation for the Supernatant Treatment System (STS) operations (discussed in other DOE-approved WVDP safety documentation). This ventilation system has redundant ventilation trains, each containing a mist eliminator, heater, roughing filter, and two HEPA filters in series. The filtered air is exhausted to the PVS stack (discussed in other DOE-approved WVDP safety documentation).

An isometric drawing showing the primary components and jumpers of Pit 8Q-2 is given in Figure C.5.2.3.7-3. A Piping and Instrumentation Drawing (P&ID) of Pit 8Q-2 is shown in Figure C.5.2.3.7-4. The transfer pump, located in Pit 8Q-2, pumps the Tank 8D-2 slurry to the CFMT in the Vitrification Cell through one of two redundant transfer lines. Valving in Pit 8Q-2 provides path control for liquid transfer paths such as the transfer of Tank 8D-2 waste through size reduction equipment or transfer to the CFMT. The pump discharge piping is coupled to the double-walled transfer pipe of the Transfer Trench with a single-walled pipe (jumper), as shown in Figure C.5.2.3.7-2. As shown in the figure, the single-walled jumper transitions to the double-walled transfer pipe at the pit/Transfer Trench wall.

The Transfer Trench contains piping for transfers both to and from the waste tanks and the Vitrification Cell. The trenches are constructed of reinforced concrete walls and footings with precast concrete covers, as illustrated in Figure C.5.2.3.7-5. The trench walls range in thickness from 457 to 610 mm (1.5 to 2 ft) and the roof covers are 610 mm (2 ft) thick. The floor slab of the trench is 305 mm (1 ft) thick. The trench is approximately 3,048 mm (10 ft) wide and ranges in height from 1,829 to 2,743 mm (6 to 9 ft).

The double-walled stainless steel piping within the trenches is supported on carbon steel box tube sections that have been welded with clip angles to vertical embedded plates in the walls of the trenches (see Figure C.5.2.3.7-5). All pipe connections within the trench are welded. The double-walled pipes provide double containment and a means to detect any leaks that develop in the inner pipe.

Diversion Pit 8Q-5 (shown in Figure C.5.2.1.1-8) is a piping control point located between the tank pits and the Vitrification Cell. The pit is constructed similarly to Pit 8Q-2. It provides valving arrangements to route HLW from Tank 8D-2 to the CFMT and routes return waste solutions from the Vitrification Cell to the Tank Farm tanks. The Waste Header and Condensate return lines do not require jumpers and are "hard-piped" through an adjacent concrete chamber of the 8Q-5 Pit, because they are gravity drained and require no maintenance. A P&ID drawing of Pit 8Q-5 is shown in Figure C.5.2.3.7-6. The pit floor drain line is routed from Pit 8Q-5 through the

Transfer Trench (which has a floor level lower than Pit 8Q-5) to Pit 8Q-2, where it drains to the floor of that pit. Once on the floor of Pit 8Q-2, the liquid is drained into Tank 8D-2.

To accomplish a transfer from Tank 8D-2 to the CFMT, the valves in Pits 8Q-2 and 8Q-5 are properly aligned to send the waste through one of the two redundant lines. The flow controller is set to transfer a predetermined batch volume of waste to the CFMT at a specific flow rate. Normally, approximately 13.25 m^3 (3,500 gal) of waste is batch transferred to the CFMT at approximately 15 weight percent solids concentration. The pump controller automatically shuts down the transfer pump when the preset volume is transferred. Section C.5.7.2 discusses control and leak detection systems of the HLWTS.

Adjoining each pump pit is a reinforced concrete underground compartment coupled to the pump pit wall called a utility pit. Inside the utility pit are the isolation valves for the pit utility jumpers and supply utilities, such as utility water. The utility pit is covered with a removable sheet metal roof. All utility (nonradioactive) piping within these utility pits is single-walled.

The Transfer Trench does not have a ventilation system, since all lines transferring process liquids within the trench are double-walled pipe, which drain to the floor of one of the pits. The Transfer Trench and pits are restricted access areas, requiring industrial and radiation work permits (specifying work precautions, required protective clothing, and equipment) for entry.

The HLW Transfer Trench and pits provide formed enclosures and radiation shielding, but are not designed to provide the primary engineered confinement barrier for the HLW during transfer. These structures eliminate live loads, soil pressure loads, wind loads, or tornado loads on the transfer piping which is the actual waste confinement barrier. Independent analysis of the HLWTS structural components is reported in Gates (January 28, 1994; September 23, 1994). The reported vulnerabilities (expressed as a multiple of design basis accident events) are shown in Table C.5.2.3-3. The table indicates that the margin of safety of the double-walled stainless steel piping in the trenches exceeds 4 x DBE. The safety margins against ultimate failure due to seismic loading of the pipe support structures, in the trenches, exceed 2 x DBE. A failure of the pipe support does not necessarily lead to a breach of confinement by the piping. The single walled stainless steel jumpers and their components, in the pump pits and transfer pits, have a margin of safety > 3 times the DBE. However, the connecting PUREX couplers have an estimated margin of only 1 x DBE.

C.5.2.4 High-Level Waste Interim Storage & Equipment Decontamination Room

Information on the EDR and HLWIS (formerly the CPC) is provided in Section C.5.2.7.

C.5.2.5 New General Construction

The metal building, shown in Figure C.5.2.1.1-1, that surrounds the engineered confinement structures has not been designed for DBE or DBT conditions. This structure has been designed to satisfy design provisions of the UBC. It is assumed that under design basis events, this outer metal structure fails and plays no part in the confinement of radioactive materials within the Vitrification Cell. However, special precautions have been taken in the design of the cell wall penetrations, as discussed in Section C.5.2.3.6. (Further information on the metal building surrounding the Vitrification Cell, the Cold Chemical Building, and the Diesel Fuel Storage Building is found in Section C.5.2.7.)

C.5.2.6 Seismically Hazardous Equipment and Components

The primary inventories of radioactive liquids and solids are contained in process vessels located in the Vitrification Cell pit.

There are major vessels, equipment and components within the Vitrification Cell that are designed to maintain structural integrity during potential seismic events in order not to be challenges to the confinement barrier or threats to adjacent components if they were not capable of surviving seismic events. These have been designed with consideration for seismic forces and include the following:

- Vitrification Cell Crane system
- Vitrification Cell In-Cell Coolers
- Slurry-Fed Ceramic Melter (SFCM)
- Process Tanks (CFMT, Melter Feed Hold Tank [MFHT], Submerged Bed Scrubber [SBS])
- Canister Turntable
- Canister Storage Rack (in-cell)
- Canister Weld Station
- Canister Decontamination Station
- Canister Transfer Cart
- Vitrification Cell (Process) Off-Gas system.

- In-Cell Maintenance Station

Figures C.5.2.1.1-9 and C.5.2.1.1-10 illustrate some of the seismically hazardous components and equipment within the Vitrification Cell.

The most significant accident postulated to occur within the Vitrification Cell is seismically induced collapse of the SFCM onto the adjacent process tanks. Any overhead equipment such as the crane trolleys and girders, overhead coolers, etc., that might fall on the SFCM or process vessels represents a seismic hazard. The above equipment and vessels have been identified as representing seismic hazards and consequently have been reviewed to determine their capacity to survive the DBE without collapse or impact on adjacent vessels. Of similar significance are the HVAC confinement barrier components (e.g., primary filters) in the Vitrification Cell.

The SFCM is of primary concern during DBE conditions because of its large mass of hot molten glass and its elevated location on top of a 4,267-mm (14-ft) high support truss. Special restraints have been added to this vessel to prevent its collapse under the DBE. The three process vessels (CFMT, MFHT, and SBS) contain a large inventory of liquid HLW. These three vessels were designed under the UBC Seismic Zone 3 forces with an importance factor of 1.5. (See Table C.5.2.2.4-1.) Since the UBC static design approach does not provide for the actual assessment of the interaction between the tanks on their flexible support frame, there is a potential for continuous contact/impact (pounding) between the tanks resulting in dynamic impact loads and potential breach of the vessels. A dynamic analysis was performed to assess the safety margins on all three vessels, as well as the SFCM, Canister Turntable and in-cell Canister Storage Rack, to assess the margins of safety against structural collapse or breach of vessel integrity due to pounding. The result of these analyses are reported in Gates and Gorman (September 22, 1994; September 21, 1994; September 26, 1994) and Gates (January 27, 1994).

These analyses show that all major process components in the Vitrification Cell pit have a seismic design capacity sufficient to prevent their ultimate failure or collapse from extreme environmental loading, in excess of the DBE. Furthermore, the three tanks will not pound together, causing them to lose their structural integrity. However, they may lose their functionality (e.g., could lose their gravity feed lines) during a DBE.

Independent dynamic analysis (Gates January 27, 1994) of all the process components in the Vitrification Cell pit has shown that, under the DBE, none of the components will cause damage to another component resulting in loss of structural support or vessel integrity. Furthermore, the analysis showed that the overhead equipment (e.g., crane, coolers) will not collapse on the vessels in the pit or the primary filters of the HVAC confinement system. Table C.5.2.6-1 illustrates what components within the Vitrification Cell are at risk of being damaged by seismically induced failure of an adjacent or above component within the cell. The table also discusses consequences and mitigative circumstances of component failures to process operations. Table C.5.2.6-2 shows a summary of the vulnerability assessment in terms of the modes of failure and safety margins against collapse of seismically hazardous components within the Vitrification Cell.

An in-cell Maintenance Station was added to the east wall of the Vitrification Cell after the commencement of radiological operations. The Station provides a work surface for performing maintenance activities, including the remote repair of in-cell equipment using remote manipulators. The Station was designed to support a total load of 1,361 kg (3,000 lb), spread over a 381 mm by 381 mm (15 in by 15 in) area anywhere on its work surface. Analysis shows that the Maintenance Station frame and supports have considerable margins of safety against collapse under DBE loads (Dames & Moore September 30, 1996). Additional analysis shows acceptable structural performance of the Maintenance Station even with two waste cans (each weighing 364 kg {800 lbs}) hanging from the Maintenance Station (WVNS, September 23, 1999).

C.5.2.6.1 Vitrification Cell Crane

The Vitrification Cell crane (shown in Figure C.5.2.1.1-9) is designed and tested in accordance with crane standards Crane Manufacturers Association of America (CMAA) Specification No. 70, Service Class C and ANSI B30.2, *Overhead and Gantry Cranes*. Operation of the crane is not required during a seismic event, but the bridge and trolley are required not to fall from their support rails during a DBE event. The computed margin of safety against uplift of the crane girder or trolley from their rails is > 1.7 x DBE.

C.5.2.6.2 In-Cell Fan Coolers

The Vitrification Cell has four large cooler units that are attached to the under side of the roof in the Vitrification Cell. The location of these coolers is shown in Figures C.5.2.1.1-9 and C.5.2.1.1-10. These coolers are structurally designed to maintain integrity, but not necessarily functionality, during and after the occurrence of a DBE. Loss of structural integrity of one or more of the in-cell coolers could lead to the coolers (or parts of the coolers) falling on and damaging equipment in the Vitrification Cell. As with the discussion of failure of the cell crane, the largest concern is potential damage to the in-cell HVAC confinement system and the process vessels in the pit.

The in-cell cooler design was reviewed in Gates and Gorman (September 22, 1994). The analysis shows that the hanger supports, support frame, and components attached to the cooler frame have considerable margins of safety against collapse under DBE loads. The lowest margin of safety (6.0 x DBE) is associated with buckling of a support frame element of the cooler.

C.5.2.6.3 Melter and Supports

The brick-lined steel-frame vitrification SFCM (shown in Figures C.5.2.1.1-9 and C.5.2.1.1-10) is supported on a steel truss frame at approximately elevation +30.63 m (+100.5 ft), directly above the pit in the Vitrification Cell and adjacent to the northeast corner walls. The SFCM rests on four steel wheels that roll on a rail system located on top of the support frame. It has been designed to be removable from the cell for replacement or maintenance purposes.

For purposes of restraint, four horizontal braces have been attached to a circumferencial structural belt located at mid-height of the SFCM to restrain it from rolling along the steel rail system or collapsing the support frame. Due to thermal expansion of the SFCM, the restraint arms were designed with slotted or oversized holes to accommodate SFCM expansion caused by normal operating temperature or accidental loss of coolant in the melter jacket.

A finite-element analysis was performed on the melter seismic restraint and vertical support frame (Gates and Kasar August 12, 1991). This analysis included thermal loads and DBE response spectra generated for the base of the Vitrification Cell. This study shows that the melter's restraints will prevent the melter from toppling and the refractory in the melter will not fail during a DBE. The margin of safety against potential failure generally exceeds 2 x DBE as shown in Table C.5.2.6-2.

C.5.2.6.4 Pit Process Vessels and Tank Support Frame

The three vessels (CFMT, MFHT, and SBS) are supported on a common structural steel frame that is seated on bearing plates anchored to the process pit floor. The frame is comprised of a grid of A36 carbon steel I-beams. Each of the three tanks has a different support detail. The CFMT and SBS have support skirts that are bolted to the frame, while the MFHT rests directly on the support frame. The CFMT and SBS support details allow for remote installation and removal of the tanks from the support frame using an impact wrench.

The CFMT is a 3,048-mm (10-ft) outer diameter and 4,267-mm (14-ft) tall cylindrical tank. The stainless steel shell is 9.5 mm (0.375 in) thick. The top of the tank has numerous penetrations, which accommodate the various jumper nozzles, instrumentation, etc. The bottom of the tank is supported on a 660-mm (26-in) high, 9.5-mm (0.375-in) thick stainless steel skirt. The skirt is welded to a 25-mm (1-in) thick skirt flange that is bolted to a 51-mm (2-in) thick stainless steel mounting ring welded to the tank support frame.

The MFHT is a 3,048-mm (10-ft) outer diameter and 3,048-mm (10-ft) tall cylindrical tank. The stainless steel shell is 12.7 mm (0.5 in) thick. The MFHT is vertically supported on the 12.7-mm (0.5-in) thick stainless steel cover plate over the tank support frame. No positive attachment against uplift is provided. Lateral support is provided by four 102-mm (4-in) diameter trunnions. The trunnions are welded to the tank shell and are seated in trunnion guides that are welded to the tank support frame.

The SBS is an 2,438-mm (8-ft) outer diameter and 3,505-mm (11.5-ft) tall cylindrical tank. The stainless steel shell is 9.5 mm (0.375 in) thick. The tank is supported on a 584-mm (23-in) high, 19-mm (0.75-in) thick stainless steel skirt. The support skirt is welded to four 51-mm (2-in) thick stainless steel support plates. The 51-mm (2-in) thick support plates are seated on four 25-mm (1-in) thick base plates attached to the tank support frame with remote release pins.

Dames & Moore conducted an independent analysis of the tank support frame with all three tanks on the frame (Gates and Gorman September 29, 1994). The results of this analysis show that the component which is most likely to fail during a DBE is the common support beam under the tanks, as shown in Table C.5.2.6-2. This component has sufficient reserve capacity, due to inherent safety factors provided in the design, to withstand the DBE without loss of structural integrity leading to beam collapse. The minimum safety margins against ultimate failure, due to seismic loading for the support structure, exceed 2.2 x DBE. If the support beam were to fail, the three tanks (that rely on this beam for their vertical stability) could pound together leading to possible vessel leakage. Thus, 1.4 x DBE is the minimum margin of safety for all three tanks.

C.5.2.6.5 Canister Turntable

The Canister Turntable is located in the process pit of the Vitrification Cell. Loss of structural integrity of the turntable could cause the turntable, or canisters stored in it, to impact (collide with) other equipment in the pit, such as the melter support frame.

The independent dynamic analysis of the turntable design, reported by Gates and Gorman (September 26, 1994), states that the turntable has sufficient structural capacity to withstand the DBE without loss of structural integrity, and sufficient separation to prevent it from pounding into the melter support frame. Calculated safety margins against ultimate failure are shown in Table C.5.2.6-2. The smallest margin exceeds 3 x DBE.

C.5.2.6.6 In-Cell Canister Storage Rack

The in-cell Canister Storage Rack is a braced stainless steel frame designed to store both empty and full canisters. The independent analysis of the storage rack design, reported by Gates and Gorman (September 21, 1994), concluded that the rack has a sufficient margin of safety to maintain structural integrity during a DBE. The lowest margin of safety found (1.5 x DBE) is associated with the buckling failure of a main transverse frame brace.

C.5.2.6.7 Canister Weld Station

The Canister Weld Station has been designed for structural integrity and anchorage under UBC Seismic Zone 3 forces with an importance factor of 1.5. Based on experience and engineering judgement, the margins of safety of the Canister Weld Station have been conservatively assessed as being > 1.8 x DBE.

C.5.2.6.8 Canister Decontamination Station

The Canister Decontamination Station has been designed for structural integrity and anchorage under UBC Seismic Zone 3 forces with an importance factor of 1.5. Based on experience and engineering judgement the margins of safety of the Canister Decontamination Station have been conservatively assessed as being > 1.9 x DBE.

C.5.2.6.9 Canister Transfer Cart

The Canister Transfer Cart loaded with filled canisters is in the Vitrification Cell for a very limited time during vitrification operations. Approximately 300 canisters will be produced, requiring at least 75 cart trips to transport them. Assuming one hour per cart trip and a 30 month vitrification campaign, the fully loaded cart is in the Vitrification Cell less than 0.4% of the time. The frequency of a design basis seismic event is approximately 5E-04 per year. Hence, the likelihood of the cart being in the Vitrification Cell during a DBE event is less than 2E-06 per year.

C.5.2.6.10 Vitrification Cell Process Off-Gas System

The seismic behavior of the in-cell off-gas support framework and interconnected process components has been reviewed for structural integrity and anchorage requirements. The in-cell off-gas support framework has been designed for structural integrity and anchorage under UBC seismic Zone 3 force with an importance factor of 1.5. Information on the Process Off-Gas system is provided in Sections C.5.2.7.4 and C.6.3.

C.5.2.7 Other Structures

This section provides further information on several structures that are not in the category of confinement barriers required to remain functional under site-specific design basis events. The structures considered in this section include:

- The Vitrification Building surrounding the Vitrification Cell
- The Cold Chemical Building
- The Diesel Fuel Oil Storage Tank Building
- The off-gas pipe trench and portions of the 01-14 Building
- The CPC
- The EDR
- The Load-In Building

C.5.2.7.1 Vitrification Building

The sheet metal building surrounding the Vitrification Cell provides protection from the environment for workers and certain equipment and instrumentation. The sheet metal building is designed to meet the requirements in the *New York State Code Manual for the State Building Construction Code*. General arrangements are shown in Figures C.5.2.7.1-1 through C.5.2.7.1-8.

C.5.2.7.2 Cold Chemical Building

The Cold Chemical Building houses several tanks and associated pumps that mix the glass formers which are used for the vitrification process. These tanks and pumps do not contain or process radioactive materials or liquids. The Cold Chemical Building is 10.4 meters (34 ft) wide and 17.2 meters (56.5 ft) long, and is a structural steel frame and sheet metal structure designed to the *New York State Code Manual for the State Building Construction Code*. The Cold Chemical Building Ventilation system is independent of the Vitrification Building Ventilation system. General arrangements for the Cold Chemical Building are shown in Figures C.5.2.7.2-1 through C.5.2.7.2-3.

C.5.2.7.3 Diesel Fuel Oil Storage Tank Building

The Diesel Fuel Oil Storage Tank Enclosure, which protects the storage tank and transfer pump from adverse environmental conditions, is shown in Figure C.5.2.7.3-1.

The Enclosure consists of a structural steel frame and sheet metal covering and is 6.4 meters (20.9 ft) by 4.3 meters (14.3 ft).

C.5.2.7.4 Off-Gas Pipe Trench and 01-14 Building

After initial conditioning in the Vitrification Cell, off-gas from the process equipment is routed to the 01-14 Building where it is passed through a reheater, a final set of HEPA filters, the off-gas blowers, and the NO_x abatement system. It is then exhausted to the nominal 60-meter (197-ft) main stack. See Section C.5.5.4 for process design information on the ex-cell Off-Gas system. The off-gas is transferred between the two process buildings by an all-welded, nominally sized 254-mm (10-in), schedule 10, 304L stainless steel pipe, which is supported in the concrete Off-Gas Trench. This trench is schematically shown in Figure C.1.2-1. Figure C.5.2.7.1-1 is a general arrangement drawing showing the trench as it leaves the Vitrification Building. (See coordinates K9.) Figure C.5.2.7.4-1 (Page 2) shows general arrangement details of the trench from the Vitrification Building to the 01-14 Building.

Anhydrous ammonia is stored in the above-ground ammonia storage tank (64-D-004), which sits on a concrete pad above the off-gas trench adjacent to the 01-14 Building at the southwest end of the Main Plant. The vertical tank is supported on four steel angle section legs. It is 1.07 meters (3.5 ft) in diameter and 5.2 meters (17 ft) high. The total working volume of the tank is 3.78 m^3 (1,000 gal).

Fabrication, installation, and testing of the ammonia storage tank and supply subsystem for the NO_x abatement system has been performed in accordance with the latest edition of ASME Section VIII - Division 1 and the requirements of 28 CFR 19190.111, the recommendations of the Compressed Gas Association (CGA) Pamphlet G-2, and the American National Standards Institute (ANSI) Pamphlet K61.1.

The ammonia storage tank is designed to standard commercial practice for ammonia tanks that pose the same hazard as the WVDP ammonia storage tank. No evaluation has been made of the tank's ability to withstand a DBT wind or DBT generated missile. The structural design of the ammonia storage tank is based on ASME Boiler & Pressure Vessel Code, Section VIII, Division 1 (and U stamped), ASME B31.3 Chemical Plant and Petroleum Refinery Piping Code, and the 1988 UBC for seismic loads. The structural design loads include 1,724 kPag (250 psig) pressure, 40.2 m/s (90 mph) severe environment wind and minimum 0.3g horizontal seismic load.

C.5.2.7.5 CPC and EDR

The primary function of equipment originally located in the CPC was the dissolution and handling of fuel. Additional cell vessels supported concentration and adjustment of process solutions. The CPC has been selected to provide storage of borosilicate glass in canisters as part of the HLWIS.

The CPC is located on the northwest side of the main process building at the 30.5-m (100-ft) elevation. The cell is 28.3 meters (93 ft) long north to south, 6.7 meters (22 ft) wide, and 13 meters (43 ft) high. The walls are of reinforced concrete 1.8 meters (5.9 ft) thick. The cell floor is lined with 304 stainless steel, which extends up the wall 0.46 meters (1.5 ft) from the floor. Above the stainless steel liner, the interior concrete surface is coated with a radiation resistant paint.

Access to and from the CPC is available through the EDR and a Crane Maintenance Room. The CPC Crane Maintenance Room is located at the north end of the CPC and is accessible through a vertical-lift 0.9-meter (3-ft) thick shield door. The Crane Maintenance Room allows isolation of cell cranes from the CPC for maintenance purposes. Access to the EDR is through a tunnel with a concrete filled shield door. The shield door is 3.4 meters (11 ft) wide, 1.2 meters (4 ft) thick and 4.3 meters (14 ft) high and moves horizontally in an east-west direction.

Four shield windows support operations in the CPC. Three windows are located along the west wall in the Chemical Viewing Aisle (CVA). The fourth window, located in the north wall, permits viewing along the length of the cell. Shielding is provided by separated slabs of lead glass filled with mineral oil.

The CPC crane bridge is mounted on the upper of two sets of rails in the CPC. The upper set of rails is at an elevation of 42.2 m (138.3 ft). This unit is equipped with a 14.5-MT (16-ton) trolley-mounted hoist used for heavy lifting and a 1.8-MT (2-ton) trolley-mounted hoist, which is used for jumper placement. The crane equipment is controlled remotely from any of three consoles that may be plugged into either of two electrical outlets in the CVA or into an outlet in the aisle south of the CPC Crane Maintenance Room viewing window. A second set of rails at elevation 40.54 m (133 ft) provides travel for the second crane bridge. The bridge is equipped with a power-operated manipulator and a trolley-mounted 1.8-MT (2-ton) hoist. The unit is controlled from a portable console that may be plugged into either of two electrical outlets in the CVA or the outlet in the operating aisle south of the viewing window in the CPC Crane Maintenance Room.

Rails on the west side of the cell floor provide for movement of the transfer cart between the Vitrification Cell, EDR, and CPC.

The EDR served as a transfer station for equipment going into the CPC and as a decontamination and transfer area for equipment removed from that cell. In support of interim storage of vitrified HLW, this room serves as the transfer interface between the Vitrification Cell and the CPC. Transfer of empty canisters from the

Load-In Building to the Vitrification Cell and filled canisters from the Vitrification Cell to the EDR is via the shielded Transfer Tunnel.

The EDR is located at the northwest corner of the process building at elevation 30.5 m (100 ft). The room is 13.3 meters long x 9.8 meters wide x 7.6 meters high (43.75 ft x 32 ft x 25 ft). The EDR is serviced by two 9-MT (10-ton) hoist/trollies on a single bridge with rails at elevation 37 m (121.5 ft). Bridge travel is east-west. A battery powered, radio controlled transfer cart runs on rails into the CPC. The transfer cart is controlled from either the Vitrification Building or the north CVA.

LANL analyses for the EDR and CPC showed lateral pile failure at 0.14g and no other failure below 0.2g (Los Alamos National Laboratory 1978). LLNL analyses for the EDR and CPC conservatively showed lateral pile failure at 0.11g, and for the CPC onset of failure (cracking) of one wall at 0.15g (Lawrence Livermore National Laboratory 1977).

General arrangements for the EDR and CPC are shown in Figures C.5.2.7.5-1 through C.5.2.7.5-3.

C.5.2.7.6 Load-In Building

The Load-In Building is located west of the EDR and is designed to utilize the EDR as primary access for moving canisters and equipment into and out of the Vitrification Cell and/or HLWIS, as necessary. The Load-In Building is also used as the staging area to temporarily store the cold chemicals needed for melter feed preparations since the Cold Chemical Building does not have adequate space for this function. The Load-In Building concrete base mat and steel structures are designed to withstand a DBE of 0.1g. Refer to Section C.6.4.1 for more information on the Load-In Building.

C.5.2.7.7 Applicable Codes, Standards, and Specifications

The design criteria for many of the structures discussed in this section (i.e., Section C.5.2.7) are stated in Chapter 4 of this FSAR. Codes, standards, and specifications for the Vitrification Building, Cold Chemical Building, Diesel Fuel Oil Storage Tank Enclosure, and Off-Gas Trench are also indicated in the design documents previously cited for those structures and in the *New York State Code Manual for the State Building Construction Code*. Principal design criteria for the CPC and EDR are discussed in other DOE-approved WVDP safety documentation and in Section C.5.2.2.2 of this FSAR. The design criteria for the Load-In Building is provided in WVNS-DC-066.

C.5.3 Vitrification Support Systems

Various systems support accomplishment of the vitrification process. They include the HVAC systems, power systems, compressed air systems, cooling water systems, drain systems, fire protection system, and the steam and condensate system. These systems are discussed in this FSAR in Sections C.5.4.1, C.5.4.2, C.5.4.3, C.5.4.6, C.5.4.11, C.5.4.9, and C.5.4.4, respectively. These types of systems (especially power, cooling water, and air) are considered "support" systems in risk assessments for commercial nuclear power plants.

Other types of systems or components that could be considered to serve in a support role are discussed in Chapter 6. These include the Cold Chemical systems (CCS), the Off-Gas system, and the Waste Header system. Chapter 6 also discusses mechanical systems, including canister handling equipment, the Load-In Building, manipulators, cranes, and the transfer cart.

C.5.4 Service and Utility Systems

C.5.4.1 Heating, Ventilation, and Air Conditioning Systems

The HVAC systems maintain a suitable thermal environment and acceptable air quality to ensure personnel health, safety, and comfort. A primary function is to ensure that air flows from areas of less potential for contamination to areas with a higher potential for contamination. HVAC systems also contribute to proper equipment operation and to maintaining the integrity of structures. The HVAC equipment that services the Vitrification Cell is designed to minimize the release of radioactive and other hazardous materials via exhaust effluent during normal operations, anticipated off-normal operational occurrences, and design basis accidents (DBAs), including severe natural phenomena and manmade events.

The release point from each ventilation system is located in such a manner as to minimize the possibility of the released air being drawn back into a fresh air intake. Exhaust from potentially contaminated areas is appropriately filtered and discharged. The Vitrification Building and Cold Chemical Building exhaust release points are shown on Figure C.5.4.1-1.

Provisions are made to ensure continuous and uninterrupted air flow during normal operations including maintenance and stand-by conditions. These provisions incorporate the following features:

- Systems are designed with redundancy and/or diversity where required to improve reliability.

- Filtration train flow rates are limited to less than 11.8 m^3/s (25,000 cfm).
- Instrumentation is used to automatically control the volume through supply and exhaust systems in the event of shutdown or reduced exhaust flow.
- Parallel or redundant filtration trains are connected to common exhaust ductwork to improve reliability.
- Filter change-out is designed to be accomplished with minimum exposure to personnel and minimum release of contaminants outside the housing.
- Filter housings are readily accessible to assist in filter change-out.
- Access to and maintenance of HVAC equipment does not require removal of HVAC ductwork. Access is provided for maintenance and testing.
- Redundant fans connected to common ductwork use isolation valves to prevent recirculation through the idle fan and facilitate maintenance.
- Test sections and connections are provided for HEPA filters to confirm leak tight installation and efficiency.
- Component design and testing in accordance with ANSI/ASME N509 and ANSI/ASME N510, as applicable.

The following HVAC systems or components are associated with vitrification operations and are discussed in subsequent subsections.

- Vitrification Building HVAC
- In-Cell Coolers
- VF Control Room HVAC
- Diesel Generator Room HVAC
- Cold Chemical Building HVAC
- 01-14 Building HVAC
- Main Plant HVAC and Head End Ventilation
- Pump Pit Ventilation.

C.5.4.1.1 Vitrification Building HVAC

The Vitrification Building HVAC system provides for area temperature control and is instrumental in confinement of airborne radioactivity by directing air flow from areas of low potential for contamination to areas of successively higher potential for contamination. Three confinement zones are defined for this purpose. Zone I consists of those areas that are expected to contain a significant amount of airborne activity during normal operations. This zone includes the Vitrification Cell, Transfer Tunnel, and CMR. Zone II consists of the operating areas and other potentially contaminated areas surrounding Zone I. Zone III designates areas inside the Vitrification Building that are expected to be free of contamination (e.g., the Main Control Room). Figures C.5.4.1.1-1 and C.5.4.1.1-2 show the zones.

Figure C.5.4.1.1-3 shows the key components of the Vitrification Building HVAC system. The Ventilation Supply system provides HEPA filtered and conditioned air (i.e., heated or cooled, as appropriate) to equipment and/or working areas. The Ventilation Exhaust system is a filtered system balanced to maintain potentially contaminated areas below atmospheric pressure and prevent unfiltered outleakage of airborne radioactive material.

Design Basis

The Vitrification Building HVAC system was designed to:

- Maintain release of radioactivity and airborne particulates within the limits of DOE Order 5480.1, Section XI, *Environment Safety and Health Program for U.S. Department of Energy Operations* (U.S. Department of Energy September 23, 1986) and DOE Order 5480.10, *Contractor Industrial Hygiene Program* (U.S. Department of Energy June 26, 1985).

- Meet applicable requirements of DOE Order 5480.11, *Radiation Protection for Occupational Workers* (U.S. Department of Energy December 21, 1988).

- Maintain an air flow pattern (cascade) from areas of less potential for contamination to areas with a higher potential for contamination.

- Prevent unfiltered outleakage of airborne radioactive material.

- Minimize the spread of airborne radioactive contamination by locating the primary HEPA filters as close as practical to the source of contamination.

- Continue to provide confinement of radiological and hazardous materials (located in Zone I) during and after the occurrence of a DBA or design basis natural phenomena event.

- Reduce the potential for airborne particulates by supplying HEPA-filtered air (except to the chiller room).

- Provide HEPA filters between Zone I and Zone II areas to assure that inadvertent backflows (due to an upset condition) from Zone I areas are HEPA-filtered before being transferred to the facility and then to the atmosphere.

- Minimize particulate loadings on the HEPA exhaust system by the use of prefilters in the exhaust train and by prefilters and HEPA filters in the supply system.

- Maintain ambient temperature below 29.4°C (85°F) (summer) and above 18.3°C (65°F) (winter) in Zone II and Zone III areas. (Note: Zone I is maintained by the in-cell coolers discussed in Section C.5.4.1.2.)

- Ensure continuous reliable performance during normal facility operations and upset conditions by the use of redundant components.

- Ensure operability of the exhaust system by use of redundant/back-up components.

- Maintain protection of Zone I areas (confinement boundary) from the effects of tornado pressures.

- Preclude failures of non-seismically designed equipment or components from deleteriously affecting the Ventilation Exhaust system.

- Provide back-up means for pressurization and ventilation of the stairways (northeast and northwest) during facility fire/smoke conditions.

Description

Figure C.5.4.1.1-4 shows detailed zone designations, air flow rates, and differential pressures. Additional information is given Figure C.5.4.1.1-5. The pressures in various rooms/cells/areas with respect to outside atmosphere and adjacent zones are shown in Table C.5.4.1.1-1.

As a result of zoning the air spaces, inside air flow is from Zone III into Zone II and then into Zone I, or is filtered and exhausted directly from Zone II. During normal plant operation, the Vitrification Building supply system provides filtered air directly to the Zone II or Zone III ex-cell areas. The filtered exhaust system filters the Vitrification Cell (Zone I) air through the in-cell primary HEPA filter units and ex-cell secondary filter unit prior to release. A filtered exhaust system also filters and exhausts air from building areas (Zone II) located outside of the Vitrification Cell prior to release.

The differential pressure to atmosphere of the Vitrification Cell is measured by one of two pressure differential transmitters either of which send its signal to one of two separate pressure controllers. The controller outputs control the position of the Variable Inlet Vanes (VIVs) in exhaust fans. If Vitrification Cell negative pressure cannot be maintained, differential pressure controls automatically isolate the Vitrification Cell by closing appropriate isolation valves and initiating automatic shut-off of the supply fan. These isolation valves can be manually opened at the direction of the shift supervisor to permit natural circulation ventilation.

The ventilation supply system distribution plenum has a pressure sensor to control the supply fan VIV to maintain constant flow. A system of duct louvers and dampers distributes the air during normal plant operation. When the main supply unit shuts down, the following occurs:

1. Exhaust from the ex-cell areas is isolated.

2. Back-up fresh air intake dampers are opened to provide make-up/transfer air for the continuously exhausted Zone I spaces.

3. Back-up stairway pressurization fans start to pressurize the respective stairways (only if supply unit is shut down due to tripped fire/smoke sensor).

Smoke/fire detection automatically initiates shutdown of the supply fan to prevent the spread of smoke and reduce the supply of air to the fire, in accordance with National Fire Protection Association (NFPA) 90A.

The secondary filter unit is an internally partitioned housing with a section dedicated to the in-cell area and the other section to the ex-cell area. The secondary filter unit draws Zone I air from the in-cell primary HEPA filters (via dedicated ducts, each with a shutoff valve) and filters air from Zone II and Zone III areas directly. The section that services in-cell air consists of nine HEPA filters arranged in three isolable filter modules. Dampers are provided to allow isolation of one train of HEPA filters during off-line periods or filter replacement. The section that services ex-cell air draws air via a common plenum from the operating aisles, equipment rooms and other ex-cell areas. This section consists of twenty-one prefilter and HEPA sections grouped into nine isolable modules. Excess capacity and isolation dampers are provided to allow filter change-out and aerosol testing of the HEPA filters while the exhaust system remains operating. In addition, local prefilters for each duct exhausting Zone II areas are provided to minimize loading of the ex-cell area secondary filter section. The inlet to the ex-cell area section is automatically isolated if either exhaust fan fails to operate (including loss of normal power) or upon shutdown of the Ventilation Supply system.

The in-cell and ex-cell sections of the secondary filter unit are connected to two (redundant) centrifugal fans through a common plenum. Each fan incorporates an isolation valve on its inlet and outlet to prevent reverse air flow through the inactive fan during stand-by mode or maintenance activities. These air-operated isolation valves also utilize an air accumulator to assure availability of motive power in case the normal air supply is not available. Each fan utilizes VIVs to control air flow based on predetermined desired pressures in the cell.

The stairways are equipped with back-up ventilation fans to maintain stairway pressurization and ventilation in the event of the ex-cell Ventilation Supply system being shut down due to a tripped fire/smoke detector. Each stairway is normally ventilated and pressurized by the conditioned supply air from the Vitrification Building air supply components, and exhausts to the outside via wall louvers located in the lower portion of the stairway. Each louvered opening is provided with a pneumatically operated fail-closed damper. Dedicated pressure-relief louvered wall openings with counter-balanced dampers are located high on the wall, under each stairway roof. The counter-balanced dampers are adjusted so that there is no flow when the normal ventilation system is in operation. When the back-up fans are energized, the normal relief openings are automatically closed and backflow dampers prevent reverse flow through the supply duct.

The chiller equipment room, designated HVAC Zone III, is ventilated by a dedicated axial fan. The chiller equipment room ventilation fan, activated via a local temperature switch, draws in outside air through a fail-open air-operated damper. The chiller equipment room is not supplied from the ex-cell Ventilation Supply system.

Local electric heater units are provided for HVAC Zone II and Zone III areas. They are provided with local on-off fan switches and local thermostats for controlled heating.

The valves isolating the cell, fan controls, and stair fans are supplied with stand-by as well as normal power.

The Vitrification Building HVAC system functions as a confinement barrier. An extensive discussion of the HVAC system from this perspective, i.e., as a confinement barrier, is provided in Section C.5.5.

Design Evaluation

For accident scenarios evaluated in Chapter 9 of this FSAR, the Vitrification Building HVAC system is not required to maintain doses below the Evaluation Guidelines provided in Chapter 9. The redundancy of Vitrification Building HVAC system components and the capability of the Vitrification Cell HVAC system to withstand a relatively large seismic event provide a significant measure of "extra" protection to workers and the public.

Inspection and Testing

To ensure operability of the Vitrification Building HVAC system, components and equipment are subject to testing to verify proper wiring and controls, and proper functioning of system components and control devices, and to establish system airflow rates. The Vitrification Building HVAC system undergoes preoperational and confirmatory tests as noted in Section C.10.2 of this FSAR.

Instrumentation

The Vitrification Building HVAC system is equipped with instrumentation to indicate and/or monitor proper performance of system components. Flow and pressure differential instruments are provided to monitor fan performance and air flow through filters. For instrumentation details, see the figures previously cited in this section.

Vitrification Building HVAC components and associated parameters are monitored and controlled at two operator interface locations, one in the HVOS and the other in the Chiller Room. Each operator interface location has provisions to sound an alarm in the VF (main) Control Room upon any panel alarm. Control/operation can also be performed from the VF Control Room via an interface between the HVAC programmable logic controller and the Distributed Control System (DCS).

A selector switch on the HVOS control panel designates which of the two exhaust fans is in the standby mode. Each fan is operated by a start/auto/stop switch on the control panel. The stand-by fan automatically starts on high (i.e., approaching zero inches water gauge) pressure in the secondary filter unit common suction plenum. The stand-by fan starts after a 10-second delay after the operating fan is tripped off.

Fan flow is controlled by the fan's VIV. A fan's VIV is modulated by a pressure differential controller (Vitrification Cell to atmosphere) to maintain the Vitrification Cell at the design pressure condition stated in Table C.5.4.1.1-1. An adjustable signal limiter allows a fan's VIV to be modulated within a pre-determined air flow range. Upon failure or shutdown of the supply air handling unit, the exhaust fan's VIV controls automatically compensate for the reduced air flow. In the event of off-site power failure, both of the exhaust fans and all controls and instrumentation associated with the filtration system are powered by a stand-by diesel generator. The exhaust fans are electrically interlocked to prevent simultaneous operation of both fans. All valves and dampers required to operate in the event of off-site power or instrument air failure are provided with uninterruptible power and pneumatic accumulators sized to allow for operation of the filtration system and to maintain the sub-atmospheric pressure in the cell.

In the event of unavailability of the filtration and exhaust system, all Zone I/II isolation valves close and the supply air system shuts down through the exhaust fans' motor starter interlocks. Solenoid valves and hand switches associated with these butterfly valves are provided with uninterruptible battery power. Certain isolation valves may be opened manually to vent cell pressure through the filtration system.

The exhaust stack on top of the Vitrification Building and secondary filter units are monitored for radioactivity and high radiation levels. These conditions are annunciated in the VF Control Room.

C.5.4.1.2 In-Cell Coolers

The purpose of the in-cell fan coolers is to remove heat liberated by operation of equipment in the Vitrification Cell and to maintain the temperature of the Vitrification Cell within a nominal range of 15.5°C (60°F) to 35°C (95°F).

<u>Design Basis</u>

The in-cell fan coolers are designed to remove heat from the Vitrification Cell atmosphere during normal operation and abnormal events.

In particular, the in-cell fan coolers are designed to:

- Remove the heat transferred from the in-cell equipment to the in-cell atmosphere.

- Provide sufficient heat removal capacity to keep the Vitrification Cell within design temperature conditions during normal operations or after abnormal events, assuming maximum credible heat load conditions.

- Maintain adequate cooling of the Vitrification Cell atmosphere even if failure of a single active cooler unit occurs.

- Maintain structural integrity during and after occurrence of the postulated DBE.

- Maintain compatibility with the anticipated environment resulting from normal and abnormal operating conditions. Environmental conditions include radiation and chemical composition of the Vitrification Cell atmosphere, process wash liquids, and cooling fluids.

- Withstand the effects associated with re-start of the Chilled Water system in the event chilled water is lost.

- Allow for remote removal and replacement as well as servicing from an area external to the Vitrification Cell.

- Maintain Vitrification Cell functional integrity against potential vapor leakage paths and radiation streaming paths to areas external to the cell.

- Minimize retention of contaminants and liquids in the cooler housing (maintaining exposure as low as reasonably achievable [ALARA]).

- Allow for remote washing and/or decontamination while installed.

<u>Description</u>

Four in-cell fan coolers are provided to cool the Vitrification Cell by forced recirculation of cell air through cooling coils. In-cell fan coolers remove heat during normal operations and abnormal events and transfer the heat to the Chilled Water system. Chilled water flow through the cooler coil is cycled in response to Vitrification Cell temperature. The units are suspended from the Vitrification Cell ceiling. The location of the cooler units can be seen in Figures C.5.2.7.1-3 and C.5.2.7.1-5. The seismic and structural adequacy of the in-cell coolers is addressed elsewhere in this chapter.

Each in-cell fan cooler unit consists of a cooling coil section, two direct-drive vane axial flow fans, inlet bell, exit vanes, filter section, plenum, and a structural frame. A typical cooler unit is shown on Figure C.5.4.1.2-1. This figure also contains design information.

The cooler units operate with both fans drawing air from the Vitrification Cell through their associated half of the cooling coil section, and they discharge through exit nozzles directed towards specific areas of the Vitrification Cell. As the cell air passes through a unit's cooling coil, it is cooled. Each cooler unit is provided with two high-velocity discharge nozzles to promote air mixing inside the Vitrification Cell. Arrangement of the cooler units and major in-cell components is shown in Figure C.5.4.1.2-2. The high-velocity nozzles of each cooler unit direct turbulent air jets from separate discharge points on the Vitrification Cell ceiling.

Discharge nozzles are directed towards the Vitrification Cell pit to maximize cooling to components such as the canister turntable.

Only one of the four units is required to maintain Vitrification Cell design conditions under maximum heat loads. The actual number of cooler units in operation at any given time is determined by an operator, based on the temperature in the Vitrification Cell.

Design Evaluation

For accident scenarios evaluated in Chapter 9 of this FSAR, operation of the in-cell coolers is not required to maintain doses below the Evaluation Guidelines provided in Chapter 9. The in-cell coolers are designed to remain in-place (but not necessarily remain operational) through a DBE. Thus, the design of the in-cell coolers is considered satisfactory.

Inspection and Testing

Factory tests verify cooling coil and motor performance. Hydrostatic tests and nondestructive examinations were performed in accordance with ANSI B31.1. The in-cell coolers were pre-operationally tested as discussed in Section C.10.2.

Instrumentation

The in-cell coolers are started manually and run continuously. Each unit fan is provided with a start-stop hand switch and indicating lights on the HVOS control panel. When any of the in-cell coolers is placed in operation, the corresponding chilled water valve opens/closes in response to Vitrification Cell temperature.

C.5.4.1.3 VF Control Room HVAC

The Control Room HVAC system maintains a predetermined environmental envelope for the control room during normal operation and abnormal events.

Design Basis

The VF Control Room HVAC system is designed to:

- Maintain the control room at a design temperature of between 20°C (68°F) and 25.5°C (78°F) dry bulb.
- Prevent the introduction of airborne radioactive particles into the control room by maintaining the space at a positive pressure.

- Isolate upon receipt of a signal from fire detection instruments.
- Allow manual remote operation of fans and dampers during normal and abnormal operations.
- Accommodate the effects of a component failure in the system or a failure in the normal electrical power supply.
- Permit testing, adjustment, and inspection of the principal system components on a regular basis to assure system functional reliability.

Description

The VF Control Room HVAC system controls the atmosphere in the VF Control Room as shown in Figure C.5.4.1.3-1.

The Control Room HVAC system is designed to maintain a nominal design temperature of approximately 23.9°C (75°F) under normal conditions.

The Control Room HVAC system consists of two 100% capacity air handling units (one operating unit and one back-up). Each air handling unit is factory-assembled and includes (in the direction of air flow): an intake plenum, prefilter section, final filter section, access section, electric heating coil section, chilled water cooling coil section with insulated drain pan, and centrifugal fan. The air handling units are served by common supply and return ductwork. The air handling units are supplied with chilled water from the Chilled Water system.

The pressure within the control room is maintained at a positive pressure with respect to the outdoors and adjacent areas. This positive pressure feature precludes the introduction of contaminants into the control room.

Design Evaluation

During normal operation, HEPA filtered make-up air from the main building air handling unit mixes with the returned air before it is conditioned by the control room air handling units and resupplied to the control room. In addition, the air passing through the control room air handling units is filtered by pre-filters and final filters. Approximately 0.14 m^3/s (300 cfm) of HEPA filtered and conditioned make-up air is supplied from the main air handling unit. This fresh air replaces air lost through doors and other openings due to the higher than atmospheric pressure maintained in the control room. During an abnormal event, the system would continue to process a mixture of control room air and HEPA-filtered fresh air, and would maintain the control room environmental envelope. If smoke were detected in the air handling units, the system would automatically shut down.

Damper position indication lights allow continuous monitoring of the system performance and confirm manual control actions taken.

During accident conditions, habitability of the control room is not required to maintain doses below the Evaluation Guidelines provided in Chapter 9.

Confidence in the continued operation of the VF Control Room HVAC system during normal and abnormal conditions is provided by the use of redundant components in the system design.

Inspection and Testing

To ensure operability of the VF Control Room HVAC system, components and equipment are subject to testing to verify proper wiring and controls, and proper function of system components and control devices, and to establish system air flow rates. The VF Control Room HVAC system underwent preoperational and confirmatory tests as discussed in Section C.10.2. Components in the system are accessible for inspection and maintenance purposes.

Instrumentation

Each of the air handling units is started manually by means of its associated start/stop switch on the control panel. The activated unit runs continuously, with the other on stand-by. Upon start of either unit, its corresponding inlet and outlet dampers open.

Upon flow failure of the operating unit, an alarm sounds on the control panel. The stand-by unit is placed in operation by manual operation of the start/stop switch.

The room temperature controller cycles its corresponding chilled water control valve to maintain the room temperature. Upon loss of cooling water, a manual switch may be used to open the outside air damper so that 100% outdoor air is provided to the air handling unit and also to close off the return duct.

See Figure C.5.4.1.3-1 for additional instrumentation details.

C.5.4.1.4 Diesel Generator Room HVAC

Ventilation of the DGR is accomplished by use of the diesel radiator fan when the diesel generator is running and through a supply duct from the Vitrification Building HVAC system at other times. The DGR ventilation is required to provide cooling to the DGR, including electrical components, when the engine is running. An electric heater is provided to maintain minimum acceptable temperature in the room during winter conditions when the diesel generator is not in operation. When the diesel generator is energized, room ventilation and cooling is provided by the diesel radiator fan through the supply and exhaust louvers and dampers, which are equipped with tornado-generated missile shields. The dampers are designed to fail open upon loss of power or instrument air. Operational control and monitoring of DGR ventilation is provided on the control panel. This includes hand switches for opening or closing of the air intake damper and air exhaust damper, along with damper position indicating lights. Figure C.5.4.1.1-4 shows the air flow rates provided by the DGR HVAC system. Figure C.5.4.1.1-5 (page 1) shows the diesel radiator fan.

C.5.4.1.5 Cold Chemical Building HVAC

The purpose of the Cold Chemical Building HVAC system is to maintain a suitable thermal environment and acceptable air quality for personnel health, safety, and comfort, as well as support proper equipment operation. The subject system utilizes a once-through type design. The components consist of the ventilation supply fans, roof exhaust fans, make-up air heating units and a fume hood exhaust fan. The Cold Chemical Building H&V Air Flow system is shown in Figure C.5.4.1.5-1. Steam heating sections are provided to warm the air entering the building via the supply fans during winter conditions. The equipment areas of the building are typically maintained at a slight negative pressure with respect to the outside atmosphere, and slightly positive with respect to the adjacent Vitrification Building.

A separate supply fan normally maintains the Cold Chemical Building Control Room at a slightly positive pressure. An electric heater is provided to warm the room during winter conditions.

The Cold Chemical Building Scale Room is provided with a fume exhaust hood and filters to minimize exposure to possible airborne chemical contaminants in the room. A dedicated outside air intake provides fresh air to the room through a damper interlocked with the hood exhaust fan. A steam heating section is provided to warm air entering the room via the outside air intake during winter conditions. Scale Room air is drawn through filters and exhausted by a hood exhaust fan. Filter change-out is designed to be accomplished with minimum chemical exposure to personnel and minimum release of chemical contaminants outside the housing. Filter housing is readily accessible to assist in filter changeout.

In an accident situation, any chemical vapors generated/released in the Cold Chemical Building will be exhausted directly to the atmosphere. The three ventilation exhaust points from the Cold Chemical Building - from the dust collection hood and general ventilation fans - are located on the building's north side so that the possibility of exhaust being drawn back into any air intakes is minimal. The Cold Chemical Building air intakes are located on the south side of the building, while the Vitrification Building main air handling unit is situated near the top of the Vitrification Building. None of the liquids to be transferred in the Scale Room have a significant vapor pressure, so there is no potential for buildup of hazardous, heavier than air fumes in the Cold Chemical Building. In addition, worst-case accidental release from the Cold Chemical Building will not affect the air quality of personnel within the Vitrification Building (Bradley July 7, 1994). Entrainment of dusts and vapors has been minimized through the dust collection hood in the Scale Room, where material transfers occur.

C.5.4.1.6 01-14 Building HVAC

Equipment in the 01-14 Building supports vitrification operations in ways that are discussed in Section C.5.5.4.

The 01-14 Building HVAC system is designed to prevent buildup of high airborne contamination levels in routinely occupied operating aisles by routing ventilation air from areas of low contamination potential to areas of higher contamination potential. The air is filtered through two stages of HEPA filters to remove contaminants before the air is released from a stack. Any NO_x or ammonia that might be released within the 01-14 Building would pass through the HEPA filters and then be forced through the blowers for discharge via the stack to the atmosphere. Since the ventilation system runs continuously, no build-up of NO_x or ammonia would occur and their concentration could reasonably be expected to be low. Figure C.5.4.1.6-1 shows the 01-14 Building HVAC system.

The 01-14 Building HVAC system is not likely to be challenged with contamination because process off-gas (from Vitrification Cell process vessels) is essentially free of radionuclides by the time it reaches equipment located in the 01-14 Building. Also, process off-gas components and/or piping located in the 01-14 Building would have to be breached before any HVAC function would be required. For these reasons, and because the 01-14 Building HVAC system is discussed extensively in other DOE-approved WVDP safety documentation, no further discussion of the 01-14 Building HVAC system is provided.

C.5.4.1.7 Main Plant HVAC and Head End Ventilation

The Vitrification Building interfaces with previously existing Main Plant HVAC zones through limited areas. The interface area is the Transfer Tunnel from the Vitrification Cell to the EDR. The Transfer Tunnel itself normally receives air from the SFR for subsequent transfer into the Vitrification Cell during operation. The EDR interfaces with the "truck lock" from which it normally receives air, which is in turn transferred to the CPC. The CPC is normally maintained at negative pressure by the Head End Ventilation (HEV) system to minimize uncontrolled outleakages. The differential between the Transfer Tunnel pressure and the EDR pressure is minimized during normal operation to avoid air transfer. See Figure C.5.4.1.1-4 for air flows between the Transfer Tunnel, EDR, CPC, and adjacent areas. See Section C.6.5.3 for a discussion of cooling equipment dedicated to servicing the CPC.

Systems providing ventilation for the Main Plant building are discussed in other DOE-approved WVDP safety documentation. Filters in these systems ensure a minimum removal efficiency of 99.95% for particulates 0.3 microns (1.2E-05 in) in diameter and larger. Particulate removal efficiency is determined routinely via aerosol testing. Air in the main plant ventilation system flows at an approximate rate of 14.2 m^3/s (30,000 cfm) through a bank of roughing filters and a bank of HEPA filters prior to exhausting to the Main Plant stack. Air in the HEV system flows at an approximate rate of 6.8 m^3/s (14,350 cfm) through a bank of prefilters, a bank of roughing filters and two banks of HEPA filters in series prior to exhausting to the Main Plant stack. Performance of filters in these ventilation systems is monitored continuously through sampling of exhaust air. Redundant spares associated with each of these ventilation systems ensures confinement of radioactivity during abnormal operations.

C.5.4.1.8 Pump Pit Ventilation

High level waste in Tank 8D-2 is discharged from a pump located in Pit 8Q-2 and directed to the Vitrification Building via diversion Pit 8Q-5. Ventilation for these pits is provided by the Waste Tank Farm Ventilation system, which is discussed in other DOE-approved WVDP safety documentation and in Section C.5.2.3.7 of this FSAR.

C.5.4.2 Electrical Power Distribution

The Electrical Power Distribution system (EDS) provides reliable power to the VF electrical loads during normal operating and shutdown conditions. Sufficient power sources, switching capacity, and circuit protection are provided to accomplish this function.

C.5.4.2.1 Off-Site Power Distribution

Electrical power for the normal operation of the VF is supplied from the Niagara Mohawk Power Corporation's (NMPC) 34.5 kilovolt (kV) utility system. The NMPC system has two independent power sources supplying the WVDP switching station. One source is from a station located at North Angola, New York, approximately 40 km (24.9 mi) from the WVDP site. The other source is from a station located at Machias, New York, approximately 16 km (9.9 mi) from the site. The primary power system expansion is shown in Figure C.5.4.2.1-1. A power failure of one source does not interrupt service to the VF. The power is received at two 2000/2300/2240/2576 kVA, OA/FA, 55°C/65°C, 34.5 kV-480/277V step-down transformers. Each transformer provides power to associated low voltage 480V switchgear A or B. Switchgear A and B along with the associated transformer, make up one double-ended 480 volt substation A and B. Switchgear sections A and B are electrically connected via a normally open, 480V, 3200A rated power circuit breaker. This configuration is illustrated in Figure C.5.4.2.1-2. The 480V Substations A and B are located east of the Vitrification Building.

C.5.4.2.2 Vitrification, Load-In, and Cold Chemical Building EDS

The Vitrification Building, Load-In Building, and Cold Chemical Building EDS is a 480V distribution system that supplies power to loads with acceptable voltage and frequency in accordance with code and standard requirements. Spare circuits are provided in the Motor Control Centers (MCCs) and panels for connection of future devices. The EDS design conforms to the National Electrical Code (NEC) and manufacturers' recommendations.

The Vitrification Building, Load-In Building, and Cold Chemical Building EDS one line diagram is shown on Figure C.5.4.2.2-1. Power is normally supplied from 480V Substation A and B. The 480V Substation A supplies power to MCCs 1, 2, and 3, Cold Chemical MCC, 480V switchgears A1 and A2, Load-In Building Power Distribution Panel, and the SFCM. Power required for two Power Distribution Panels, the PVS, and STS is normally supplied via 480V Substation B.

In the event of loss of normal power, non-required loads are de-energized. Selected loads then receive power from the on-site stand-by power sources, which consist of the VF diesel generator and STS/PVS diesel generator. These generators are discussed in Section C.5.4.2.3. The VF diesel generator provides stand-by power to the 480V switchgear A1 and A2 via the 800A breakers located in the 480V switchgear A1 and A2. The VF diesel generator is automatically connected to the 480V switchgear A1 and A2 dead buses upon loss of normal off-site power. The STS/PVS diesel generator automatically supplies lighting, overflow heaters, and SBS pump power upon loss of normal (off-site) power.

Outgoing feeders from 480V Substation A and B have air circuit breakers with long-time and short-time trip settings. Motor starters located in MCCs consist of magnetic starters in combination with circuit breakers which act as motor controller and circuit overcurrent protection. Magnetic starters are operated by a control circuit powered from the nominal 120V secondary of a control transformer.

MCCs 1, 2, Cold Chemical MCC, and 480V switchgear A1 and A2 have 600A buses. MCC 3 has an 800A bus. Except for MCC 1 and 480V switchgear A1, all are supplied from 800A feeder breakers located at 480V substation A. The SFCM power, MCC 1 and 480V switchgear A1 are supplied from 1600A feeder breakers located at 480V Substation A. Outgoing breakers in the MCCs and 480V switchgear A1 and A2 distribution panel are 150A frame size.

Power and control cables for the 480V system are 600V rated, stranded copper conductor, THHN/XHHW insulation, suitable for continuous operation at a conductor temperature not to exceed 90°C (194°F). All power and control cables penetrating the Vitrification Cell and for underground applications in wet or dry locations are 600V rated, stranded copper conductor, XHHW insulation suitable for continuous operation at a conductor temperature not to exceed 75°C (167°F) in wet locations and 90°C (194°F) otherwise. The power conductors are sized to carry the maximum available short circuit current for the time required for the circuit breaker or fuse to clear a fault.

All MCC buses, 480V switchgears A1 and A2 buses, power panels, and lighting panels and their associated transformers, have adequate capacity to supply the continuous loads connected to the systems with adequate reserve capacity and spare feeders available in MCCs and 480V switchgears A1 and A2 buses.

Loads for which 480V three-phase supply is either impractical or undesirable are supplied from 208/120V and 240/120V distribution panels. These panels are connected to 480-208/120V three-phase transformers and 480-240/120V single-phase transformers, respectively. Loads may be supplied at 208V three-phase, 208V single-phase, 240V single-phase, or 120V single-phase.

The transformer secondary wye winding has its neutral solidly grounded. 600V rated power and control cable are used for 240V AC, 208V AC, and 120V AC service.

C.5.4.2.3 Standby AC Power Supply

The standby (on-site) power source consists of a VF diesel generator located in the DGR, adjacent to the SFR, and a diesel generator located in the PVS building along with its associated switchgear, distribution cabling, and controls. The VF diesel generator supplies sufficient power to selected loads to enable shutdown in the event of temporary or extended power outage. Selected loads include instrumentation and controls as well as other equipment used. The 600 kW STS/PVS diesel generator has enough capacity to supply 400 kW at 0.8 power factor to PP-3 and, via manual actions, to selected loads such as the SFCM, UPS batteries, and agitators in the Vitrification Building and Cold Chemical Building. (Lighting panels, overflow heaters, and the SBS pump are powered from PP-3).

The VF diesel generator in the DGR is designed to withstand the effects of the site DBT or the DBE without loss of power to components. The diesel generator is designed for starting and automatic acceptance of the largest single load (either HVAC exhaust fan) to maintain proper Vitrification Cell negative pressure. When required, other loads can be administratively loaded to the diesel generator. The essential loads are shown in Table C.5.4.2.3-1.

The VF diesel generator controls are designed for automatic as well as manual operation. The manual operation is from one of two locations, namely, HVAC control panel 67-V019 (remote) and the diesel generator control panel (local). The choice of the operating location is controlled by a RUN/STOP/REMOTE selector switch located at the diesel generator control panel. Placing the selector switch in the RUN mode manual starts the diesel generator from the local panel. The position of the selector switch is also indicated on the HVAC control panel 67-V019. Placing the selector switch in the remote mode permits automatic starting of the diesel generator from the HVAC control panel 67-V019 only. The normal position of the selector switch is the remote position so that the diesel generator will start automatically on loss of off-site power.

The diesel-driven generator is rated at 600 kW, 0.8 power factor, 1800 revolutions per minute (rpm), 480/277V AC, three-phase, 4-wire, 60-Hertz (Hz) and is complete with its accessories. The generator has a drip-proof frame, Class F insulation and is wye connected synchronous type. The voltage regulator provides voltage regulation within 2.0% under varying loads from no-load to full load. The generator has a static, solid-state excitation system. The unit is capable of one-step load acceptance equal to 80% of its nameplate rating and is capable of operating at its nameplate rating during utility power interruptions.

Voltage and frequency sensing devices are provided to prevent loading the generator until the diesel engine has accelerated to rated speed, and rated voltage is available.

A factory-mounted radiator with engine-driven pusher type radiator fan provide a self-contained cooling system. The diesel engine has been provided with two water jacket heaters mounted on the unit that maintain adequate engine water (coolant) temperature. Each heater is energized from 480V switchgear A1.

The starting and control circuits for the diesel generator operate from a 24V DC battery supply.

An ammeter is provided on control panel 67-V019 located in the HVOS for continuous monitoring of the diesel generator loading. Administrative control will be exercised to prevent loading the diesel generator over its rated capacity.

The diesel engine starting system, fuel oil storage and transfer system, cooling lube oil, fuel oil day tank, and the combustion air intake and exhaust, are described in Section C.5.4.14.

The DGR is protected from potential tornado generated missiles. A diesel generator failure modes and effects analysis is outlined in Table C.5.4.2.3-2.

Automatic Loading, Tripping and Testing of Diesel Generator

- The 480V switchgear A1 and A2 buses have been provided with undervoltage relays to monitor voltage condition on these buses. If a sustained, degraded voltage condition or loss of voltage on these buses is sensed by its time-delayed undervoltage relays, loads connected to the bus are de-energized, the main circuit breaker opens, disconnecting the off-site power source, and the VF diesel generator is started automatically.

- The undervoltage relays (with inverse time characteristics) for each bus are physically located in each 480V switchgear A1 and A2. The relay contacts are combined in a two out of two logic to generate a loss of voltage signal and one out of three logic to generate an alarm on loss of instrument potential transformer fuse. A complete loss of off-site power would result in a loss of voltage signal actuation. The diesel generator would start and be available to accept loads within 10 seconds.

- Starting Mechanism and System

  The diesel generator engine is started by 24VDC battery current. The battery is mounted near the unit.

- Tripping Devices

  Manual tripping of the diesel generator breaker can be done by the operator from the Control Panel 67-V019 in the HVOS.

  Automatic tripping of the diesel generator breaker will occur in the event of the closing of the 480V Switchgear A1 and A2, main circuit breaker.

- Interlocks

  Automatic connection of an HVAC exhaust fan motor load without voltage on the associated 480V switchgear A1 and A2 bus is prevented by a bus voltage sensing relay contact present in the closing circuits of the individual breakers.

- Permissives

  1) To start the diesel generator automatically, the following conditions are to be satisfied:

     - Local selector switch is in remote position, and control fuses are intact

     - Diesel generator reset relay is in reset position.

- There is a tripping of both 480V switchgear A1 and A2, main circuit breaker.

2) Tripping of the diesel generator when in operation (covered in diesel generator protection).

3) To close the diesel generator circuit breaker:

   - Manual, with dead bus

     a) 480V Switchgear A1 and A2 main circuit breakers are open.

   - Auto Close to dead bus (after diesel generator start)

     a) generator reset relay must be in reset position,

     b) near-rated voltage and frequency on the diesel generator, and

     c) 480V Switchgear A1 and A2, main circuit breaker are open.

- Load De-energization

  Loads connected to the 480V switchgear A1 and A2 are de-energized upon loss of normal (off-site) source power. The VF diesel generator breaker closes to the dead bus with time delay. The VF diesel generator will energize 480V switchgear A1 and A2 buses. The STS/PVS diesel generator will energize MCC-A, which in turn will supply power to power panel PP-3 located in the Vitrification Building. When the VF diesel generator and STS/PVS diesel generator are the only sources of supply, all loads except for those fed from 480V switchgear A1 and A2 and power panel PP-3 are de-energized. The area unit heaters fed from A1 and A2 are also de-energized. Subsequent reconnection of loads to the diesel source can be done manually under administrative control.

- Testing

  The VF diesel generator and the STS/PVS diesel generator are equipped with means for starting periodically to test for readiness, for loading, and for shutdown after test.

C.5.4.2.4 Vitrification Facility Uninterruptible Power Supply

In the event of loss of normal (off-site) and standby (on-site) power, uninterruptible power is provided to essential control, instrumentation, and computer systems. The source of this power is provided by 67-UPS-1, located in the VF HVOS (elevation 34 m [111.5 ft]), and UPS 63-UPS-2 and 63-UPS-3, located at elevation 30.5 m (100.0 ft), in a northwest area of the Vitrification Building.

UPS 67-UPS-1 is sized to provide 10 kVA supply at 120V AC for a period of one hour upon loss of power. UPS 63-UPS-2 and 63-UPS-3 are each sized to provide 20 kVA supply at 120V AC for a period of one hour upon loss of power.

UPS 67-UPS-1 provides AC power to 480V switchgear A1 and A2 (for tripping and closing AC power circuit breakers), HVAC control panel 67-V019, the stack radiation monitoring control panel, the diesel generator battery charger, the Closed Circuit Television (CCTV) control cabinet located in the CMR operating aisle, vertical shield door No. 2 control, pump VP-510, and miscellaneous loads. In the event of a loss of normal (off-site) power, the battery-inverter system supplies power during the interim period necessary for the VF diesel generator to attain the required voltage and frequency levels. When diesel generator voltage and frequency are established, the diesel generator supplies the UPS requirements via 480V switchgear A1 and at the same time recharges the UPS batteries. In the event the diesel generator is not connected to the 480V switchgear A1 and A2 buses, the batteries have been sized with sufficient ampere-hour capacities to maintain 10 kVA maximum load for a period of one hour. Loads (as shown in Table C.5.4.2.4-1) from UPS 67-UPS-1 are supplied via power panel PP-6.

UPS 63-UPS-2 provides AC power to equipment located in the VF Control Room, including the DCS station, the shift engineer/supervisor DCS station, the CCTV control cabinet, the communication system, HVAC control panel 67-V020, and the Control Room radiation monitor rack. The UPS also supplies alternate power to the control panel 67-V019, located in the HVOS. In the event of loss of normal (off-site) power, the battery-inverter system supplies power during the interim period necessary for the STS/PVS diesel generator to attain the required voltage and frequency levels and be connected to the system. When voltage and frequency are established, the diesel generator supplies the UPS requirements, and at the same time recharges the UPS batteries. In the event the diesel generator is not connected to the system, the batteries have been sized with sufficient ampere-hour capacities to maintain 20 kVA maximum load for a period of one hour. Loads (as shown in Table C.5.4.2.4-2) from 63-UPS-2 are supplied via power panel PP-10 .

UPS 63-UPS-3 provides AC power to equipment located in the VF Control Room including the fire control panel, DCS panels 1, 2, and 4, and the operator DCS station. The UPS also supplies power to the instrument racks located in the Vitrification Building. In the event of loss of normal (off-site) power, the battery-inverter system supplies power during the interim period necessary for the STS/PVS diesel generator to attain the required voltage and frequency levels. When diesel generator voltage and frequency are established, the diesel generator supplies the UPS requirements and recharges the UPS batteries. In the event the diesel generator is not connected to the system, the batteries have been sized with sufficient ampere-hours capacities to maintain 20 kVA maximum load for a period of one hour. Loads (as shown in Table C.5.4.2.4-3) from 63-UPS-3 are supplied via power panel PP-11.

Components

- Batteries: The batteries for the UPS units are completely sealed and non-gassing. No equalizing charge is needed and the batteries have a 10-year design life. Vents on the batteries are factory sealed. The batteries for 67-UPS-1 are mounted separately on a seismically designed rack. The batteries for 63-UPS-2 and 63-UPS-3 are mounted in a separate enclosure adjacent to its UPS cabinet.

- Rectifier-Inverter: The inverter sections of the UPS utilize the 125V DC output of the UPS rectifier under normal condition, inverting it to provide 120V single-phase AC power. The inverters are frequency and voltage regulated devices. The outputs are fed through a static transfer switch to supply the 120V AC loads under both normal and loss of off-site power conditions. The transfer switch provides the 120V AC source in 1/4 cycle (0.004 seconds) under conditions of inverter failure or overloads that exceed the inverter current capacity.

C.5.4.2.5 Electrical Circuit Protection Systems

480V AC System Protection. Feeders to the SFCM, the 480V switchgear A1 and A2, and the MCCs are protected against bus faults by air circuit breakers located at the 480V substation A. These breakers also provide backup protection to the individual load feeders. The feeder to the HVAC exhaust fan motors (in the Vitrification Building) from 480V switchgear A1 and A2 has been provided with long-time and instantaneous trips. Motor protection is arranged to trip on overloads or short circuits.

For short circuit protection, the 480V MCC combination motor starters have been provided with magnetic breakers with adjustable instantaneous trip settings. For overload protection of MCC motor circuits, thermal overload devices are provided, one per phase. The overload elements have been set to protect the connected motor and its feeder cable.

The 480V MCC static loads are fed from thermal magnetic breakers, which provide overcurrent and short circuit protection.

208/120 VAC and 240/120 VAC System Protection. The 208/120V AC and 240/120V AC loads are supplied from 208/120V and 240/120V distribution panels, respectively. Each panel is directly connected to the secondary terminals of a three-phase 480-208/120V transformer or single-phase 480-240/120V transformer. The primary side of the transformer is protected by a thermal magnetic breaker. The instantaneous trip element of this breaker trips from faults on the feeder cable or within the transformer itself. Each outgoing feeder is provided with overcurrent and short circuit protection by a thermal magnetic breaker. Single pole breakers are used for 120V single-phase circuits. Double pole breakers are used on 208V and 240V single-phase circuits. Triple pole breakers are used on 208V three-phase circuits. The continuous rated current of the thermal-magnetic breakers has been selected on the basis of the next higher standard size, corresponding to 125% of the equipment full load current; therefore, a 25% margin above the equipment full load current has been allowed for breaker tolerance, as well as to avoid false tripping due to breaker characteristic drifting.

<u>120V Uninterruptible AC System Protection</u>. The 120V output from the inverters has inverse time magnetic breakers on the outgoing feeders. The continuous rated current of the breakers has been selected on the basis of 125% of the equipment full load current, minimum, to allow for breaker tolerances and drifting of breaker characteristic.

<u>Ground Fault Protection</u>. The 480V, 208/120V and 240/120V systems are solidly grounded. The ground faults on Vitrification Building exhaust fans are detected and alarmed by a sensitive relay connected to a current transformer whose core surrounds the three conductors of the circuit.

The 120V UPSs have been provided with a DC ground fault alarm and indication.

<u>Diesel Generator Protection</u>. The diesel generator engine is tripped during the following conditions:

a. Engine overspeed,
b. Overcrank,
c. Low lube oil pressure,
d. High coolant temperature.

The diesel generator breaker is tripped during the following condition:

a. 480V switchgear A1 and A2 bus fault,
b. Overcurrent,
c. When the normal (off-site) source main circuit breaker is closed.

Pre-alarm indication and alarm is provided in the diesel generator local panel, HVAC control panel 67-V019, and in the DCS for the following conditions:

a. Diesel generator pre-alarm,
b. Diesel generator tripped,
c. Diesel generator ground fault.

Protective tripping of the engine and generator are annunciated locally, in the HVAC control panel 67-V019, and in the DCS.

C.5.4.2.6 Maintenance

A. The EDS is designed to facilitate the recognition, location, replacement, and repair of failed parts including assemblies and subassemblies. Where practical, means are provided to maintain the EDS equipment without having to shut down the whole system.

B. Where practical, interchangeability and standardization are used for parts, materials, and equipment such as electrical circuit breakers, relays, and motor starts. This minimizes the need for large spare parts inventories.

C. The EDS layout and design incorporate the necessary features to provide for the periodic inspection and maintenance. The design includes adequate space inside equipment for inspection and maintenance. Inspection and maintenance procedures provide maximum safety for personnel and for system operation.

C.5.4.2.7 Testing

Specifications for equipment procurement and installation included requirements for inspection and/or tests necessary to demonstrate or establish confidence that the EDS equipment performs satisfactorily in service. Tests performed on the EDS equipment include:

A. Factory acceptance tests at the manufacturer's facility.

B. Field testing at the VF installations.

C. Start-up and operation Test Requirements

   Installation and start-up procedures include requirements for examinations and/or tests necessary to demonstrate or establish confidence that the EDS performs satisfactorily in service.

C.5.4.2.8 Instrumentation and Control

Each 480V switchgear A1 and A2 has an instrument compartment consisting of a voltmeter and voltmeter selector switch for monitoring voltage of the incoming feeder to the switchgear A1 and A2 bus. The outgoing switchgear breakers have indicating lights to indicate the status of the breaker's "Open" or "Close" position, an ammeter and ammeter selector switch for monitoring outgoing feeder current, and test pushbuttons for testing operation of the switchgear feeder circuit breakers. The stand-by diesel generator has a local panel consisting of a voltmeter, ammeter, voltmeter/ammeter phase selector switch with an off position, rheostat for voltage adjustment, frequency meter, local selector switch for local or remote control of the generator, indicating lights for various diesel alarms and status conditions at the local panel, remote control desk (control panel 67-V019) and in the DCS. The UPSs have alarms and status conditions at the UPSs and common alarm to DCS and control panel 67-V019 (for 67 UPS-1 only). The combination starter units in the 480V MCCs are provided with selector switches, pushbuttons for manual and remote controls, and indicating lights for indicating the status of operation.

C.5.4.2.9 Electrical Power Distribution Failure Modes and Effects Analysis

A Failure Modes and Effects Analysis of the EDS is provided in Table C.5.4.2.9-1.

C.5.4.2.10 Electrical Power Distribution Plant Interface

The power supplies to the Sludge Mobilization System (SMS), including the zeolite mobilization pumps (Tank 8D-1), sludge mobilization pumps (Tank 8D-2), zeolite, sludge, and THOREX removal pumps (Tank 8D-1, 8D-2, and 8D-4), the STS, and the PVS are shown in Figure C.5.4.2.1-2.

Power to the equipment associated with the 01-14 Building is supplied from the 480V Main Plant/utility room substations. The HVAC blowers and the off-gas blowers are fed from 480V MCC 1 located in the utility room and 480V MCC 1,2,3 located in the 01-14 Building. The 480V MCC 2 and 3 are backed by on-site 500kW and 1250kW diesel generators, respectively, to provide power for selective essential loads including one HVAC blower, and two off-gas blowers. In the event of concurrent loss of off-site and on-site power, UPS 64-B-010, located in the 01-14 Building, provides power to essential controls, instrumentations, and computer system. This UPS can provide 20 kVA power at 120V AC for a period of one hour upon loss of power.

Upon loss of site power, the DCS automatically shuts down the melter feed. As soon as the standby generators are operational, the control logic automatically starts blower 64-K-003B or 64-K-003C and the reheater elements, which are connected to the standby power. Therefore, off-gases will continue to be drawn from the in-cell Off-Gas system and be directed to the stack. The electrical elements for the preheaters are not equipped with standby power, so the reactors are not able to provide continuous service. The residual heat and ammonia held by the catalyst bed would continue to provide a limited amount of NO_x destruction during the period that the NO_x generation rate is diminishing to a level acceptable for release without treatment. Feed to the melter would not be reestablished until normal site power is resumed.

Power to the equipment associated with the EDR and HLWIS is supplied from the existing EDS, which is fed from the 480V Main Plant/utility room substation.

C.5.4.3 Compressed Air

The Compressed Air system consists of two air subsystems: the Instrument Air (IA) system and the Utility Air (UA) system. Both IA and UA for the VF are supplied from an electric-powered compressor located in the utility room of the Main Plant. Two electric-powered compressors serve as backups. Standby power sources can supply the backup compressors. The normally running centrifugal-design air compressor provides a peak air flow rate and pressure as shown in Table C.5.4.3-1. The backup compressors start automatically when header pressure drops to a preset value. Air from the running compressor splits into two lines, one for UA and the other for IA. The IA system delivers dry, filtered, oil-free compressed air at a reduced pressure to meet pneumatic instrument and control requirements. The high-pressure air system serves as a back-up to IA for HVAC confinement barrier control.

The IA compressor is not included in the Table C.5.4.2.3-1 list of equipment on stand-by power because high-pressure bottled air is used to backup critical pneumatic controls for the Vitrification Building HVAC system. If the IA and the backup UA compressors become inoperable (due to power loss or other reasons), normal VF operations would be discontinued. The High-Pressure Air system automatically provides bottled air to the pneumatic controls of key HVAC equipment. Table C.5.4.3-2 lists the valves and controls that are operated by the High-Pressure Air system.

<u>Design Basis</u>

UA system pressure is designed to be 793 kPag (115 psig) under static conditions. A booster pump in the third floor operating aisle of the Vitrification Building increases UA pressure up to 1,034 kPag (150 psig) for use by select in-cell applications. IA system pressure to the VF is 379 kPag (55 psig) under static conditions. UA and IA for the VF are Class D breathing quality air.

<u>Description</u>

Table C.5.4.3-1 shows the nominal pressure variance in UA and IA pressure and estimated demand. UA is used for mixing, purging, conveying cold chemical, cooling, sampling, and pumping. The UA supplies an ex-cell air dryer, a dozen Vitrification Building utility stations, several instrument racks prior to cell penetration, and several "nonrack" applications (e.g., the sample transfer cell, melter pressure control, various sparging and air driven pumps, etc.). UA is delivered from the Vitrification Building to the Cold Chemical Building by a 51-mm (2-in) line. Inside the Cold Chemical Building, UA is provided to two utility stations, eductors, three chemical tanks, and an air dryer. After passing through the air dryer, the air is directed to various pumps, tanks, hoppers, and air manifolds (see Figures C.5.4.3-1, C.5.4.3-2, and C.5.4.3-3).

IA is typically used for instrument purge, valve actuation, and controlling instruments. Before reaching the Vitrification Building, IA passes through a two-bed regenerative air dryer and a pressure reduction station. IA supplies the following:

- Seventeen utility stations (one or more utility stations are located in the Vitrification Building, Chiller Room, EDR, SFR, Control Room, DGR, and CMR operating aisle). Use of an IA utility station is by administrative procedure (authorized use only). Unrestricted use of IA utility station(s) could jeopardize normal plant operation;

- Several "nonrack" interfaces, e.g., valves, solenoids, and I/P converters;

- Several instrument racks (air is supplied directly to instruments within the racks or to manifolds for distribution);

- The CMR door seal and Transfer Tunnel door seal;

- Cold Chemical Building IA loads (once inside the Cold Chemical Building, the IA line feeds two utility stations, as well as level indicators, valves, and instrumentation); and

- Several HVAC valves or controls within the SFR and CMR.

See Figure C.5.4.3-4 for more information.

In addition to the back-up compressors supplied in the utility room, the UA and IA systems are also backed up by two STS air compressors. When the Vitrification Building UA or IA header drops to a preset pressure, air automatically flows to the appropriate header. A check valve in the Vitrification Building UA and IA systems prevents backfeed to the utility room. Activation of the back-up compressors to supply the required header pressure alerts operators that a problem exists (such as a significant leak or unauthorized use) and corrective measures would be taken.

All UA and IA in the Vitrification Building is breathing air quality grade D. A carbon monoxide monitor continuously monitors the utility room UA header for carbon monoxide contaminants and is set to alarm at concentrations of 5 parts per million (ppm) or greater.

The High-Pressure Air system is a back-up to IA for select key HVAC components. Upon loss of IA, high-pressure air is used to reposition damper and butterfly valves as necessary. A compressed air bottle, containing air between 3,792 kPag and 13,790 kPag (550 psig and 2,000 psig), supplies air that is reduced to about 3,447 kPag (500 psig) through a pressure regulator to accumulators. Pressure control valves reduce the pressure to 276 kPag (40 psig) before reaching actuators. Pressure relief valves in the system are set at 3,792 kPag (550 psig) ahead of pressure control valves and at 448 kPag (65 psig) after pressure control valves (see Figures C.5.4.3-5 and C.5.4.3-6).

Design Evaluation

The UA and IA systems are required to operate continuously, 24 hours a day, seven days a week. The likelihood of satisfying this requirement is increased by providing a back-up compressor that automatically starts on low header pressure and a cross connect to the STS UA and IA systems. The use of existing compressed air system components (e.g., the compressors) is considered to satisfy design requirements for UA and IA in the Vitrification Building and Cold Chemical Building. If the UA and IA systems become inoperable, safe shutdown of the facility is made possible by the High-Pressure Air system reserve air supply, until normal compressor air supplies can be reinstated.

Testing and Inspection

The UA and IA systems were initially tested for satisfactory performance during the testing evolutions discussed in Chapter 10 of this FSAR. WVNS-DC-022 requires that test requirements and provisions for accommodating testing activities shall be considered during VF design efforts, and cites "calibration points for pneumatic systems" as an example. Since the UA and IA systems are normally operating, periodic operational testing is not required. Routine operations will detect any system abnormalities. However, the compressors that are not normally running are periodically started to ensure their operability. Key components in the UA and IA systems, including the compressors and air dryers, are readily accessible for inspection and maintenance.

Instrumentation

Adequate instrumentation is provided to verify UA and IA pressure to systems and components. Instrumentation is shown on the UA and IA figures previously cited.

C.5.4.4 Steam Supply and Condensate Return

The VF Steam and Condensate system receives steam from the Main Plant utility room and distributes the steam to various components/steam users within the Vitrification Building, Cold Chemical Building, and Load-In Building for heating and transferring operations. Steam is also provided to purge and flush certain lines and equipment. Most users deliver the resulting condensate to the Condensate system, which returns the condensate to the utility room for eventual reuse in the boilers.

Design Basis

Boilers in the utility room are designed to supply steam at approximately 1,034 kPag (150 psig) under static conditions. Steam at this pressure enters the Vitrification Building, and after passing through a drip-trap and start-up trap, exits the Vitrification Building via a line that leads out to the Waste Tank Farm Equipment Shelter. Except for this case, steam pressure is designed to be (through use of a pressure reducing station) approximately 689 kPag (100 psig) prior to distribution within the Vitrification Building and Cold Chemical Building. An air handling unit (63-V-136) and seven area unit heaters located in the Load-In Building are provided with 1,034 kPag (150 psig) steam directly from the Main Plant steam distribution network. The fundamental design features of the Condensate system are to: 1) collect condensate from the various steam users into the condensate collection sump, 2) monitor the condensate for radioactive contamination, and 3) return the condensate that has been collected in the sump to the utility room.

Description

There are two natural gas fueled fire-tube boilers with a 15,658 kg/hr (34,520 lb/hr) combined steam generating capacity in the utility room. Number 2 diesel fuel oil can be used as an alternate fuel source in the event of an interruption in the gas supply. Each boiler has been designed to provide full demand requirements (i.e., 7,829 kg/hr [17,260 lb/hr]). Cessation of nuclear fuel reprocessing operations has resulted in a major reduction in steam usage, so that the demand load (without Vitrification Building or Cold Chemical Building loads) is 3,629 to 5,443 kg/hr (8,000 to 12,000 lb/hr). The normal operating pressure for Main Plant steam systems was approximately 1,034 kPag (150 psig); hence, the boilers provide steam at about 1,034 kPag (150 psig). Steam generation and condensate components located in the utility room are discussed in more detail in other DOE-approved WVDP safety documentation.

The Steam system is shown in Figure C.5.4.4-1. Steam is delivered to the Vitrification Building at approximately 1,034 kPag (150 psig) in a 152-mm (6-in) header, and is then routed at this pressure (via a tap off the 152-mm [6-in] header) to the Waste Tank Farm Equipment Shelter. Pressure is then reduced to approximately 689 kPag (100 psig) prior to distribution within the Vitrification Building and Cold Chemical Building. Individual steam users then further reduce the pressure as needed for their particular applications. All steam supply lines to the Vitrification Cell have a remotely operated flow-control valve and a manually operated cell-wall block valve.

VF steam requirements vary between 249 and 4,990 kg/hr (550 and 11,000 lb/hr), depending on the time in the process cycle and the weather conditions. Steam flow rate to the CFMT can be up to 1,406 kg/hr (3,100 lb/hr), which corresponds to a potential heat addition rate of 8.0 MW to the CFMT.

The steam header branches off to utility stations, instrument racks, and the Cold Chemical Building. Utility stations are provided at various elevations, as well as in the Transfer Tunnel, CMR, and CMR operating aisle. Steam is used for heating purposes, and steam jets are used for various applications in-cell. In the Cold Chemical Building, steam at approximately 689 kPag (100 psig) is provided to eductors, while steam reduced to approximately 172 kPag (25 psig) is provided to heaters, tanks, and utility stations. The Cold Chemical Building Steam and Condensate system is shown in Figure C.5.4.4-2.

Most Vitrification Building and Cold Chemical Building steam users deliver the resulting condensate to the Vitrification Building Condensate system; however, steam used by the transfer jets, and in some cases the steam used for purging, flushing, or agitating, enters the process liquids/slurries. When appropriate, after steam is shut off from the purge or jet, the line is blown through with utility air to displace the steam and dry out the line to prevent forming a vacuum. (A vacuum could draw contaminated liquid into undesirable locations, e.g., piping runs located out of cell.) When a designated level is reached in the condensate collection sump, one of two condensate pumps activates and directs the water to a return header running to the utility room Condensate system for reuse as boiler feed. The two electrically driven condensate pumps run alternately (or together if a high-high sump level is reached). Sump capacity is 4.4 m^3 (1,165 gal). Condensate is monitored for contamination, and the condition is alarmed in the VF Control Room. If contamination is detected, the valve in the condensate return line (i.e., valve HV-6075) remains closed to prevent the transfer of contaminated condensate to the utility room. The VF Condensate system is shown in Figure C.5.4.4-3.

<u>Design Evaluation</u>

The use of existing steam generation equipment is considered to satisfy design requirements for steam in the Vitrification Building, Cold Chemical Building, and Load-In Building. Each of the boilers has ample capacity to meet VF and other currently existing WVDP needs. Measures exist to ensure that radiologically contaminated water does not leave the Vitrification Building. Furthermore, the heat exchanger shown in Figure C.5.4.4-3 uses closed-loop cooling water as its heat sink. Should the condensate become contaminated and the heat exchanger tubing fail, this design provides for containment of the contaminated water. The Steam and Condensate system does not aid in performing any safety related function.

Testing and Inspection

The Steam and Condensate system is initially tested for satisfactory performance during the testing evolutions discussed in Chapter 10 of this FSAR. WVNS-DC-022 requires that test requirements and provisions for accommodating testing activities be considered during VF design efforts. Since the Steam and Condensate system is normally operating, periodic operational testing is not required. Since the Steam system does not aid in performing any safety-related function, failure of the Steam or Condensate system could result in delayed operations but not in safety concerns. Minor leaks in the Steam system are easily located and do not represent a significant personnel hazard, as with higher pressure steam. Routine operations will detect any system abnormalities. Steam generation and condensate equipment, including the condensate collection sump and associated pumps, are readily accessible for inspection and maintenance.

Instrumentation

Adequate instrumentation is provided to set, maintain, and verify steam pressure to Vitrification Building, Cold Chemical Building, and Load-In Building systems and components. Instrumentation is also provided to alarm an excessively high level in the condensate collection sump and to alarm radioactive contamination in the condensate. Instrumentation is shown on Figures C.5.4.4-1 through C.5.4.4-3.

C.5.4.5 Water Supplies

Three distinct types of water supplies are used in vitrification operations. These supplies are referred to be as demineralized water, utility water, and potable water. Fire water is discussed in Section C.5.4.9.

C.5.4.5.1 Demineralized Water

The Demineralized Water system receives demineralized water from the Main Plant and distributes it to the Vitrification Building, Cold Chemical Building, and STS Building for various uses. Vitrification-related uses include chemical make-up, process additions, flushing, decontamination, and utility services.

Design Basis

The Demineralized Water system is required to supply demineralized water for end uses at a maximum flow rate, pressure, and conductivity shown in Table C.5.4.5.1-1.

Description

Demineralized water is produced in the Main Plant utility room by passing water through a two-bed, cation-anion demineralizer. Demineralized water is stored in a 68.1-m^3 (18,000-gal) storage tank. Three pumps are available to provide water distribution. Demineralized water exits the utility room at approximately 345 to 414 kPag (50 to 60 psig) when pump 32-G-5A or 32-G-5B is in service, and at 1,034 kPag (150 psig) when pump 32-G-5C is used. The storage tank is not insulated, but is equipped with a steam coil to maintain the temperature of the water above the freezing point during cold weather.

Demineralized water enters the Vitrification Building from the Main Plant through a 51-mm (2-in) pipe. After passing through the system shut-off valve, water pressure is reduced and stabilized with a pressure regulating valve. Seven taps are located on the header pipe to supply demineralized water to locations within the Vitrification, Cold Chemical, and Supernatant Treatment Buildings.

Demineralized water is available at nine utility stations (i.e., eight stations in the Vitrification Building, and one in the STS Building). Demineralized water forms the base ingredient for all chemical slurries and solutions used in the vitrification process, supernatant treatment process, and canister decontamination. Demineralized water is also used to fill and maintain the proper water level in the SBS and the seal pots, and for flushing various systems and components, including: 1) The chemical make-up tank and transfer pipes; 2) The STS; 3) Portions of the Off-Gas and Vessel Vent systems; 4) CFMT and MFHT mist eliminators; 5) The air displacement slurry (ADS) feed pump; 6) Two ADS slurry sampler pumps and slurry sample extraction systems; 7) Eighteen bubbler lines; 8) The sample transfer station; 9) The decontamination tank; and 10) The vitrified waste storage canisters after decontamination.

Design Evaluation

Water pressure throughout the Demineralized Water system may vary at the user locations, dependent upon the actual number of demineralized water users and the type of service that those users require. Based upon a review of flow rates associated with various Demineralized Water system uses and the expected frequency of those uses, it is considered unlikely that the Demineralized Water system will not satisfy, particularly for any significant duration of time, the purposes for which it was designed. Additionally, the intended source and provisions for providing demineralized water to the VF are deemed satisfactory in consideration of the fact that the Demineralized Water system does not aid in performing any safety related function (i.e., there are no worker safety issues associated with loss of the system).

Testing and Inspection

Various preoperational testing evolutions (as discussed in Chapter 10 of this FSAR) serve to demonstrate whether the Demineralized Water system provides adequate flow rates at acceptable pressure levels. Since the Demineralized Water system is a normally operating (i.e., routinely used) system, testing is not required. Routine uses will detect any system abnormalities.

The Demineralized Water system is a "passive" distribution system, and should perform all of its required functions without operator intervention as long as all isolation valves and control valves are set in their proper position. Key components in the system, including the pumps in the Main Plant, are readily accessible for inspection and maintenance.

Instrumentation

The key parameter in the Demineralized Water system is the water pressure in the distribution header (located downstream of the pressure regulating valve). Instrumentation is provided to monitor this parameter so that actions may be taken as necessary to maintain a constant pressure in this header. Other instrumentation is user-specific and provided as considered necessary.

C.5.4.5.2 Utility Water

The Utility Water system receives utility water from the Main Plant and distributes it to various areas and systems in the Vitrification Building and Cold Chemical Building. Utility water is generally used for purposes that are not process-related, such as washing, flushing, and make-up to the Closed-Loop Cooling Water (CLCW) system and Chilled Water (CC) system.

Design Basis

See Table C.5.4.5.1-1 for numerical design information associated with the Utility Water system.

Description

Utility water is stored in a 1,798-m^3 (475,000-gal) storage tank. Two pumps are available to distribute utility water. Utility water enters the Vitrification Building through a 102-mm (4-in) pipe at approximately 689 kPag (100 psig) under static conditions. Lines branch off to feed: a) utility stations, b) Cold Chemical Building utility water needs, c) the SFR sump, d) the sample transfer station, e) the CC system (i.e, HVAC cooling water supply), f) the CLCW system holding tank and heat exchanger, and g) hose connections in the CMR, EDR, and Transfer Tunnel. A pressure relief valve is used to reduce pressure to the CC system.

Design Evaluation

Tapping off to the Vitrification Building with a 102-mm (4-in) line from the existing Utility Water system is considered to satisfactorily meet design needs for utility water to support the vitrification process. Additionally, the intended source and provisions for providing utility water are deemed satisfactory in consideration of the fact that the Utility Water system does not aid in performing any safety-related function.

Testing and Inspection

Various preoperational testing evolutions (as discussed in Chapter 10 of this FSAR) serve to demonstrate whether the Utility Water system provides adequate flow rates at acceptable pressure levels. Since the Utility Water system is a normally operating (i.e., routinely used) system, testing is not required. Routine uses reveal any system abnormalities.

The Utility Water system is a "passive" distribution system, and should perform all of its required functions without operator intervention as long as all valves are set in their proper position. Key components in the Utility Water system, including the pumps, are readily accessible for inspection and maintenance.

Instrumentation

The key parameter in the Utility Water system is the water pressure in the distribution header. Instrumentation is provided to monitor this parameter so that actions may be taken as necessary to maintain adequate pressure in this header. Pressure indication is also provided downstream of the strainer and pressure relief valve associated with supplying utility water to the CC system. Other instrumentation is user-specific and provided as considered necessary.

C.5.4.5.3 Potable Water

The Potable Water system receives potable water from the Main Plant and distributes the water to the Vitrification Building and Cold Chemical Building. Potable water is supplied to six eye wash and shower stations, and to "Mens" and "Ladies" rest room facilities.

Design Basis

See Table C.5.4.5.1-1 for numerical design information associated with the Potable Water system.

Description

Water is supplied to the potable water accumulator tank on demand from a level/pressure instrument. The unit controls the volume in the tank and allows the tank to be pressurized to approximately 414 kPag (60 psig). A 51-mm (2-in) line provides potable water to the Vitrification Building. A backflow preventer valve is installed in the piping between the Vitrification Building Potable Water system and the Main Plant Potable water system. Once inside the Vitrification Building, the Potable Water system is activated at each delivery point by a faucet or bar. As previously stated, potable water is supplied to six eye wash and shower stations, and to rest room facilities.

Design Evaluation

Supplying the Vitrification Building and Cold Chemical Building with potable water from the existing Potable Water system is considered to satisfactorily meet design needs for potable water. Furthermore, potable water is not needed for safe operation, though it is noted that eye wash and shower stations are routinely provided and are necessary in many industrial activities.

Testing and Inspection

Since the Potable Water system is a normally operating (i.e., routinely used) system, testing is not required. Routine uses detect any system abnormalities. (Eye wash and shower stations are tested periodically to ensure their operability.) The Potable Water system is readily accessible for inspection and maintenance.

Instrumentation

Proper functioning of the duotrol unit in the utility room should generally ensure a satisfactory potable water flow rate and pressure.

C.5.4.6 Cooling Supplies

The three water cooling systems necessary for vitrification operations are the CLCW system, the Cooling Tower Water (CW) system, and the Chilled Water (CC) system.

C.5.4.6.1 Closed-Loop Cooling Water

The Closed-Loop Cooling Water (CLCW) system removes excess heat from selected components and transfers the excess heat to the CW system. The CLCW system also serves to prevent radioactive contaminants that might inadvertently enter the cooling water from being released into the environment.

Design Basis

The CLCW system design requirements are addressed in WVNS-DC-022. The primary purpose of the CLCW system is to supply a continuous and sufficient amount of cooling water to designated components so that the components will operate within design temperatures.

Description

Figure C.5.4.6.1-1 is a functional flow diagram of the CLCW system. As shown in the figure, the primary pump circulates the cooling water from the hold tank through the heat exchanger to the CLCW system supply headers. The heat exchanger reduces the cooling water temperature to 38°C (100°F) or less. Valve 66-PV-030 maintains the high pressure supply header at approximately 345 kPag (50 psig), while valve 66-PV-036 maintains the low pressure supply header at approximately 241 kPag (35 psig). All CLCW system supply lines to the Vitrification Cell have a remotely operated flow control valve and a manual cell-wall block valve.

An electrically driven back-up pump is provided in the event that the electrically driven primary pump becomes unavailable. The backup pump can be powered from the stand-by generator. Transfer to the back-up pump occurs automatically on low-discharge header pressure. Both pumps supply water at a flow rate and pressure shown in Table C.5.4.6.1-1. The hold tank has a working volume of approximately 3.0 m^3 (800 gal), but the normal volume during operations is approximately 2.2 m^3 (570 gal). A commercially available chemical corrosion inhibitor is added to the cooling water hold tank, in accordance with the manufacturer's recommendations, via a valve with a funnel opening. Additional inhibitor is added, as needed, to allow for made-up water added to the system. Utility water is used to initially fill the CLCW system and provide make-up water. Additionally, a configuration can be established such that utility water can be used to cool the melter electrode silicon-controlled rectifier if the CLCW system is unavailable and power to the melter electrodes must be maintained.

The Vitrification Cell equipment supplied by the CLCW system and associated cooling water flow rates are shown in Table C.5.4.6.1-2.

Design Evaluation

The CLCW system is required to operate continuously, 24 hours a day, seven days a week. The likelihood of satisfying this requirement is increased by providing a back-up pump that can be powered from the stand-by generator and automatically starts on low discharge header pressure. In general, adequate provisions are considered to have been made to provide cooling water to those components that, as a matter of good engineering design practice, should be provided with closed-loop cooling water. The components that use closed-loop cooling water do not aid in performing any safety-related function.

Upon loss of the CLCW system, feed to the melter is stopped and power to the electrodes is interrupted. If operators are unable to reestablish normal cooling water flow, procedures are in place directing utility water to be rerouted to cool the melter shell and the silicon-controlled rectifier. Feed to the melter would not be reestablished until the normal CLCW system supply is reestablished.

Loss of the CLCW system to the melter side or bottom cooler would cause the melter refractory and shell to increase in temperature and expand due to the increased temperature. This growth would allow the refractory blocks to shift, thereby creating additional new cracks in the refractory. The molten glass would flow into these tiny cracks, as already occurred in existing cracks. This would not lead to failure of the melter shell, but has the potential to shorten the melter operational life.

If cooling water is lost to the silicon-controlled rectifier, power to the unit is automatically shut down. Operators have up to 6 hours to restart the rectifier before the operational requirement is imposed to use start-up heaters to resume melter operations.

A carbon-steel coupon is used to determine the corrosion rate. The coupon is bolted to a coupon holder on line 6-66-2-041. The coupon is periodically evaluated.

Instrumentation

User-required flow controls and instrumentation are provided in the designated instrumentation racks as shown in Figure C.5.4.6.1-1. Flow rates are generally determined by temperature sensors located either in the user equipment, at the coolant outlet of the user equipment, or at the cooling outlet of the Vitrification Cell. Two components do not use this method of component temperature control. The melter electrode silicon-controlled rectifier cooler and the radiation monitor heat exchanger have their cooling water flow rates established manually through operation of appropriate valves. The radiation monitor shown in Figure C.5.4.6.1-1 samples the coolant in the return header and activates an alarm if the radiation level of the coolant exceeds the setpoint. High- and low-level alarms are provided for the hold tank. The low-low-level hold tank alarm is interlocked to deactivate the pump.

C.5.4.6.2 Cooling Tower Water

Additions have been made to the existing CW system so that the system may service components associated with the vitrification process. These additions allow the CW system to: a) serve as the ultimate heat sink for excess heat removed from components by the CLCW system, b) service two water chillers, and c) service several tanks in the Cold Chemical Building. The CW system that existed prior to the additions needed to support the vitrification process is discussed in other DOE-approved WVDP safety documentation. Only that portion of the CW system that supports VF operations is discussed in this section.

Design Basis

Some CW system design requirements are addressed in WVNS-DC-022. See Table C.5.4.6.1-1 for numerical design information associated with the CW system.

Description

The CW system is shown on Figure C.5.4.6.2-1. As shown in this figure, the CW system supports operation of the CLCW system heat exchanger, two water chillers associated with the HVAC system, and components located in the Cold Chemical Building. The components in the Cold Chemical Building are three decontamination tanks, a drain tank, a shim tank, a main mix tank, a slurry hold tank, and a scrub solution heat exchanger.

Design Evaluation

The CW system is required to operate continuously. The provision of redundant CW system pumps significantly aids in fulfilling this requirement. The CW system does not aid in performing any safety-related function.

Testing and Inspection

The CW water system was initially tested for satisfactory performance during preoperational testing as discussed in Chapter 10 of this FSAR. Since the CW system is a normally operating system, periodic operational testing is not required. Routine operations detect any system abnormalities. CW system water chemistry is analyzed daily. Key components in the CW system, including the pumps and the tower, are readily accessible for inspection and maintenance.

Instrumentation

A temperature element, transmitter, and indicator are provided on the CW system piping that supplies and exits the CLCW system heat exchanger. A flow element, transmitter, and indicator are provided in the CW system piping downstream of where the return piping from the Cold Chemical Building and CLCW system heat exchanger join. Instrumentation is also provided to control the flow of cooling water through the water chillers.

C.5.4.6.3 Chilled Water

The CC system supports operation of the HVAC system. The CC system services in-cell cooling units, an ex-cell air handling unit, and two Control Room air handling units.

Design Basis

HVAC system design requirements are addressed in WVNS-DC-022. The CC system must provide sufficient chilled water to maintain temperatures in-cell, ex-cell, and in the Control Room within design limits.

Description

The CC system is shown in Figure C.5.4.6.3-1. The CC system includes three electric pumps that circulate chilled water through the following components:

- Three chiller packages, one of which is air-cooled,
- Four in-cell coolers,
- Two Control Room air handling units, one operating and one back-up,
- Four coils associated with one ex-cell air handling unit, and
- An air separator.

One or two pumps are normally operating, depending on the system load. See Table C.5.4.6.1-1 for chilled water pump numerical information. An expansion tank is provided as well as a (pressure-pot type) chemical feeder. Make-up water is provided from the Utility Water system.

During the summer months, two water-cooled chillers are normally operated in a lead/lag arrangement to meet system loads, with the air-cooled unit on stand-by. The lead chiller runs continuously, whereas the lag chiller operates intermittently, as required to satisfy the coincident cooling demand. In the winter only one water-cooled chiller unit is needed to meet cooling demands, with two chillers available for standby operations.

Any combination of one chiller and one chilled water pump can provide cooling capacity to satisfy the cooling demand of the Vitrification Cell coolers and the VF Control Room during process operations. In the event of loss of condenser water, the air-cooled chiller is put into operation.

Design Evaluation

The CC system is required to operate continuously. The provision of redundant CC system pumps significantly aids in fulfilling this requirement. By making one of the chiller packages air-cooled, dependence on the CW system for the chiller package function is lessened. The CC system is considered to satisfactorily support design HVAC system needs. Additionally, the CC system does not aid in performing any safety-related function.

Testing and Inspection

The HVAC system was initially tested for satisfactory performance during preoperational testing as discussed in Chapter 10 of this FSAR. Since the HVAC system is a normally operating system, periodic operational testing is not required. Routine operations detect any CC system abnormalities. Chilled water chemistry is periodically checked. With the exception of the in-cell coolers, key components in the CC system are readily accessible for inspection and maintenance.

As stated in Section C.5.4.1.2, the in-cell coolers are designed so that only one of the four in-cell cooler units is adequate to maintain the Vitrification Cell design conditions under maximum heat loads. The units are also designed to allow remote removal, in the unlikely event they must be serviced. This remote removal is accomplished by a specially designed remote handling fixture that rides the Vitrification Cell crane bridge to remove and retrieve the defective in-cell cooler unit.

Instrumentation

Various flow, pressure, and temperature indicating devices are located throughout the CC system. A temperature control valve is located downstream of each of the Control Room air handling units and downstream of the ex-cell air handling unit. An air-operated piston-actuated butterfly valve is provided upstream of each of the four Vitrification Cell coolers and upstream of each of the three chiller packages to control flow to these components.

C.5.4.7 Sanitary Facilities

Sanitary facilities are needed to support VF activities. The Sanitary system is designed so as to prevent inadvertent introduction of radiologically contaminated materials or liquids into the system. Sewage from the VF is treated and disposed of by the existing WVDP sewage treatment plant approved by the state of New York. Routine use of sanitary facilities will detect any abnormalities. Sanitary facilities are readily accessible for inspection and maintenance. Instrumentation is provided as necessary to monitor and control sewage treatment and transport evolutions.

C.5.4.8 Safety Communication and Alarms

WVDP site communications and alarm systems are discussed in WVNS-SAR-001 and in WVDP-022, *WVDP Emergency Plan Manual*. WVDP-022 provides information on emergency response equipment, including communications and alarm equipment. Communications equipment listed in WVDP-022 include commercial telephones, the 812 "all page" system, the 222 plant page system, the 223 Ashford Office Complex page system, the Gaitronics system, the power fail telephone system, cellular telephones, portable radios, pagers, and telefax machines. WVDP-022 indicates that alarm features are associated with: the fire detection system, continuous air monitors, process radiation monitors, area radiation monitors, stack monitors, portal monitors, and personnel contamination monitors.

C.5.4.8.1 Alarms

Instrumentation and control facilities, including alarms, that support vitrification processes are discussed in Section 6.6 of this FSAR. Section C.6.6 also identifies the primary process alarms associated with vitrification operations. The DCS, which is the key instrumentation and control system for vitrification processes, is also discussed. Alarms, both area and process, related to vitrification operations are annunciated in the VF Control Room and, in some instances, locally. Alarms associated with the Radiation Monitoring system and Fire Protection system also annunciate on panels monitored by WVDP Security. Continuous air monitors and area radiation monitors have a local alarm function to assure immediate personnel notification and action at the applicable location. The operation and response of specific types of detection and alarm equipment are further discussed in various sections of this FSAR.

Due to the shut-down status of the Main Plant (which includes the EDR and CPC), the Main Plant Control Room is no longer continuously manned. A video camera in the Control Room allows remote viewing of Control Room alarm panels from CCTV monitors in the Main Plant shift office and the utility room. An audible alarm in these areas indicates an alarm in the Control Room. The shift office and utility room are not continuously manned areas; therefore, an additional audible alarm is provided in the main guard house. The main guard house is a continuously manned area. Upon notification of a Control Room alarm, a security inspector notifies the shift supervisor of the alarm condition. For more information on the currently existing active alarms in the Main Plant, see other DOE-approved WVDP safety documentation.

C.5.4.8.2 Site Communications

Incorporated into the WVDP telephone system is the on-site paging/public address system. A paging system is maintained at the WVDP for notification of WVDP personnel. When the appropriate number (i.e., 812) is dialed, a distinct alarm is annunciated over the paging system, followed by a description of the type and location of the emergency. On-site communications systems include telephones, pagers, and radios. The WVDP radio network consists of nets A and B. Net A is assigned to Security and net B is assigned to Operations, Radiation Safety, the Emergency Operations Center, and Security. The WVDP also maintains a radio link with the Cattaraugus County Sheriff's Department, which can be used to request assistance or as a source of information.

C.5.4.8.3 VF Communications

Figures C.5.4.8.3-1 and C.5.4.8.3-2 show communication block diagrams of various areas of the VF. The Paging and Communications system consists of master desktop and field units equipped with the following features:

- All field units housed in weatherproof enclosure,
- Ability to broadcast site wide emergency "812" all-page,
- Centralized main distribution cabinet
- UPS backup power to central cabinet,
- All units equipped with jack for headset operation (master desktop and field units),
- Expandable,
- Talk-back speakers in contaminated areas for listening to equipment or hands free communications for personnel working in contaminated areas.

Many activities associated with the vitrification process are not performed from the VF Control Room. Hence, extensive communications hardware is necessary to ensure proper coordination of various job activities. Of particular significance in this regard are the communications that occur between the Cold Chemical Building and the VF Control Room, and between the local control stations in the Vitrification Building operating aisles and the VF Control Room.

C.5.4.9 Fire Protection System

The VF fire protection and life safety features satisfy requirements of the WVDP Fire Protection Program, which has been developed in accordance with DOE Order 420.1, *Facility Safety* (U.S. Department of Energy October 13, 1995) and DOE Order 440.1, *Worker Protection* (U.S. Department of Energy September 30, 1995). WVDP-177, *WVDP Fire Protection Manual*, provides site-specific guidance in this regard.

Pertinent analyses include the *VF Fire Hazards Analysis* (VF FHA), WVNS-FHA-001. The VF FHA provides a large amount of specific information about the VF fire protection system. Flowrates, discharge pressures, volume of water available, types of pumps, power supplies, design density of the coverage, actuation mechanisms, and other information of this nature are provided in the VF FHA. As indicated in the VF FHA, automatic water sprinkler coverage has been provided throughout the Vitrification Building, except for the Vitrification Cell. The VF FHA concludes that "the results of this FHA conducted in accordance with the documents listed in Section 10 below, indicate that the Vitrification Facility, consisting of . . . and the Cold Chemical Building meets and exceeds the Life Safety requirements for Special-Purpose Industrial occupancies and the DOE property loss requirements."

C.5.4.9.1 Design Basis

The objectives of the VF Fire Protection system are to:

- Minimize the potential for occurrence of a fire;
- Ensure that a fire does not cause an on-site or off-site release of radiological or other hazardous material that would threaten public health and safety or the environment;
- Ensure that an acceptable degree of safety to site personnel in the event of a fire, and that there would be no undue hazards to the public from a site fire;
- Ensure that process control systems would not be damaged by fire (or related perils);
- Ensure that vital DOE programs would not suffer unacceptable delays, as a result of fire or its effects; and

- Ensure that property damage from a fire and related perils would not exceed acceptable levels.

Fire protection is accomplished through design features (i.e., detection and suppression equipment) and personnel and administrative controls. VF design features meet NFPA codes, as documented in the VF FHA, as appropriate for safety- and non-safety-related SSCs. Noncombustible construction materials are used and fire detection and suppression systems of appropriate capacity and capability are provided to minimize the adverse effects of fires. Fire suppression systems are designed to ensure that inadvertent operation, rupture, or failure would not impair the capability of operating systems and components.

Specific criteria utilized as the design basis for the Fire Protection Program are as follows:

- Fire Protection systems comply with DOE 420.1 and DOE 440.1;

- The fire protection design incorporates an "improved risk" level of fire protection as defined in DOE 6430.1A Section 1530-2, and use of the maximum possible fire loss (MPFL) in determining the need to provide automatic fire suppression systems and additional fire protection features (refer to VF FHA and 01-14 Building FHA);

- Fire protection-dedicated water storage and distribution systems meet requirements of DOE Order 6430.1A, Section 1530-9, including NFPA 20, 22, and 24;

- Fire Protection system design flow rate, pressure, and total volume of the water necessary to provide fire protection exceed requirements of NFPA 13, as delineated in DOE Order 6430.1A, Section 1530-3;

- Automatic sprinkler protection complies with NFPA 13 as delineated in DOE Order 6430.1A, Section 1530-4;

- Special extinguishing systems have been installed in addition to sprinkler systems in special hazard areas;

- The standpipes and hose systems comply with NFPA 14 as required by DOE Order 6430.1A, Section 1530-6;

- Portable fire extinguishers comply with NFPA 10, as required by DOE Order 6430.1A, Section 1530-7;

- The fire detection and alarm system meets NFPA 72, as required by DOE Order 6430.1A, Section 1530-8;

- Requirements for nonreactor nuclear facilities, as delineated by DOE Order 6430.1A, section 1530-99.0, are incorporated as appropriate.

Three Fire Protection systems (a water system in the SFR, a water system in the DGR and a halon system in the HVOS) are DBE qualified for structural integrity but not necessarily for function. The DBE seismic qualification is assigned to prevent the fire protection hardware from falling on or impacting against other equipment (e.g., HVAC controls and standby power). Fire Protection systems that are not DBE qualified meet the seismic provisions of the NFPA and UBC codes as outlined in DOE Order 6430.1A.

C.5.4.9.2 Design Features of Structures

The VF is constructed as much as practicable using building components of fire-resistant and noncombustible material, with attention to locations vital to providing confinement. Confinement barriers have been designed to exclude combustible materials. Confinement barriers, particularly the Vitrification Cell, are designed to retain the confinement function during and after credible fire scenarios.

The Fire Protection systems for the Cold Chemical Building and Vitrification Building are shown in Figures C.5.4.9.2-1 through C.5.4.9.2-14. The shell (exterior) of the Vitrification Building is constructed of corrugated sheet metal and one layer of fiberglass insulation (Celotex Thermax Sheathing, a glass-fiber-reinforced polyisocyanurate foam board) over steel structural members. The peripheral walls and partitions are constructed of one layer of 15.9-mm (0.625-in) gypsum wall board over metal studs except in the east truck bay and southwest entry. The Vitrification Cell is constructed of heavily reinforced concrete walls, ceilings, and floors. The cell is approximately 20.1 m long x 11.6 m wide x 14.0 m high (66 ft long x 38 ft wide x 46 ft high), and the pit in the Vitrification Cell is approximately 11.6 m x 7.9 m x 4.3 m deep (38 ft x 26 ft x 14 ft deep). Surrounding the Vitrification Cell are three floors of operating aisles, hallways, and various special occupancy areas. The floors and ceilings of these areas are constructed of concrete with the uppermost level having a metal roof. The VF Control Room is located in the northwest corner of the Vitrification Building and is constructed of one-hour fire-rated enclosure material, 15.9-mm (0.625-in) gypsum wall board. The DGR and the HVOS are both constructed of reinforced concrete. Exit stairwells' structural support components are covered by two layers of 15.9-mm (0.625-in) gypsum wall board and provide a two-hour-rated smokefree egress fire enclosure. Occupied areas in the Vitrification Building total approximately 1,505 m^2 (16,200 ft^2).

The Cold Chemical Building's dimensions are approximately 18.3 m x 10.4 m x 11.0 m high (60 ft x 34 ft x 36 ft high). The occupancy area of the building is 376 m^2 (4,046 ft^2). The building is a two-story, open-bay, corrugated sheet metal structure. The first floor consists of a reinforced concrete slab foundation. The second floor is a combination of open grating and checkered plate. The building's structural and architectural components are all noncombustible.

The 01-14 Building, located south of the Vitrification Building, is used to house the ex-cell Off-Gas system. Dimensions of the portion of the building used for vitrification related off-gas components are 21.3 m x 9.1 m x 18.3 m high (70 ft x 30 ft x 60 ft high). Occupancy areas of the 01-14 Building, including the MCC instrument room, the 4th floor blower room, 01 cell airlock, and portions of the 2nd and 3rd floors of the building, comprise approximately 251 m^2 (2,700 ft^2). The 01-14 Building outer walls are constructed of concrete block and interior cell walls are reinforced concrete. The Off-Gas system instrument room, 01 cell airlock, stairwell, and MCC room enclosures are steel-framed, and have gypsum board interior walls, are insulated, and have metal siding outer walls. The off-gas blower room enclosure is steel-framed with concrete block walls.

C.5.4.9.3 Fire Detection and Protection

Fire detection and suppression includes the following:

- Detection (of heat or smoke),
- Notification of personnel (by audible/visual alarm and control panel light),
- Actuation of flow (of water, halon, or combination thereof), and
- Suppression (of heat, smoke, and/or flame by manual or mechanical methods).

Fire detection and alarm consists of fire detection actuation and alarm and signaling components that detect fires and provide alarm notification of the situation and actuation of fire suppression hardware. Additionally, the actuation functions include shutdown of HVAC equipment and repositioning of dampers. Two stairwell supply fans located in the Vitrification Building are automatically started if a fire alarm occurs anywhere in the Vitrification Building except the VF Control Room. The detection and alarm equipment includes a control panel, detectors, annunciators, manual alarm stations, alarm devices, and associated wiring and connections.

The VF Fire Control Panel (VFFCP) transmits fire and trouble signals to the VF data gathering panels (33-DGP-009 and 33-DGP-010), which in turn relay the signal to the WVDP site central alarm receiving station via telephone lines. The system is capable of being expanded and programmed in the field to add or change devices and to change messages by a licensed subcontractor using the manufactures software program and a portable computer and device programmer. All programmed information is stored in a non-volatile memory. The system is capable of operating addressable ionization and thermal detecting devices, manual alarm stations, and suppression material flow and tamper switches.

Fire detection and alarm devices have Underwriters Laboratory (UL)-listed components or are Factory Mutual (FM)-approved. Devices and systems comply with NFPA 72 as applicable to the VF.

The main fire alarm portion of the VF Control Room and the HVOS are fed from UPS-backed power panels. The VFFCP automatically receives standby power from the PVS diesel generator in the event of a loss of off-site power. In addition, the VFFCP contains its own battery back-up power source. The Fire Protection systems are capable of performing their intended function during and after a normal power outage. Back-up electric power sources with their associated distribution circuits have been installed independently from the normal power supplies and distribution network, and therefore provide a degree of assurance that common mode failures and power disruptions would not affect the back-up power source for the same root cause.

Automatic fire detection components are used to detect small or smoldering fires before enough heat can be generated to activate a Water Suppression system. Their primary purpose is to alert occupants and sound an evacuation. Some detectors are interfaced with the Halon Fire Suppression system in the Control Room and with pre-action sprinklers covering the same area. (The VF Control Room has a Pre-Action Water Spray system installed to provide backup to the Halon 1301 Total Flooding Fire Suppression system.) These detectors are part of the control interfaces used to activate the related system. They also have the function of alerting occupants by audible horns and high intensity strobe lights.

Heat-actuated detectors are used when any of the following conditions exist:

- Speed of detection is not the prime consideration;
- The space is small or confined, and rapid heat build-up is expected; or
- Ambient conditions do not allow use of other detection devices.

Smoke detectors have been installed in all areas. Smoke detectors are of a type operating on one of the principles described in NFPA 72E. A mixture of detector types have been installed, as appropriate. The location and required spacing of smoke detectors have been determined by the methods delineated in NFPA 72E, including Appendix C of that document.

Alarming capabilities associated with the VF have the following basic features:

- Transmission of signals to the fire alarm control panel in the Control Room and the Guard House;
- Local alarms for the building or zone in alarm;
- Trouble signals as specified by code of all detectors, manual pull stations, and interface devices;
- Backup battery for system operation to support a minimum of 24 hours of battery operation;
- Electronic supervision of circuits;
- Supervisory devices for all critical functions (e.g., valve position switches) and operational condition of smoke detectors;
- Capability of annunciating at least three separate conditions, namely a fire alarm, supervisory alarm, and trouble signal indicating a fault in either of the first two. Annunciation of each condition is separate and distinct from the other two; and
- Compatibility with and tied into the existing WVNS fire watch system.

Alarms that respond to flow of water are provided wherever a sprinkler system is installed and comply with requirements of the NFPA standard for the type of signaling system used. Additionally, a manual fire notification method, such as manual fire alarm pull stations, is provided.

C.5.4.9.4 Water Storage and Distribution

Dedicated fire water storage and distribution capabilities are provided. Underground fire water mains, including valves, hydrants, and fittings, have been installed, flushed, and tested in accordance with NFPA 24. Water storage tanks comply with NFPA 22. Fire pumps comply with NFPA 20. Water storage is sufficient to exceed the density, pressure, and duration requirements of NFPA 13. The water distribution system is of the looped grid type, providing two-way flow with sectional valving arranged to provide local isolation at various points in the system. Fire mains (except those supplying a single hydrant or extensions of existing smaller mains) are at least 203 mm (8 in) in diameter. Water mains at the Vitrification Building and the Cold Chemical Building are 203 mm (8 in) in diameter; however, there is some 152-mm (6-in) underground pipe in the distribution piping.

C.5.4.9.5 Manual Fire Fighting

Installation of standpipe systems comply with NFPA 14, and portable fire extinguishers comply with NFPA 10. CO_2 is used in approximately eight portable extinguishers, while about 18 others use dry chemical. Agent quality requirements and installation procedures comply with NFPA 12.

C.5.4.9.6 Sprinkler and Deluge Systems

Sprinkler systems have been installed throughout the Vitrification Building, with the exception of the Vitrification Cell. No fire suppression capabilities have been installed in-cell for reasons stated in the VF FHA. Sprinkler systems comply with the requirements and intent of NFPA 13. Sprinkler supply lead-ins are 203 mm (8 in) in diameter. Post indicator valves that can be locked open have been provided on each supply lead-in.

A pre-action system is installed where it is particularly important to prevent the accidental discharge of water, namely in the VF Control Room. The detection method chosen to activate the pre-action valve has high reliability and a separate alarm and supervisory signal to indicate status. The detection mechanism is designed to be more sensitive than the closed sprinklers in the Pre-Action system, but not so sensitive as to cause false alarms and unnecessary actuation of the Pre-Action system water admission valve.

A Deluge system has been installed in the DGR to remove the heat and lower the temperature of the surrounding area to preclude the spread of fire. The system complies with NFPA 13.

In accordance with NFPA 15, *Water Spray Fixed Systems for Fire Protection*, an automatic water Deluge system is installed for the ammonia storage tank located near the 01-14 Building. The Deluge system is primarily for fire suppression, but also functions as an ammonia-absorbing spray to mitigate accidental releases near the tank. The system consists of a 6,096-mm (20-ft) high metal frame surrounding the tank. The frame is equipped with 11 spray nozzles aimed inward and four heat detectors evenly distributed around the perimeter and height of the tank to provide effective coverage. Since ammonia vapor is partially soluble in water, four ammonia detectors were added to the grid to activate the Deluge system in the event of an ammonia leak. Both sets of detectors (heat and ammonia) are divided into two groups and cross-zoned; at least one detector from each group must activate to trigger the deluge valve. Per ANSI K61.1-1989, *Safety Requirements for the Storage and Handling of Anhydrous Ammonia* (American National Standards Institute, Inc. 1989), the system produces a flow rate of not less than 0.95 L/min (0.25 gpm) per square foot for the vertical sides of the tank and 0.38 L/min (0.10 gpm) per square foot for the top and bottom exposed surface, up to a maximum of 1,893 L/min (500 gpm). The Deluge system is a "dry" system - the flow of water to the outside pipes is valved from the inside the 01-14 Building - so freeze protection of the system is not needed. Its effectiveness in mitigating an ammonia release would depend upon the location of the failure and the release rate from the tank. Activation of the ammonia tank deluge system does not alarm in the VF control room. Because the deluge system is part of the existing fire system (which includes 01-14 Building), it alarms in the Main Gatehouse. This alarm is then reported to the VF control room by security.

C.5.4.9.7 Special Systems

Special Protection systems (e.g., Halon systems) are used to extinguish or control fire in easily ignited, fast-burning substances such as flammable liquids, some gases, and chemicals. They are also used to protect ordinary combustibles in certain high-value occupancy areas that would be especially susceptible to damage. Special Protection systems supplement automatic sprinklers as described by NFPA codes and have not been used to substitute for them except where water is not available for sprinkler protection. Halon systems are provided in the VF Main Control Room and HVOS. The Halon system for the VF Main Control Room is backed up by a Pre-Action system. The installation of Halon 1301 systems comply with NFPA 12A.

C.5.4.10 Maintenance Systems

The Vitrification Cell is equipped with cranes and manipulators that can remotely perform the maintenance functions as well as remove and replace vessels, components, jumpers, and major pieces of equipment. HLWIS maintenance is also provided by remote cranes and tooling. In general, the rest of the VF has been designed for hands-on maintenance. In all cases the equipment that requires hands-on maintenance must be inspected and appropriate action (e.g., by-passing, isolation, flushing, decontamination, etc.) taken to ensure the safety of the site personnel. Little to no maintenance is anticipated in the Transfer Trench. The need to perform hands-on maintenance or remote maintenance in the Transfer Trench is made on a case-by-case basis. WVNS-DC-046, *Design Criteria, Sludge Mobilization Waste Removal System*, provides remote maintenance and replacement design criteria for the Transfer Trench and associated hardware.

Section C.6.4 of this FSAR addresses some of the more significant features for performing maintenance activities (e.g., cell cranes, the transfer cart, and the CMR). Section C.5.2.7.5 and Figure C.5.2.7.5-1 indicate that adequate space is available in the HLWIS to accommodate the storage of replaced process equipment, including one or more of the larger process components (e.g., the SFCM or CFMT).

C.5.4.11 Drain Systems

Drain systems collect fluids from various other vitrification-related systems or areas and transfers them to the appropriate processing system or storage tank.

The VF Drain systems are designed to:

- Support ALARA requirements when washing down or draining potentially radioactively contaminated systems and components;

- Prevent inadvertent transfer of radioactive contamination to uncontaminated Drain systems;

- Indicate leakage or spillage on the in-cell apron, in the SFR, or in the Cold Chemical Building.

The VF Drain systems are composed of three separate systems to handle fluids from segregated or distinct areas. The Drain systems consist of the High-Level Drainage System (HLDS), the Low-Level Drainage System (LLDS), and the Cold Chemical Sump System (CCSS). Fluids are routed by gravity, or a combination of gravity and pumping, to the appropriate system for processing or a storage tank and subsequent processing or removal. Whenever possible, gravity is used for the movement of fluids to processing systems. If a gravity flow path is precluded because of location or other design requirement, fluids are pumped from a collection area or tank.

The HLDS and the LLDS are not interconnected to prevent inadvertent transfer of high-radioactivity fluids to low radioactivity or nonradioactive systems. As a result of this non-interconnection of systems and by virtue of the layout of the vitrification-related systems and equipment, high-activity fluids are isolated in-cell or within defined confinement features. The CCSS handles fluids in the Cold Chemical Building, which is segregated and does not contain radioactive fluids.

The VF Drain systems do not serve a safety function for accident mitigation and therefore are not required to operate during postulated WVDP accident conditions. The VF Drain systems are shown on Figures C.5.4.11-1 through C.5.4.11-3.

System components consist of drain fittings, pipes, valves, sumps, tanks, and pumps specifically designed to achieve rapid and unobstructed flow from the fluid effluent point to the point of processing or storage. Components are selected for planned or anticipated liquids to be received.

Each system is engineered to convey the design volume of effluent or leakage expected. Uncontrolled volumes of liquids resulting from equipment failure or tank overflow are directed to the appropriate floor drains or sumps. Floors are pitched to the proper floor drain or sump for carry-off of spillage. Controlled release of liquids also directs the liquids to the associated drain via floor grade or drain tubing, as required.

Gravity drain systems are designed using the normal anticipated maximum discharge through an enclosed pipe. Horizontal drain pipe is sloped at a uniform rate. Drain piping is seamless stainless steel, Type 304L. Piping is butt-welded, with stainless steel filler to prohibit contamination or debris build-up. Fittings are drainage pattern whenever possible and are installed so as to provide a continuous extension of piping runs. Discharge lines from pumps are routed as directly as possible to their destination, so as to minimize turns and traps which can slow liquid flow.

Drain piping is either 102 mm (4 in), 76 mm (3 in), or 51 mm (2 in) in diameter. Ex-cell Drain systems use cleanouts to permit cleaning in the event of a blockage. The size of cleanouts are in proportion to the size of the pipe they serve. Cleanouts are located where the change in horizontal runs exceeds 90°, at a maximum interval of 15.2 m (50 ft) on straight runs, and at the base of vents (stacks). Piping runs embedded in concrete or located in inaccessible areas have cleanouts extended to accessible locations. The use of 51-mm (2-in) pipe is limited to areas where anticipated fluid flow rates are low and are not likely to produce drain fluids containing particulates that might fall out of suspension.

Strainer plates are used and are made from stainless steel to minimize build-up of corrosion. Strainer plates are either 102-mm or 152-mm (4-in or 6-in) squares. In addition to preventing oversized debris from entering the Drain system, strainer plates serve to limit the in-flow of liquid, and thus minimize the potential for backflow into other areas associated with the same drain line or system.

C.5.4.11.1 High-Level Drainage System

The HLDS collects radioactive fluids from in-cell areas and potentially radioactive ex-cell areas during normal operations and discharges them to the Vitrification Cell south sump, which is considered part of the Liquid Waste Header system. The Liquid Waste Header system subsequently transfers the fluids back to the main process via (waste) Tank 8D-4.

The areas served by the HLDS are the in-cell transfer cart area, Vitrification Cell apron area, Transfer Tunnel, SFR and CMR sumps, and the off-gas trench sump. The SFR sump receives fluids from the secondary filter units, SFR, SFR shielded plenum floor, HVOS, and DGR.

The HLDS lines to the south sump do not incorporate traps, but are self-vented. The HLDS to the SFR incorporates a water seal in the SFR sump to isolate ventilation between the sump area and the areas served. The minimum water level is maintained by tripping the sump pump at the predetermined low-level setpoint. In the event of insufficient or infrequent fluid flow to the sump, provisions can be made to maintain the minimum water level in the sump by adding utility water. The sump low-level switch would alert the Control Room operator to add water.

The SFR sump has been sized to accommodate anticipated normal and transient fluid flows from areas and equipment it serves. The sump has been provided with a full capacity pump operated by a level switch. When the level reaches the predetermined high setpoint, the level switch automatically starts the pump and opens the pump discharge valve. The level switch also shuts off the pump and closes the valve upon reaching the low setpoint. If the SFR sump level continues to rise and reaches the predetermined high-high setpoint, an alarm is initiated in the Control Room. Local control of the pump is provided to enable manual operation.

The ex-cell HLDS lines drain to the SFR sump, where sump fluids are then pumped to the Vitrification Cell south sump for eventual removal by the Waste Header system, as discussed in Chapter 6.

C.5.4.11.2 Low-Level Drainage System

The LLDS collects fluids during normal operations from low activity or nonradioactive ex-cell areas and transfers the liquid to the Low-Level Waste Treatment system via the existing interceptor line for processing and eventual release.

Areas served by the LLDS are as follows:

- Operating aisles (elevation 30.5 m [100.00 ft], elevation 33.5 m [110.00 ft], and elevation 38.1 m [125.00 ft]),
- CMR operating aisle (elevation 40.0 m [131.33 ft]),
- Control Room HVAC equipment area,
- Mechanical room above truck lock area, and
- Truck lock area.

The LLDS is constructed from 304L stainless steel. The headers are vented above the roof of the Vitrification Building. Rainwater is prevented from entering the pipe by the use of downturned end sections. Vent openings are covered with screens to prevent entry by birds. Ex-cell drain lines use water seals (traps) to prevent air or gas flow from one area to another. Each floor drain is initiated with a nominally sized 102-mm x 76-mm (4-in x 3-in) conical reducer that penetrates the floor and is covered with a stainless steel drain plate. A nominally sized 76-mm (3-in) pipe continues the run through an isolation trap, with a 152-mm (6-in) water column, and drains into a nominally sized 102-mm (4-in) collector pipe. The collector pipes combine to drain their contents to a nominally sized 102-mm (4-in) interceptor line (part of the existing plant), which drains to the Low-Level Waste Treatment system for final processing and disposal.

C.5.4.11.3 Cold Chemical Sump

The CCSS collects fluids in the Cold Chemical Building and transfers them to the Cold Chemical Drain Tank for hold-up and subsequent processing or transfer off-site for disposal. The CCSS is shown in Figure C.5.4.11-3.

The CCSS collects fluids from the following areas:

- Cold Chemical Building floor drains,
- Cold Chemical Building main floor via floor trench,
- Cold Chemical Building eyewash and shower drip pan, and
- CCS vent header drain line.

The CCSS utilizes a motor-operated sump pump and associated level switch to turn the pump on and off based on predetermined setpoints. The dimensions of the sump are approximately 610 mm x 610 mm x 558 mm deep (2 ft x 2 ft x 1.83 ft deep). Building fluids are routed to the sump via gravity drains or the floor trench. The floor trench is an open design covered by a grating and screening to allow passage of fluids. The trench is sloped towards the sump.

The vent header is normally under negative pressure to assure proper ventilation flow of the components it serves. Component overflow is routed to the sump for transfer to the hold tank.

C.5.4.12 Lighting Systems

Adequate lighting is necessary for performing various operations and inspections associated with the vitrification process, and for allowing safe egress of personnel. Lighting systems are designed to provide illumination throughout the VF during normal and other than normal plant operations. The Lighting systems and their power sources are designed to provide sufficient illumination to enable the plant operators to perform all manual operations required at all times and to move safely through essential areas of the VF. Exit and Emergency Lighting systems comply with NFPA 101 and NFPA 110.

Plant lighting is divided into three main systems:

- Normal AC Lighting system,
- Normal/Emergency AC Lighting system, and
- DC Emergency Lighting system.

C.5.4.12.1 Normal AC Lighting System

The normal AC lighting is energized continuously from 480V switchgear A2 through a three-phase, four-wire, 480-208Y/120V dry type transformer. This transformer feeds lighting panel LP-6, the local area lighting panel. In-cell lighting is also energized from LP-6. Normal AC lighting to the VF Control Room is energized from power panel PP-7. When the PVS backfeed procedure has been implemented, any of the normal lighting may be activated by the Vitrification Operations Shift Supervisor.

C.5.4.12.2 Normal/Emergency AC Lighting System

The Normal/Emergency AC Lighting system is energized from the 480 Cold Chemical MCC through a three-phase, four-wire, 480-208/120V power transformer. This transformer feeds area power panel PP-7. The normal/emergency lighting is available under all plant conditions. The normal/emergency lighting provides the necessary lighting essential to the safe and orderly operation of the VF during loss of normal AC power. Normal/emergency lighting is provided to all areas of the VF, including those areas required for the safe shutdown of the vitrification process and evacuation of personnel in the event of an accident. Emergency lighting is not installed in the Vitrification Cell, CMR, or the Transfer Tunnel. The yard area is serviced by security lighting.

C.5.4.12.3 DC Emergency Lighting System

The DC Emergency Lighting system provides illumination during the loss of the normal/emergency lighting sources. This battery-energized lighting complies with NFPA 101 and NFPA 110 requirements, and illuminates egress pathways.

C.5.4.13 Natural Gas

A disconnected natural gas supply line is provided to the Vitrification Building, but it is not used in any vitrification process or system. The natural gas line is routed from the Main Plant and enters the Vitrification Building in the southwest corner at the 30.5-m (100-ft) elevation. The 51-mm (2-in) diameter pipe emerges from the floor and is immediately valved off and capped. In addition, the natural gas line is physically disconnected from the supply of the Main Plant to assure natural gas is not brought into the Vitrification Building.

C.5.4.14 Diesel Generator Auxiliary System

The VF is provided with stand-by electrical energy from a 600-kW diesel generator unit. The components of the Diesel Generator Auxiliary system are:

- Prime mover (engine),
- Fuel Oil system,
- Cooling system,
- Starting system, and
- Combustion Air Intake and Exhaust.

These components are expounded in detail below.

C.5.4.14.1 Prime Mover

The prime mover (engine) is designed to provide rated mechanical power output, using #2 fuel oil (diesel) as the primary combustion fuel, to enable the attached electrical generator to develop 600 kW rated power output.

The diesel generator engine and its attached accessories are lubricated by a pressurized engine-driven Lube Oil system. The internal components of the engine block and the head/valve assemblies receive conditioned lube oil in sufficient volume to provide lubrication and cooling effect as needed to promote reliable bearing and rotating part life for the engine.

C.5.4.14.2 Fuel Oil System

The Fuel Oil system for the VF diesel generator consists of a 27.9 m^3 (7,370-gal) fuel storage tank, transport system, 0.76-m^3 (200-gal) day tank, and related equipment to supply #2 fuel oil to the diesel generator. It is designed to provide a seven day fuel supply, assuming constant operation at full load. The Fuel Oil system also supplies fuel for the PVS diesel generator and the diesel-driven fire water pump.

The Fuel Oil system is enclosed in a metal shed that provides some weather protection for the tank and the transfer equipment against rain and dust, but the building is not heated except for two small heaters that maintain the sump area above freezing.

To prevent the fuel oil from becoming too "thick" for the pump to handle, an electrical heating element has been inserted in-line between the storage tank and the pump. When the pump is energized and the fuel oil temperature is below 4.4°C (40°F), the heater is turned on to lower the oil viscosity. Further, all fuel lines in the fuel oil shed are kept warm with heat trace elements.

C.5.4.14.3 Cooling System

The diesel generator engine is equipped with a liquid Cooling system with a radiator.

C.5.4.14.4 Starting System

The battery-driven Starting system consists of a starter, battery, and battery charger. The Starting system is designed to perform repeated hot and cold starts of the diesel generator.

C.5.4.14.5 Combustion Air Intake and Exhaust

The diesel generator Combustion Air Intake and Exhaust system provides the engine with properly conditioned (boosted) intake manifold air from the discharge of the turbochargers through the intake manifold to the combustion chamber(s) of the engine. The exhaust gases produced by the combustion chamber reaction flow to the turbocharger turbine inlet and impart energy to the turbine blades, driving the shaft and compressing the intake air. The exhaust gases continue to flow out of the discharge of the turbochargers and are directed away from the engine, through the flexible connections to a silencer, and outside the building via an exhaust pipe with a rain cap.

C.5.5 Confinement Systems

Safety features have been engineered into the design of the VF to minimize the potential environmental risks of the release of radioactivity due to loss of confinement. The safety features include a system of confinement barriers that function both during normal vitrification operations and during accident conditions or extreme environmental accident conditions. By definition, a confinement barrier serves to restrain, but not necessarily totally contain, the contents within it.

There are two types of provisions to confine radioactive materials during normal, abnormal, and accident conditions.

- Passive confinement barriers, including walls, hatches, roofs, doors, and shielded viewing windows.

- Active confinement systems or components, including the blowers associated with maintaining a negative pressure (relative to atmospheric pressure) in the Vitrification Cell.

C.5.5.1 Passive Confinement Barriers

During normal (process) operations, the majority of the HLW radioactive inventory of the vitrification operations is confined and controlled by the primary process vessels described in Chapter 6. These vessels include the CFMT, MFHT, SFCM, and SBS. These vessels serve as the primary passive confinement barrier during normal operations. The Vitrification Cell is the next and final passive confinement barrier relied upon. The below grade stainless steel lined process pit and sumps provide confinement for spilled HLW liquids.

During extreme accident conditions, such as a DBE, it is likely that the process vessels would maintain structural integrity, due to the structural safety margins discussed in Section C.5.2. If these vessels maintain their integrity during a DBE, as predicted by analysis, adequate confinement of the Vitrification Cell radioactive inventory is largely assured. Leakage from damaged jumpers, jackets, and connections may cause process liquids to spill to the floor of the process pit during extreme accident conditions.

Due to the acknowledged possibility that process liquid and/or melter contents may leak into the pit of the Vitrification Cell, the accident analysis (in Chapter 9) does not take credit for the process vessels and postulates that one or more of the primary vessels fail and the contents spill to the Vitrification Cell pit and/or floor. Physical confinement of the spilled HLW slurry and/or melter contents would be accomplished within the pit and sumps. The pit extends from the elevation 26.2-m (86-ft) level to the Vitrification Cell floor elevation level of 30.5 m (100 ft). The pit and cell stainless steel liner ends at the 37.5-m (123-ft) elevation level. Above the 37.5-m (123-ft) level the concrete wall surfaces are coated with Ameron 400 epoxy. The confinement items relied upon for accident conditions are the reinforced concrete walls and roof, doors, hatches, cell penetration seals, shielded viewing windows, and filtered Exhaust system. However, as the accident analysis in Chapter 9 of this FSAR demonstrates, the Exhaust system filters are not needed to keep doses to off-site and on-site receptors below the Evaluation Guidelines provided in Chapter 9.

The primary passive confinement structures are the reinforced concrete vault structures that enclose the Vitrification Cell, CMR, and Transfer Tunnel. These structures will maintain their confinement integrity during all credible environmental load conditions, as discussed in Section C.5.2.

C.5.5.2 Active Confinement Barriers

The reinforced concrete vault surrounding the vitrification process has a series of openings and penetrations that are covered by special doors, shield windows, and sealed piping penetrations. A negative internal pressure relative to outside atmosphere and relative to adjacent areas in the Vitrification Building is provided through a filtered HVAC system to prevent uncontrolled leakage of airborne radioactive material from the Vitrification Cell.

Three distinct Ventilation systems provide active confinement.

- The Vitrification Building HVAC system, which also services the Vitrification Cell;
- HLWIS and EDR Ventilation, which utilizes the existing Main Plant and Head End Ventilation systems;
- Process Off-Gas system.

The Vitrification Building HVAC system is described in Section C.5.4.1.1. The Off-Gas system is described in Sections C.6.3 and C.5.5.4. The HVAC systems that service the EDR and HLWIS are discussed in Section C.5.4.1.7.

The Vitrification Building HVAC system includes a Ventilation Supply Air system and a filtered exhaust system. The Ventilation Supply Air system is not part of the engineered confinement barriers, is not required to function under extreme environment design basis events, and has not been seismically qualified.

The HVAC systems that service the HLWIS and EDR and the ex-cell components of the Process Off-Gas system and 01-14 Building components are not seismically qualified. DBE qualification of these SSCs is not necessary to maintain doses to receptors during accident conditions below Evaluation Guidelines, as indicated in Chapter 9 of this FSAR.

Radioactive particulate filtration of Vitrification Cell exhaust air is accomplished by a HEPA-filtered Exhaust system, which is described in Section C.5.4.1. Contamination control is achieved by providing HEPA filtration and by differential pressure control, and by maintaining minimum recommended average air velocity (38.1 m/min [125 ft/min]) across openings between areas of different levels of potential contamination.

C.5.5.3 Vitrification Cell Filtered Exhaust System

The Vitrification Cell filtered Exhaust system is an engineered safety feature with leakage Class II as defined in ANSI/ASME N509. The Exhaust system has been designed to maintain structural integrity and remain functional during and after the postulated occurrence of the design basis events (DBE and DBT) in combination with normal operating loads such as temperature and pressure.

The portions of the Vitrification Building HVAC system that serve to support the Vitrification Cell confinement barrier function were designed and fabricated in accordance with codes and standards shown in Table C.5.5.3-1, as applicable.

In the event of loss of off-site power, the Vitrification Building HVAC system is designed to run on standby power provided by the VF diesel generator. The DGR is hardened to withstand the design basis extreme environmental events to ensure that back-up power is available to run the active HVAC components if normal site power is lost. However, the accident analysis provided in Chapter 9 demonstrates that the Vitrification Building HVAC system exhaust blowers are not necessary to maintain doses to receptors during accident conditions below Evaluation Guidelines.

The HVAC ducts and their supports, primary HVAC HEPA filter units, and secondary HVAC HEPA filter unit are protected against wind, tornado, and tornado-generated missiles by reinforced concrete structures, special doors, shielded viewing windows, and tornado missile grating.

Exhaust system control, operation, and monitoring are performed from the control console located in the HVOS.

If both of the Exhaust system blowers are unavailable, the system still provides adequate confinement as long as the HEPA filters are intact. If power is lost, the appropriate butterfly valves and dampers are closed to isolate the Vitrification Cell.

Dames and Moore performed independent assessments of the VF HVAC on systems and components (Gates and Gorman September 20, 1994; September 19, 1994) to determine structural integrity of the components during and after a DBE. A summary of the results of these studies is presented in Table C.5.5.3-2. The table shows that the SSCs key to the confinement function will withstand a DBE event without loss of structural integrity. All of the equipment in Table C.5.5.3-2 has been seismically qualified for the 0.1g DBE. More information from these studies is presented in the detailed discussions and tables in the sections below.

C.5.5.3.1 HEPA Filter Integrity Considerations

The worst accident scenarios, from a confinement barrier integrity point of view, would be for the contents of the SFCM and the CFMT or MFHT to spill on the cell floor creating steam that condenses on the HEPA filters that service the Vitrification Cell atmosphere, thereby causing the filters to breach due to an excessive pressure differential across the filters. This scenario could result in a non-negligible dose to receptors both on-site and off-site; however, the accident analysis provided in Chapter 9 of this FSAR demonstrates that these HEPA filters are not necessary to maintain doses to receptors during accident conditions below Evaluation Guidelines.

C.5.5.3.2 Primary HVAC Filter Units

Each of the three in-cell primary filter units is to operate at an approximate flow rate of 2.0 m^3/s (4,250 cfm) of Vitrification Cell air. During the vitrification process, only two primary filter units are required to operate and the third filter unit is normally on standby. Each primary filter unit exhausts through a 305-mm x 660-mm (12-in x 26-in) rectangular duct welded to an embedded plate in the cell wall. This 12.7-mm (0.5-in) thick stainless steel duct passes through the cell wall at 45° (to provide shielding) and enters the SFR near the roof of the SFR. Three 508-mm (20-in) diameter ducts connect to the three primary filter exhaust ducts and transfer the in-cell air to the secondary filter assembly. Flow through each primary filter unit is controlled by a pneumatically operated butterfly valve located in the SFR in each of the three 508-mm (20-in) diameter air ducts from the in-cell primary filter units.

The primary filter units are designed to maintain their structural integrity and remain functional during and after the DBE.

Dames and Moore conducted an independent evaluation (Gates and Gorman September 19, 1994) of the primary HEPA filter design to determine the margins of safety during a DBE event. Table C.5.5.3-2 shows that the margin of safety against structural failure or loss of function of the primary filter units exceeds 3 x DBE.

C.5.5.3.3 Secondary HVAC Filter Unit

In-cell air from the primary filters is exhausted directly through the Vitrification Cell wall via ducts into the secondary filter assembly. In addition, ex-cell air from the operating aisles is drawn directly into the secondary filter assembly through a duct that passes from the operating aisles through the HVOS and into the SFR. This ex-cell air duct contains a butterfly isolation valve and a tornado damper. These in-cell air and ex-cell air streams are passed through separate chambers of the secondary filter assembly and are exhausted via a duct into a free-standing plenum. The air is drawn out of the plenum by the exhaust fans.

The secondary filter assembly is located in the SFR, a reinforced concrete structure located adjacent to the Vitrification Cell. The secondary filter assembly removes any remaining radioactive particles from the air exhausted from the primary filters and serves as a backup during both normal and accident operational conditions.

Dames and Moore conducted an independent evaluation of the secondary HEPA filter assembly structural design to determine the margins of safety during a DBE event. The margins of safety of the secondary filter assembly are summarized in Table C.5.5.3-2. These margins of safety have been based on analytical assessment and shake table testing of the upper filter units. Table C.5.5.3-2 shows that the margin of safety against structural failure and loss of function exceeds 6 x DBE.

C.5.5.3.4 Blowers (Fans) and Stack Exhaust

Each Vitrification Building HVAC system exhaust fan has a capacity of 12.65 m^3/s (26,800 cfm) for a design air flow of 11.33 m^3/s (24,000 cfm). One exhaust fan is operating and one is on standby. Butterfly valves are used to control the flow path and to isolate the stand-by fan unit.

Independent analysis and review of the exhaust fan unit by Dames & Moore (see Table C.5.5.3-2) found that the margin of safety against structural failure and loss of function was > 4 x DBE, and for seismic anchorage was > 10 x DBE. Exhaust air exits the active exhaust fan via its own 914-mm (36-in) diameter and 6.4-mm (0.25-in) thick stainless steel duct and is controlled by butterfly valves. The two ducts join at a common 1,219-mm (4-ft) square plenum hung close to the roof of the SFR. A 914-mm (36-in) duct exits this plenum and passes through the roof of the SFR to the outside of the Vitrification Building. A tornado missile barrier protects the duct after it exits the Vitrification Building up to a pressure relief valve. Beyond the pressure relief valve, the duct passes along the outside of the CMR wall and exhausts from a stack, which is 22.9 m (75 ft) above the ground (elevation 53.3 m [175 ft]). The duct beyond the protected pressure relief valve is considered to be expendable.

C.5.5.3.5 Ductwork Accessories

In addition to the ducts themselves, several ductwork accessories integrated into the ductwork are used to control the Ventilation system. These accessories include filters, dampers, air-activated butterfly valves, tornado dampers, pressure relief valves, and flexible duct connectors. Ductwork accessories in contact with contaminated air are fabricated from stainless steel. The integrity and functioning of these accessories is required during and after the occurrence of the DBE. The accessories are designed to withstand a DBE.

The HVAC ducts and supports are protected against wind, tornado and tornado-generated missiles by the reinforced-concrete vault, special doors, and shielded viewing windows. The section of duct above the roof of the SFR up to the stack pressure relief valve is protected by a tornado missile grating. The only extreme environmental loading considered for the design of the ducts is seismic.

C.5.5.3.5.1 Tornado Dampers

Tornado dampers are provided at select HVAC penetrations to prevent air backflow during a tornado. The tornado dampers are designed and qualified to operate under DBT conditions. During tornado conditions the dampers close automatically to isolate and protect the HVAC system elements from the effects of reverse air flow or excess air flow caused by the uncompensated pressure deficit in the vortex of the tornado. The dampers are self-actuating and require no external power source or signal for operation. During normal operation the dampers remain open. The seismically designed tornado dampers are listed in Table C.5.5.3.5.1-1. Tornado dampers close in 0.20 seconds or less, given a 1,034 Pa/second (0.15 psi/second) or greater rate of change in atmospheric pressure.

C.5.5.3.5.2 Dampers

Dampers for ducts are provided to control air volume flows. The seismically designed dampers are listed in Table C.5.5.3.5.2-1.

C.5.5.3.5.3 Stack Pressure Relief Valve

The stack pressure relief valve is self-actuating and is magnetically held closed. At the design air pressure differential, the pressure relief valve opens. The exhaust stack pressure relief valve (used for exhaust vent relief) is seismically designed. This relief valve is protected from tornado generated missiles by a missile grating enclosure, and relieves (i.e, opens) at a pressure of 152 mm (6 in) water gauge.

C.5.5.3.5.4 Butterfly Valves

Air-activated butterfly valves are used to control duct air flow. They are pneumatically operated by air cylinder actuators that stroke the disk valve open - closed in response to the programmed control logic for normal/upset operation. The valves can also be positioned manually via the programmable logic controller operator interface, and by manually de-clutching the pneumatic actuator. The seismically designed butterfly valves are listed in Table C.5.5.3.5.4-1. All of the butterfly valves listed in Table C.5.5.3.5.4-1 are provided with fail-safe redundant high pressure control air to maintain valve function if the Instrument Air system fails.

C.5.5.3.5.5 Flexible Connectors

Flexible connectors are used, where required, to structurally isolate the HVAC ducts from other equipment. The flexible connectors are made of neoprene-coated glass fabric having the same leak tightness as the adjoining ductwork. Glass is noncombustible and the resistance of neoprene (polychloroprene) to ignition and burning has been recognized for many years. Polychloroprene has a kindling temperature of 900°C (1,652°F). The flexible connectors do not transmit loads between connecting parts and allow differential displacement between the two connected items.

C.5.5.3.5.6 Wall Penetrations

Where the ducts penetrate reinforced concrete confinement walls and roof, they are welded to duct sections embedded in the concrete. These penetration details prevent air leakage through the penetration.

C.5.5.3.5.7 Duct Supports

The HVAC ducts and supports were designed for seismic loads using conservative hand calculation procedures that are typically used in the design of HVAC ducts. The ducts are supported by duct supports attached to the reinforced concrete confinement structures. Four general types of supports (strut, trapeze, frame, and saddle) are used to support the Ventilation system ductwork located in the SFR, the HVOS, the DGR, and the CMR.

All of the duct supports are fabricated from A36 carbon steel and are welded to embedded plates in the floor, walls and roof of the reinforced concrete confinement structures.

Dames and Moore conducted an independent analysis of the HVAC ducts and duct supports associated with the Vitrification Cell. Table C.5.5.3-2 provides information regarding the margin of safety associated with ducts and duct supports. The table shows that there is a large margin of safety between the demand under the DBE and the ultimate capacity of the HVAC ducts and their supports.

C.5.5.4 Ex-Cell Off-Gas System

The Ex-Cell Off-Gas system, located in the 01-14 Building provides for the safe removal of process gases from the melter while maintaining the melter, related vessels and ducting at a slight vacuum for contamination control. Building 01-14 was selected as the location for the Ex-Cell Off-Gas system because the original processing plant Off-Gas system was located there and some of the existing components are used in the new system. The 01-14 Building location also provides ready access to the Main Plant discharge stack, through which the processed off-gas is released.

Ventilation to the cells within the 01-14 Building is provided by a ventilation system described in other DOE-approved WVDP safety documentation. The building is designed to maintain air flow from clean areas to areas with higher potential for contamination. The exhaust air from the building is filtered through two stages of HEPA filters to remove contaminants before it is released to a stack. The exhaust blower that maintains the negative pressure is backed up by another blower that automatically takes over if the operating blower fails.

The Ex-Cell Off-Gas system is designed to be continuously operable for the entire (approximately 30 month) vitrification campaign. This is largely accomplished with redundant equipment trains, to provide a spare operating system when equipment fails and to allow maintenance while the system is operating. The off-gas conditions entering the 01-14 Building are shown in Table C.5.5.4-1.

The Ex-Cell Off-Gas system is monitored and partially controlled from the VF Control Room. Blower speed and ammonia flow to the NO_x reactors can be controlled from the VF Control Room but some operations such as some valve alignments must be done locally. Instrumentation signals are tied into a "Micon" cabinet located in the Instrument Room of the 01-14 Building. The Micon is energized from an Uninterruptible Power Supply (UPS), and its signals are connected to the Distributed Control System (DCS).

The primary processing components of the Ex-Cell Off-Gas system (01-14 Building) are schematically shown in Figure C.5.5.4-1. The Ex-Cell Off-Gas system is connected to the In-Cell Off-Gas system by a 250-mm (10-in) diameter duct located in the shielded Off-Gas Trench. Insulation on the 250-mm (10-in) duct and the steam energized trench heaters are intended to prevent condensation, and an entrainment separator is intended to preclude condensate, should some form, from arriving at the 01-14 Building. Liquid accumulated at the entrainment separator is directed to a condensate collection tank, from which it can be pumped to the south sump in the Vitrification Cell. Liquid in the south sump is cycled back to Tank 8D-4 via the Waste Header system. After passing through the entrainment separator, the off-gas passes through one of two redundant reheaters (480 V, 3 phase, 60 kW) and one of two redundant HEPA filter trains which each contain two HEPA filters in series. The housings encasing the HEPA filters are standard bag-in/bag-out type design. Redundancy allows isolation for maintenance in case a reheater fails or in case a filter needs to be changed.

Three positive displacement, 75 hp, 3 phase, 460 V, rotary lobe type blowers, arranged in parallel, are located downstream of the HEPA filters to provide the motive force for the Off-Gas system. This arrangement allows one blower to be in use, one to be isolated for maintenance, and the third to be on stand-by service. Two of the three blowers can automatically receive back-up power from on-site diesel generators. The blower suctions are equipped with vacuum relief valves and the blower discharges are equipped with pressure relief valves that relieve to the suction side of the blowers.

The discharge from the blowers passes through a Selective Catalytic Reduction (SCR) NO_x abatement system (shown in Figure C.5.5.4-1) that eliminates oxides of nitrogen using ammonia gas (NH_3) as the reactant. (See Section C.6.2.3 for details of the chemical reaction.) The system includes two redundant parallel reactors, which allows one to be isolated for maintenance. Each reactor is preceded by redundant electrical preheaters (480 V, 3 phase, 101 kW) and a static mixer to mix the ammonia and the off-gas.

An analyzer for NO_x is connected upstream of the reactors and two analyzers, one for NO_x and one for ammonia, are connected downstream of the reactors. One spare NO_x analyzer is provided which can analyze off-gas from either upstream or downstream of the catalytic reactors and is available to replace an operating analyzer during calibration. Both the NO_x and ammonia analyzer sampling lines are heat traced to prevent condensation within the line, which could affect the instrument readings. Continuous ammonia measurements are not required for the automated process control; therefore, no spare analyzers are required during brief ammonia analysis calibration operations. Bottles of analyzer calibration gases are located outside, at ground level, next to the 01-14 Building.

The NO_x reactor vessels are right cylinders with conical top and bottom sections, made from Type 321 SS, standing on four legs, with the inlet at the top and the outlet at the bottom. The sides and conical sections are 6.4 mm (0.25 in) thick and the overall height of each reactor is 4.3 m (14.1 ft) and the diameter of the vessel is 1.0 m (3.3 ft). The reactors are insulated with calcium silicate to maintain the surface temperature below 60°C (140°F). The insulation is jacketed with Type 304 SS. The reactor vessels are American Society of Mechanical Engineers (ASME) code stamped for the following conditions:

• Pressure	170 kPag (25 psig)
• Temperature	540°C (1,000°F)

Proprietary zeolite based catalysts are used in the reactor. The catalyst beds are 1.12 m (3.7 ft) deep.

Each catalytic reactor has three temperature sensors that continually monitor the temperatures within the reactor bed. This information is collected by the DCS and used to restrict the ammonia feed should the reactor temperature become too high. A reactor high temperature alarm will sound if the temperature becomes excessive. The pressure differential across the bed is also monitored and alarmed on the DCS.

After passing through the NO_x reactor, the off-gas is routed to the Main Plant exhaust stack through an insulated 200-mm (8-in) diameter pipe. The exhaust stack has radiation monitors for alpha and beta/gamma activity, which are fed by an isokinetic sampling probe. The stack radiation monitoring sample lines are heat traced to prevent condensation within the sample lines during cold weather.

The 01-14 Building is a four story building shared by the Cement Solidification System (CSS) where low-level waste was solidified. The building dimensions are 12.5 m x 10.0 m x 18.3 m high (41 ft x 33 ft x 60 ft high). The outside walls of the service area are constructed of 305-mm (12-in) concrete block. The process cell walls are 610-mm (2-ft) thick reinforced concrete. The base of the building is a 610-mm (2-ft) reinforced concrete pad. The cell floor is covered with a 3.2-mm (0.125-in) stainless steel liner, which extends 457 mm (1.5 ft) up the side of the wall. Access into the building is through a door on the north side of the building which leads to a stairwell. The ex-cell off-gas equipment is located in the northwest cell of the building. General arrangement plan and section views are shown in Figures C.5.5.4-2 through C.5.5.4-7. The equipment is supported in the cell at various elevations (as shown in Figure C.5.5.4-7) and platform grids provide access to maintain the equipment.

The anhydrous ammonia storage tank and vaporizers are located outside, near the north wall of the 01-14 Building on the short northsouth section of the Off-Gas Trench, as shown in Figures C.5.5.4-2, -3, and -6. The location provides the following advantages:

- The run of piping from the ammonia supply piping is short.
- The ammonia tank fill connection is remote from the tank and accessible from the road.

The above ground ammonia tank sits on a concrete pad above the Off-Gas Trench adjacent to the 01-14 Building. The tank is situated vertically and supported on four reinforced legs. The tank (shown in Figure C.5.5.4-8) is a carbon steel right cylinder 5.2 m (17 ft) tall, 1.07 m (3.5 ft) in diameter, with elliptical dished heads, and a corrosion allowance of 3.2 mm (0.125 in). It is designed for a maximum inventory of 3.8 m^3 (1,000 gal). The tank is designed to American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section VIII, Division 1, and code stamped for the following conditions:

- Pressure — 1.7 MPag (250 psig)
- Temperature — 43°C (110°F)

Fabrication, installation, and testing of the ammonia storage tank and supply subsystem has been performed in accordance with the latest edition of ASME Section VIII - Division I and the requirements of 29 CFR 1910.111, the recommendations of the Compressed Gas Association (CGA) Pamphlet G-2, and the American National Standards Institute (ANSI) Pamphlet K61.1. An automatic water deluge fire protection system surrounds the tank.

A fill line is routed west to the service road, allowing remote direct transfer from the supply truck. The tank has a locally mounted level indication and a level transmitter, which is connected to the DCS. The tank is alarmed to the DCS for both low and high levels.

Redundant electric emersion vaporizers (18 kW, 480 V, 3 phase), located beneath the ammonia tank, are used to vaporize an average of 18 kilograms of ammonia per hour. One vaporizer operates, while the other serves as an installed backup. The heating bundles employ eighteen elements sheathed in Incoloy 800. The pressure transmitter is connected to the DCS which modulates the energy directed to the vaporizers and automatically switches to the backup vaporizer if the pressure drops below a preset level. On failure of the primary vaporizer, the vaporizer trouble alarm annunciates in the VF Control Room to alert the operator of the vaporizer failure. If the backup vaporizer fails to energize or the pressure in the tank continues to decrease, a Low-Low pressure alarm annunciates on the DCS. The housings are manufactured from 200-mm (8-in) diameter carbon steel pipe and are ASME code stamped for the following conditions:

• Pressure	1.7 MPag (250 psig)
• Temperature	43°C (110°F)

Liquid ammonia is fed to the vaporizers from the bottom of the tank. The vapor from the vaporizer is routed to the upper portion of the ammonia storage tank. The vaporized ammonia is drawn from the vapor space at the top of the tank, and is routed to one of two redundant, pressure reducing, mass flow control trains. Either flow control train can deliver ammonia to either NO_x reactor. Solenoid operated shut off valves are located upstream and downstream of the mass flow controllers to allow switch over by the DCS. The ammonia feed line, where outside and exposed to the weather, is insulated and heat traced.

A solenoid operated shut-off valve is located in the ammonia feed line so ammonia feed can be abruptly suspended if the temperature at the catalytic reactors is low, or if there is no off-gas flow through the Off-Gas system.

The ammonia tank is equipped with redundant pressure relief valves. The vaporizers have individual pressure relief valves which share a common vent header with the ammonia tank relief valves and vent to the atmosphere at a point 0.6 m (2 ft) above the roof of the 01-14 Building, which is about 18 m (60 ft) above the ground.

All process lines, flowing into or out of the ammonia tank, are equipped with excess flow control valves to prevent a large volume release of ammonia in the event any connected line is severed. The excess flow control valves are located as close to the tank as practical. Vehicle barriers are in place to protect the tank and excess flow control valves from inadvertent bumping by vehicles.

C.5.6 Confinement Metal Corrosion

Visual inspection is the primary method of detecting corrosion of confinement metal. Remote observations by means of CCTV and through shield windows are the primary methods of detection, followed by direct observation after a component has been removed from the in-cell area, decontaminated, and released for inspection, and possibly hands-on repairs or maintenance. An example of this latter procedure occurred in conjunction with the nonradiological test run of the SFCM, following which the apparatus was removed, disassembled, inspected, and its condition documented for wear, design flaws, and corrosion.

The in-cell confinement walls, floor, and pit area are surfaced with stainless steel plates. This material affords a level of corrosion resistance, ease of decontamination and decommissioning, and structural toughness that meets design criteria. The function of the stainless steel is to protect the concrete of the 1,219-mm (4-ft) thick confinement walls, provide attachment points for penetrations, and provide relative ease of decontamination and decommissioning upon the completion of vitrification activities.

The components considered in this section include the CFMT, MFHT, SFCM, SBS, turntable, condenser, jumpers, decontamination tank, weld station, storage racks, mist eliminator, vessel vent header, liquid waste header, penetrations, pipes, valves, and supports.

The design criteria given in WVNS-DC-022 establishes that the design life of the VF and equipment is seven years, which includes all cold testing and the planned process campaign. This criterion is a driving design consideration for the corrosion life of each confinement barrier, including piping, process vessels, cell liners, pumps, and other equipment. No single approach could be used for design of confinement barriers. Each piece of equipment was designed, on a case-by-case basis, with consideration given to the following design considerations:

- Applicable codes and standards;

- Consequence of failure (e.g., equipment redundancy availability) and the associated corrosion safety factor desired in the component design;

- Ability to perform remote maintenance and/or replacement;

- Credible corrosive elements and conditions to which the equipment will be exposed under normal and off-normal conditions;

- Corrosion experience gained from pilot plant operations;

- Corrosion resistance (both generalized and localized) of the component material to the process liquid, gaseous, and/or solid process elements;

- Process erosion considerations; and

- Necessary corrosion allowance to account for expected surface degradation.

Safety and quality levels are assigned to major SSCs in the *WVDP Quality List "Q-List"*, WVDP-204. Major applicable design standards (e.g., ASME Section VIII, Division I) are assigned by WVDP-204, based on the assigned Quality Level and Safety Class.

The primary construction material for process vessels located in the Vitrification Cell is 304L stainless steel because it is compatible with the HLW feed slurry chemical constituents and the glass former constituents transferred to the process by the Cold Chemical Building. Specialized materials are used in some applications because of the unique solutions handled at that station. For instance, the Canister Decontamination Station vessels are made of titanium because the dilute nitric acid solution with Ce^{+4} is purposely formulated to chemically "mill" the filled product canisters to remove contamination from the stainless steel canister surface. This solution is reduced, using hydrogen peroxide (H_2O_2) to reduce the Ce^{+4} to nonreactive Ce^{+3}, prior to transferring the solution to other process vessels.

Confinement materials are identified for several SSCs in text and tables within this FSAR, particularly within Chapters 4 and 5. Testing and inspection of the levels of corrosion of SSCs are provided on a case-by-case basis, taking into consideration length of service and susceptibility of a given SSC to corrosion under the given conditions.

C.5.7 Leak Detection

Leak detection capability is based on a need to maintain assurance of the whereabouts of process fluids and support materials, and to be able to discern when or where leaks may have occurred. Various methods and instrumentation are employed to perform this function, e.g., visual observation, sump level, tank level indicators, flow meters, mass balance procedures, etc. In all cases at least two of these methods of leak detection are available to detect leaks from the in-Cell vessels (such as the CFMT, MFHT and Liquid Waste Header) and Tank Farm components (including Transfer Trench piping) associated with the vitrification process and addressed in this FSAR.

To ensure that vitrification-related tanks and vessels are free of leaks when filled with radioactive material, pumping times and flow rates are monitored and compared with tank level data and volume calculations. In addition, in-cell equipment is monitored for leaks by means of observation via CCTV and through shield windows.

C.5.7.1 In-Cell Components

The in-cell process components have the potential to leak process slurry directly to the Vitrification Cell or to the interfacing heat transfer fluid lines (i.e., steam or cooling water). Also, the heat transfer fluid lines may leak into the process slurries located in, for example, the CFMT or MFHT.

Leakage from the process can be detected by the following:

- CFMT level indication;
- MFHT level indication;
- Visual examination of the CFMT exterior;
- Visual examination of the MFHT exterior;
- Visual examination of the cell (walls, etc.);
- Level indication in the north sump;
- Radiation indication in the cooling water return header;
- Radiation indication in the steam condensate return header.

Leakage from heat transfer fluids can be detected by the following:

- CFMT level indication;
- MFHT level indication;
- Visual examination;

- Analyses of the process slurries (total solids concentration and density).

The two general types of leaks for vessels are at fittings or through the base metal (e.g., due to erosion or weld cracks). Mitigating features such as corrosion allowances were included in the designs. Also, pressure control in the vessels' heat transfer jackets ensures that any leakage flow between the process slurries and the jackets is into the process slurry.

Small leaks can be detected only by visual means or by observing radiation levels in return lines from the cooling water or steam header. Larger leaks can be detected by these as well as by other means such as level indication or analyses of process slurries. Leaks detected by non-visual means may be verified by visual examination, if possible. The difference in detection depends on whether direction of the leak is into or from process slurries. The following subsections address these differences.

C.5.7.1.1 Process Slurry Leaks from the CFMT or MFHT

A volume discrepancy in either the CFMT or the MFHT of approximately 0.4 m^3 (106 gal)(corresponding to a discrepancy in vessel level of approximately 51 mm [2 in]) can be detected by the vessels' level measurement instruments. The source of the discrepancy can sometimes identify the leak. For example, a leaky jumper connector is indicated if less mass (adjusted to volume after mixing) is received than is transferred to the vessel. Similarly, a leaky vessel is indicated if measured volume drops without any transfer or mixing operations occurring at the time.

Process solutions that leak to the cell either flow downward on the vessel or wall, or travel as a free jet. A free jet either impinges on something (e.g., the pit wall liner) and then flows downward or evaporates completely. Even small flowing leaks are visible because of the significant contrasts in color and reflected light between process slurries and metal components. Small leaks that evaporate as free jets may not be visible. Such invisible jets are of little concern because no realistic metal failure mechanisms, resulting in a free jet without some visible flow on metal components, were identified during design activities.

Volume increase in the north sump (corresponding to a predetermined amount) can be detected. The volume entering the sump is less than the volume leaking from the vessels because of potentially significant evaporation while flowing over the warm vessels to the floor and then across the floor. Very small leaks that evaporate completely are not detected in the north sump.

Process leaks to heat transfer fluids can be detected by radiation monitors on the return lines. The lower limit for a detectable leak rate depends on the specific activity of the leak and on the total water flow rate at the monitor.

C.5.7.1.2 Leaks into the CFMT or MFHT Process Slurries

Leaks from steam or cooling water to the process slurries would be detected by "unexplained" level increase of greater than approximately 51 mm (2 in). Recognition of relatively small leaks into a process vessel would depend on operator observation of level increases (> 51 mm [2 in]). More significant increases in the vessel volume would lead to a vessel high-level alarm. Upon activation of the high-level alarm, the operator would take appropriate action to identify the source of the unexpected volume increase and shut off the source of the influx.

Leaks from heat transfer fluids to the Vitrification Cell would be less visible than process slurries since they would be clear (water). Free steam jets should be visible.

Leaks from steam or cooling water to the process slurries could also be detected by unexplained reduction in either density or total solids concentration (as measured by laboratory analyses). The minimum detectable change in total solids concentration is approximately 0.2%. This corresponds to a minimum detectable water in-leakage volume (calculated for the least sensitive cases of maximum total solids concentration at maximum total mass in the vessels) of approximately 0.3 m^3 (79 gal) in the CFMT or 0.1 m^3 (26 gal) in the MFHT.

Leakages from the other in-Cell vessels could be detected by level rise in the north and/or south sumps and by visual means as described above.

C.5.7.2 High-Level Waste Transfer System Components

HLWTS processing components include the sludge mobilization pumps, grinder, and transfer piping. Any leakage that could result from failure of an installed component in any of the three HLW tanks would be contained within the respective tank. Tanks 8D-1 and 8D-2 are contained separately within a concrete vault. Tank 8D-4 is enclosed in a common concrete vault shared by Tank 8D-3. A stainless steel pit liner provides secondary containment for the HLWTS components contained within a pit and for piping runs between the components of the pit and the pit wall penetrations.

Piping used to transfer the THOREX or zeolite from Tank 8D-4 or 8D-1 to Tank 8D-2 and from Tank 8D-2 to the Vitrification Cell is double-walled, i.e., the primary pipeline containing the waste is fully encased and supported inside a corrosion resistant leak tight pipe having the same integrity as the primary line, and enclosed within a concrete trench. The piping runs are supported in the trench to maintain a gradient (1.6 mm per 0.3 m [0.0625 in/ft] minimum) such that leakage from the primary transfer line to the encasement pipe is drained and collected at low points located at the Transfer Pits, 8Q-2 and 8Q-5. The collected leakage is then returned to the tanks via the pit drains. The encasement line permits detection of any leakage from the primary line by the use of conductivity probes and permits sampling and periodic leak testing as required. The stainless steel lined pits that serve as the secondary confinement for the jumpers (which are not encased) have conductivity probes in the pit drain to detect leakage from the jumpers.

Transfers of HLW from Tank 8D-2 to the CFMT are controlled by operators at the Control Room for the Tank Farm located in the PVS Building. The transfer is initiated by an administratively controlled verbal request to transfer and an electronic permissive from the VF Control Room. If a leak is detected within the encasement by the conductivity probe or if the CFMT high level alarm is activated, automatic electronic interlocks shut down the transfer pump and the operator in the PVS Building gets an alarm. If a leak is detected in the 8Q-2 or 8Q-5 pit, the PVS Building also gets an alarm and the pump transfer is shut down manually by the operator.

The transfer line is flushed with water after each slurry transfer to clean any solids left in the line. The flush volume is approximately 0.57 m^3 (150 gal). The flush water is pumped at a rate of 0.38 m^3/minute (100 gpm) to give a flow velocity of greater than 2.7 m/s (9 ft/s). Pre-operational testing, with simulated waste, has been completed which demonstrated that these flushing parameters leave negligible solids in the transfer line.

REFERENCES FOR CHAPTER C.5.0

American Institute of Steel Construction (AISC). 1980. Manual of Steel Construction, eighth edition. Chicago: American Institute of Steel Construction.

American National Standards Institute. 1982. *Minimum Design Loads for Buildings and Other Structures (NRC Adopted)*. ANSI A58.1-1989. New York: American National Standards Institute, Inc.

__________. 1989. *Safety Requirements for the Storage and Handling of Anhydrous Ammonia*. ANSI K61.1-1989. New York: American National Standards Institute, Inc.

__________. 1990. *Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley)*. ANSI B30.2.

__________. 1993. *Power Piping*. ANSI B31.1.

American Society of Mechanical Engineers. 1989. *Nuclear Power Plant Air Cleaning Units and Components*. ANSI/ASME N509.

__________. 1989. *Testing of Nuclear Air Treatment Systems*. ANSI/ASME N510.

American Society of Mechanical Engineers/American National Standards Institute. 1987. *Chemical Plant and Petroleum Refinery Piping*. ASME B31.3-1987. New York: American Society of Mechanical Engineers.

__________. 1992. *ASME Boiler and Pressure Vessel (B/PV) Code*. Section VIII, Division I.

Bradley, D. D., III. July 7, 1994. *Report of Vitrification Facility Ingestion of Cold Chemical Upset Conditions* D&M:94:OP:DDB:05:0033. Letter to T.E. Cottrell and F.W. Damerow.

Compressed Gas Association. 1984. Pamphlet G-2, *Anhydrous Ammonia*.

Crane Manufacturers Association of America. Specification No. 70. *Specifications for Electric Overhead Traveling Cranes*. Service Class C.

Dames & Moore. May 8, 1963. *Site Investigation: Proposed Spent Nuclear Fuel Reprocessing Plant Near Springville, New York, for Nuclear Fuel Services, Inc.*

__________. July 19, 1963. *Pile Load Tests and Pile Driving Criteria Spent Nuclear Fuel Reprocessing Plant Springville, New York, for Nuclear Fuel Services, Inc.*

REFERENCES FOR CHAPTER C.5.0
(Continued)

__________. March 18, 1983. *Geotechnical Investigation: Proposed Component Test Stand, West Valley Demonstration Project, for West Valley, New York.*

__________. August 17, 1983. *Seismic Hazard Analysis, West Valley Demonstration Project.*

__________. June 1988. *Subsurface Investigation: Vitrification Facility, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.*

__________. August 24, 1992. *Geotechnical Investigation: Waste Transfer Trench, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.*

__________. September 30, 1996. *Safety Margin Assessment Incell Maintenance Station.* Dames & Moore.

Gates, W.E. August 11, 1989. *Progress Report, Primary Confinement Barrier Integrity Review Vitrification Facility for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. August 12, 1992. *Confinement Barrier Integrity Review of Special Doors, Vitrification Facility, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. September 10, 1992. *Wind, Tornado and Seismic Vulnerability Analysis of Reprocessing Plant Guyed Stack, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. January 25, 1994. *Confinement Barrier Integrity Review of Vitrification Facility, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. January 26, 1994. *Confinement Barrier Integrity Review of HVAC System Vitrification Facility, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. January 27, 1994. *Integrity Review of Seismically Hazardous Components and Equipment, Vitrification Facility, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. January 28, 1994. *HLWTS Confinement Barrier Integrity Review, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

REFERENCES FOR CHAPTER C.5.0
(Continued)

__________. September 23, 1994. *Confinement Barrier Integrity Review High-Level Waste Transfer Piping, Vitrification Facility West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. September 27, 1994. *Integrity Review of HLWIS Canister Storage Racks, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

Gates, W.E., and M.R. Gorman. September 19, 1994. *Confinement Barrier Integrity Review of Primary HVAC HEPA Filter Units, Vitrification Facility, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. September 20, 1994. *Confinement Barrier Integrity Review of Secondary Filter Unit, Vitrification Facility, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. September 21, 1994. *Integrity Review of In-Cell Canister Storage Rack, Vitrification Facility, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. September 22, 1994. *Integrity Review of In-Cell Coolers, Vitrification Facility, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. September 26, 1994. *Integrity Review of In-Cell Canister Turntable, Vitrification Facility, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. September 29, 1994. *Integrity Review of In-Cell Process Tanks, Vitrification Facility, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

__________. September 30, 1994. *Integrity Review of In-Cell Crane System, West Valley Demonstration Project, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

Gates, W.E., and T.J. Kasar. August 12, 1991. *Assessment of Seismic Restraint System for Vitrification Facility Melter, for West Valley Nuclear Services Company, Inc.* Dames & Moore.

Gates, W.E., A.R. Porush, and R.W. Kupp. August 11, 1989. *Progress Report - Tornado Driven Missile Penetration Resistance Of Shield Windows on Vitrification Cell, for West Valley Nuclear Services, Inc.* Dames & Moore.

REFERENCES FOR CHAPTER C.5.0
(Continued)

Hannum, W.H. October 20, 1983. *Seismic Hazard Analysis* (DW:83:0555). Letter to R.C. Mairson. West Valley Nuclear Services Co., Inc.

International Conference of Building Officials. 1961 Edition. *Uniform Building Code*.

__________. 1988 Edition. *Uniform Building Code*.

Kupp, R. W. August 23, 1989. *Safety Analysis - Post Tornado - Vitrification Cell* (Revision to May 25, 1989 Report [FB:89:0178]). Dames & Moore for the West Valley Demonstration Project. Letter to C.J. Roberts.

Lawrence Livermore National Laboratory. May 24, 1977. *Seismic Analysis of the Nuclear Fuel Service Reprocessing Plant at West Valley, N.Y.* UCRL-52266. Prepared for U.S. Department of Energy.

Los Alamos National Laboratory. March 1978. *Seismic Investigation of the Nuclear Fuel Services, Inc.* Reprocessing Plant at West Valley, New York. LA-7087-MS. Prepared for U.S. Department of Energy.

McDonald, J.R., July 1981, *Assessment of Tornado and Straight Wind Hazard Probabilities at the New York State Nuclear Service Center West Valley, New York.*

Murray, R.C., October 1, 1981. *Natural Phenomena Hazard Studies and Recommended Design Criteria for the West Valley Site, Lawrence Livermore National Laboratory.*

National Fire Protection Association. August 5, 1994. *NFPA 10: Standard for Portable Fire Extinguishers.*

__________. August 14, 1992. *NFPA 12A: Standard on Halon 1301 Fire Extinguishing Systems.*

__________. February 11, 1994. *NFPA 13: Standard for the Installation of Sprinkler Systems.*

__________. February 12, 1993. *NFPA 14: Standard for the Installation of Standpipe and Hose Systems.*

__________. August 17, 1990. *NFPA 15: Water Spray Fixed Systems for Fire Protection.*

__________. August 20, 1993. *NFPA 20: Standard for the Installation of Centrifugal Fire Pumps.*

REFERENCES FOR CHAPTER C.5.0
(Continued)

__________. February 12, 1993. *NFPA 22: Standard for Water Tanks for Private Fire Protection.*

__________. February 10, 1992. *NFPA 24: Standard for the Installation of Private Fire Service Mains and Their Appurtenances.*

__________. August 20, 1993. *NFPA 30: Flammable and Combustible Liquids Code.*

__________. 1990. *NFPA 72A: Standard for the Installation, Maintenance, and Use of Local Protective Signaling Systems for Guard's Tour, Fire Alarm, and Supervisory Service.*

__________. 1990. *NFPA 72E: Standard on Automatic Fire Detectors.*

__________. February 12, 1993. *NFPA 90A: Standard for the Installation of Air Conditioning and Ventilating Systems.*

__________. February 11, 1994. *NFPA 101®: Code for Safety to Life from Fire in Building and Structures.* (See also *Life Safety Code® Handbook.)*

__________. February 12, 1993. *NFPA 110: Standard for Emergency and Standby Power Systems.*

New York State Code Manual for the State Building Construction Code. New York State.

Nicholas, G.W., and R.C. Eagan. January 1983. *Meteorological Program for West Valley Demonstration Project.* Dames & Moore. (See also Knabenschuh, J.L. February 10, 1993. WD:83:0074.)

Occupational Safety and Health Administration. *Storage and Handling of Anhydrous Ammonia,* 29 CFR 1910.111, as amended.

Pomerening, D. J., et. al. April 1993. *Seismic/Tornado Analysis Review for the Vitrification Facility at West Valley.* CNWRA 93-007. Prepared for Nuclear Regulatory Commission, Contract NRC-02-88-05. San Antonio, TX: Center for Nuclear Waste Analysis.

U.S. Department of Energy. DOE Order 5480.1, Section XI: *Environment Safety and Health Program for U.S. Department of Energy Operations.* Washington, D.C.: U.S. Department of Energy.

__________. June 26, 1985. DOE Order 5480.10: *Contractor Industrial Hygiene Program.* Washington, D.C.: U.S. Department of Energy.

REFERENCES FOR CHAPTER C.5.0
(Continued)

__________. April 6, 1989. DOE Order 6430.1A: *General Design Criteria.* Washington, D.C.: U.S. Department of Energy.

__________. December 21, 1988. Change 3 (June 17, 1992). DOE Order 5480.11: *Radiation Protection for Occupational Workers.* Washington, D.C.: U.S. Department of Energy.

__________. October 13, 1995. Change 2 (October 24, 1996). DOE Order 420.1: *Facility Safety.* Washington, D.C.: U.S. Department of Energy.

__________. March 27, 1998. DOE Order 440.1A: *Worker Protection.* Washington, D.C.: U.S. Department of Energy.

__________. June 1990. *Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards.* UCRL-15910.

U.S. Nuclear Regulatory Commission. 1973. *Regulatory Guide 1.60, Design Response Spectra for Seismic Design of Nuclear Power Plants.*

__________. 1973. *Regulatory Guide 1.61, Damping Values for Seismic Design of Nuclear Power Plants.*

West Valley Nuclear Services Co., Inc. WVDP-022: *WVDP Emergency Plan.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVDP-177: *WVDP Fire Protection Manual.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVDP-204: *WVDP Quality List (Q-List).* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-CAL-300: *VF Maintenance Station Structural Analysis for VEMP.* Revision 1. September 23, 1999. West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-022: *Design Criteria, Vitrification of High-Level Wastes.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-046: *Design Criteria, Sludge Mobilization Waste Removal System.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-DC-048: *Design Criteria, High-Level Waste Interim Storage System.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

REFERENCES FOR CHAPTER C.5.0
(Concluded)

__________. WVNS-DC-066: *Design Criteria, Vitrification Load-In Facility.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. WVNS-FHA-001: *Fire Hazard Analysis, Vitrification Facility.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

__________. December 1986. *Preliminary Safety Analysis Report WVNS-SAR-003: Preliminary Safety Analysis for the Vitrification System.* West Valley Nuclear Services Co., Inc.

__________. *Safety Analysis Report WVNS-SAR-001: Project Overview and General Information.* (Latest Revision.) West Valley Nuclear Services Co., Inc.

Table C.5.5.3-1

Engineering Codes/Standards for HVAC Confinement Barrier

Vessels	ASME Section VIII, Division I, 1983 Edition
Piping	ANSI B31.3, 1980 and 1987 Edition American National Standards Institute (ANSI) · ANSI B16.5 - Pipe Flanges and Flanged Fittings · B31.5 - Code for Pressure Piping, Refrigerant Piping · B16.25 - Buttwelding Ends
Dimensions and Tolerances	ANSI Y 14.5, 1973 Edition
Structural	New York State Building Code AISC 1980 Edition ANSI A58.1-1982 UBC, 1982 and 1985 Edition NRC Reg. Guide 1.60 American Institute of Steel Construction (AISC) · Design, Fabrication and Erection of Structural Steel for Buildings American Iron and Steel Institute (AISI) · Specification for Design of Cold-Formed Steel Structural Members
Ventilation	ERDA 76-21, Nuclear Air Cleaning Handbook
HVAC	American Conference of Governmental Industrial Hygienists (ACGIH) · Industrial Ventilation; Testing of Ventilation Systems, Section 9 Air-Conditioning and Refrigeration Institute (ARI) · 201 - Test Code for Air Moving Devices · 410 - Forced Circulation Air-Cooled and Air-Heated Coils · 680 - Air Filter Equipment Air Moving and Conditioning Association (AMCA) · 210 - Laboratory Methods of Testing Fans for Rating Purposes · 211 - Certified Ratings Programs - Air Performance · 300 - Test Code for Sound Rating Air-Moving Devices · 500 - Test Methods for Louvers, Dampers, and Shutters · 2404 - Drive Arrangements for Centrifugal Fans · 2407 - Motor Positions for Centrifugal Fans · 2409 - Operating Limits for Centrifugal Fans American Society of Heating, Refrigeration & Air Conditioning (ASHRAE) · 51 - Method of Testing Fans for Rating · 52 - Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter · 68 - Method of Testing in Duct Sound Power Measurement for Fans Underwriter's Laboratories (UL) · UL-586 - Safety Standard for High Efficiency Air Filter Units · UL-900 - Safety Standard for Air Filter Units American National Standards Institute (ANSI) · N303 - Guide for Control of Gasborne Radioactive Materials at Nuclear Fuel Reprocessing Facilities · N509 - Nuclear Power Plant Air-Cleaning Units and Components · N510 - Testing of Nuclear Air-Cleaning Systems
HVAC Ducts	Sheet Metal and Air Conditioning Contractors National Association (SMACNA) · HVAC Duct Construction Standards - Metal and Flexible, 1985 Edition · Rectangular Industrial Duct Construction Standards · Round Industrial Duct Construction Standards
HVAC Filters	WVNS-EQ-161 - WVNS Equipment Specification for HEPA Filters Military Specifications · MIL-F-51068E- Filter, Particulate, High-Efficiency, Fire Resistant Military Specification, 1981 · ML-F-51079C - Filter Medium, Fire Resistant

Table C.5.5.3-1 (Continued)
Engineering Codes/Standards for HVAC Confinement Barrier

Electrical Power	Institute of Electrical and Electronics Engineers (IEEE) · 59 - Standard for Semi-conductor Rectifier Components · 324 - Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations · 450 - Recommended Practices for Maintenance, Testing, and Replacement of Large Lead Storage Batteries · 472 - Guide for Surge Withstand Capability (SWC) Tests (ANSI C37.90a) · 485 - Recommended Practice for Sizing Large Lead Storage Batteries for Generator Stations · 944 - Application and testing of UPS for Power Generating Stations Insulated Cable Engineer Association (ICEA) · ICEA S-66-524 - Cross-Linked Thermosetting - Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC5) · ICEA S-68-516 - Interim Standard #2, Cables Rated 2000 Volts and Less and Having Ozone-Resistant Ethylene-Propylene-Rubber Integral Insulation and Jacket (NEMS WC3) Underwriter's Laboratories (UL) · 44 - Rubber Insulated Wire and Cable National Electric Code (NEC) · 480 - Storage Batteries · 503.14 - Storage Batteries Charging Equipment, Class III · 700.12a - Emergency Systems - Storage Batteries American National Standards Institute (ANSI) · C34.2 - Practices and Requirements for Semiconductor Power Rectifiers · C37.13- Low Voltage AC Power Circuit Breakers Used in Enclosures · C37.16- Preferred Ratings, Related Requirements and Application Recommendations for Low Voltage Power Circuit Breakers and AC Power Circuit Protectors · C37.20- Switchgear Assemblies Including Metal-Enclosed Bus (Supplement a,b,c,d) · C37.51- Conformance Testing of Metal Enclosed Low-Voltage AC Power Circuit Breaker Switchgear Assemblies · C37.90- Relays and Relay Systems Associated with Electric Power Apparatus (IEEE 313) · C57.12- General Requirements for Distribution Power and Regulating Transformers · C57.13- Requirements for Instrument Transformers National Electrical Manufacturer's Association (NEMA) · PE1 - Uninterruptible Power Systems · PE5 - Constant Potential - Type Electric Utility (Semiconductor Static Converter Battery Charges) · ICS6 - Enclosures for Industrial Controls and Systems · ICS2 - Standards for Industrial Control Devices, Controllers and Assemblies · NEMA PV 4 - Semiconductor Self-Commutated Converters · NEMA ST 20 - Dry Type Transformers for General Application · NEMA AB 1 - Molded Case Circuit Breakers · NEMA MG 1 - Standard Publication for Motors and Generators
Fire Protection	National Fire Protection Association (NFPA) · 70 - National Electric Code · 90A - Standard for the Installation of Air-Conditioning and Ventilation Systems · 91 - Standard for the Installation of Blower and Exhaust Systems · 110 - Emergency and Standby Power Systems
Bearings	Antifriction Bearing Manufacturers Association (AFBMA) · 9 - Load Ratings and Fatigue Life for Ball Bearings · 11 - Load Ratings and Fatigue Life for Roller Bearings

Table C.5.5.3-1 (Concluded)
Engineering Codes/Standards for HVAC Confinement Barrier

Structural Welding	AWS D1.1, 1988 Edition American Welding Society (AWS) · AWS A5,4 - Specification for Covered Corrosion - Resisting Chromium and Chromium - Nickel Steel Welding Electrodes · AWS A5.9 - Specification for Corrosion Resisting Chromium and Chromium - Nickel Steel Bare and Composite Metal Cored and Stranded Welding Electrodes and Welding Rods · AWS QC1 - Qualification and Certification of Welding Inspectors · AWS D1.1 - Structural Steel Welding Code · AWS D10.4 - Recommended Practices for Welding Chromium-Nickel Stainless Steel Piping and Tubing · AWS D9.1 - Specification for Welding of Sheet Metal · AWS A2.4 - Symbols for Welding and Nondestructive Testing
Electrical/Instrumentation	National Electrical Code, ANSI/NFPA-70 NFPA National Fire Codes ANSI Standards NEMA Standards Institute of Electrical and Electronics Engineers (IEEE) Standards Underwriters Laboratories, Inc. (UL) Standards and Product Directories Department of Labor, "Occupational Safety and Health Standards," Title 29, Code of Federal Regulations (CFR), Part 1910 Electrical and Electronics Graphic Symbols and Reference Designations, ANSI/IEEE Y32E National Electric Safety Code, ANSI-C2 Instrumental Society of America, ISA-S5.1-73
Machined Surfaces	ANSI B46.1, 1978 Edition
Material Specification	ASME Section II - Part A: Ferrous Materials American Society for Testing and Materials (ASTM) · ASTM A182 - Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service · ASTM A194 - Carbon and Alloy Steel Nuts for Pressure and High Temperature Service · ASTM A276 - Specification for Stainless Steel and Heat Resisting Bars and Shapes · ASTM A325 - High Strength Steel Bolts for Structural Steel Joints · ASTM A380 - Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems · ASTM 388 - Standard Specification for Seamless Copper Water Tubes · ASTM D1056 - Gasket Material Neoprene
Nondestructive Examination (NDE)	ASME Section V - Nondestructive Examination American Society for Nondestructive Testing (ASNT) · ASNT-CD-189- Recommended Practice for Nondestructive Testing Personnel Qualification and Certification
Qualifying Welders and Welding Procedures	ASME Section IX - Welding Qualification
Design	INEL Architectural Engineering Standards, Rev. 6, October, 1986 DOE 6430.1A, "General Design Criteria Manual," April 6, 1989 Operational Safety Design Criteria Manual, ID-12044
Quality Assurance	ANSI/ASME NQA-1-1986