GE Nuclear Energy

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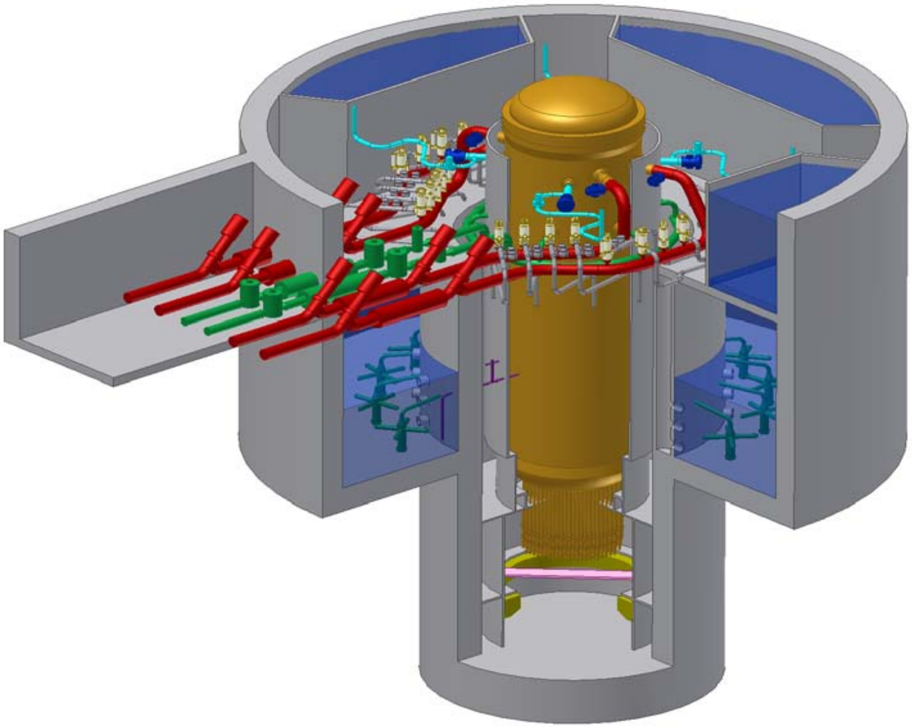

ESBWR Design Control Document
Tier 2
Chapter 17
Quality Assurance

(Conditional Release - pending closure of design verifications)

Contents

Global Abbreviations And Acronyms List

Term	**Definition**
10 CFR	Title 10, Code of Federal Regulations
A/D	Analog-to-Digital
AASHTO	American Association of Highway and Transportation Officials
AB	Auxiliary Boiler
ABS	Auxiliary Boiler System
ABWR	Advanced Boiling Water Reactor
ac / AC	Alternating Current
AC	Air Conditioning
ACF	Automatic Control Function
ACI	American Concrete Institute
ACS	Atmospheric Control System
AD	Administration Building
ADS	Automatic Depressurization System
AEC	Atomic Energy Commission
AFIP	Automated Fixed In-Core Probe
AGMA	American Gear Manufacturer's Association
AHS	Auxiliary Heat Sink
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AL	Analytical Limit
ALARA	As Low As Reasonably Achievable
ALWR	Advanced Light Water Reactor
ANS	American Nuclear Society
ANSI	American National Standards Institute
AOO	Anticipated Operational Occurrence
AOV	Air Operated Valve
API	American Petroleum Institute
APLHGR	Average Planar Linear Head Generation Rate
APRM	Average Power Range Monitor
APR	Automatic Power Regulator
APRS	Automatic Power Regulator System
ARI	Alternate Rod Insertion
ARMS	Area Radiation Monitoring System
ASA	American Standards Association
ASD	Adjustable Speed Drive
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
AST	Alternate Source Term

Global Abbreviations And Acronyms List

Term	Definition
ASTM	American Society of Testing Methods
AT	Unit Auxiliary Transformer
ATLM	Automated Thermal Limit Monitor
ATWS	Anticipated Transients Without Scram
AV	Allowable Value
AWS	American Welding Society
AWWA	American Water Works Association
B&PV	Boiler and Pressure Vessel
BAF	Bottom of Active Fuel
BHP	Brake Horse Power
BOP	Balance of Plant
BPU	Bypass Unit
BPWS	Banked Position Withdrawal Sequence
BRE	Battery Room Exhaust
BRL	Background Radiation Level
BTP	NRC Branch Technical Position
BTU	British Thermal Unit
BWR	Boiling Water Reactor
BWROG	Boiling Water Reactor Owners Group
CAV	Cumulative absolute velocity
C&FS	Condensate and Feedwater System
C&I	Control and Instrumentation
C/C	Cooling and Cleanup
CB	Control Building
CBHVAC	Control Building HVAC
CCI	Core-Concrete Interaction
CDF	Core Damage Frequency
CFR	Code of Federal Regulations
CIRC	Circulating Water System
CIS	Containment Inerting System
CIV	Combined Intermediate Valve
CLAVS	Clean Area Ventilation Subsystem of Reactor Building HVAC
CM	Cold Machine Shop
CMS	Containment Monitoring System
CMU	Control Room Multiplexing Unit
COL	Combined Operating License
COLR	Core Operating Limits Report
CONAVS	Controlled Area Ventilation Subsystem of Reactor Building HVAC
CPR	Critical Power Ratio

Global Abbreviations And Acronyms List

Term	**Definition**
CPS	Condensate Purification System
CPU	Central Processing Unit
CR	Control Rod
CRD	Control Rod Drive
CRDA	Control Rod Drop Accident
CRDH	Control Rod Drive Housing
CRDHS	Control Rod Drive Hydraulic System
CRGT	Control Rod Guide Tube
CRHA	Control Room Habitability Area
CRT	Cathode Ray Tube
CS&TS	Condensate Storage and Transfer System
CSDM	Cold Shutdown Margin
CS / CST	Condensate Storage Tank
CT	Main Cooling Tower
CTVCF	Constant Voltage Constant Frequency
CUF	Cumulative usage factor
CWS	Chilled Water System
D-RAP	Design Reliability Assurance Program
DAC	Design Acceptance Criteria
DAW	Dry Active Waste
DBA	Design Basis Accident
dc / DC	Direct Current
DCS	Drywell Cooling System
DCIS	Distributed Control and Information System
DEPSS	Drywell Equipment and Pipe Support Structure
DF	Decontamination Factor
D/F	Diaphragm Floor
DG	Diesel-Generator
DHR	Decay Heat Removal
DM&C	Digital Measurement and Control
DOF	Degree of freedom
DOI	Dedicated Operators Interface
DOT	Department of Transportation
dPT	Differential Pressure Transmitter
DPS	Diverse Protection System
DPV	Depressurization Valve
DR&T	Design Review and Testing
DS	Independent Spent Fuel Storage Installation
DTM	Digital Trip Module

Global Abbreviations And Acronyms List

Term	Definition
DW	Drywell
EB	Electrical Building
EBAS	Emergency Breathing Air System
EBHV	Electrical Building HVAC
ECCS	Emergency Core Cooling System
E-DCIS	Essential DCIS (Distributed Control and Information System)
EDO	Environmental Qualification Document
EFDS	Equipment and Floor Drainage System
EFPY	Effective full power years
EHC	Electrohydraulic Control (Pressure Regulator)
ENS	Emergency Notification System
EOC	Emergency Operations Center
EOC	End of Cycle
EOF	Emergency Operations Facility
EOP	Emergency Operating Procedures
EPDS	Electric Power Distribution System
EPG	Emergency Procedure Guidelines
EPRI	Electric Power Research Institute
EQ	Environmental Qualification
ERICP	Emergency Rod Insertion Control Panel
ERIP	Emergency Rod Insertion Panel
ESF	Engineered Safety Feature
ETS	Emergency Trip System
FAC	Flow-Accelerated Corrosion
FAPCS	Fuel and Auxiliary Pools Cooling System
FATT	Fracture Appearance Transition Temperature
FB	Fuel Building
FBHV	Fuel Building HVAC
FCI	Fuel-Coolant Interaction
FCM	File Control Module
FCS	Flammability Control System
FCU	Fan Cooling Unit
FDDI	Fiber Distributed Data Interface
FFT	Fast Fourier Transform
FFWTR	Final Feedwater Temperature Reduction
FHA	Fire Hazards Analysis
FIV	Flow-Induced Vibration
FMCRD	Fine Motion Control Rod Drive
FMEA	Failure Modes and Effects Analysis

Global Abbreviations And Acronyms List

Term	Definition
FPS	Fire Protection System
FO	Diesel Fuel Oil Storage Tank
FOAKE	First-of-a-Kind Engineering
FPE	Fire Pump Enclosure
FTDC	Fault-Tolerant Digital Controller
FTS	Fuel Transfer System
FW	Feedwater
FWCS	Feedwater Control System
FWS	Fire Water Storage Tank
GCS	Generator Cooling System
GDC	General Design Criteria
GDCS	Gravity-Driven Cooling System
GE	General Electric Company
GENE	GE Nuclear Energy
GEN	Main Generator System
GETAB	General Electric Thermal Analysis Basis
GL	Generic Letter
GM	Geiger-Mueller Counter
GM-B	Beta-Sensitive GM Detector
GSIC	Gamma-Sensitive Ion Chamber
GSOS	Generator Sealing Oil System
GWSR	Ganged Withdrawal Sequence Restriction
HAZ	Heat-Affected Zone
HCU	Hydraulic Control Unit
HCW	High Conductivity Waste
HDVS	Heater Drain and Vent System
HEI	Heat Exchange Institute
HELB	High Energy Line Break
HEP	Human error probability
HEPA	High Efficiency Particulate Air/Absolute
HFE	Human Factors Engineering
HFF	Hollow Fiber Filter
HGCS	Hydrogen Gas Cooling System
HIC	High Integrity Container
HID	High Intensity Discharge
HIS	Hydraulic Institute Standards
HM	Hot Machine Shop & Storage
HP	High Pressure
HPNSS	High Pressure Nitrogen Supply System

Global Abbreviations And Acronyms List

Term	Definition
HPT	High-pressure turbine
HRA	Human Reliability Assessment
HSI	Human-System Interface
HSSS	Hardware/Software System Specification
HVAC	Heating, Ventilation and Air Conditioning
HVS	High Velocity Separator
HWCS	Hydrogen Water Chemistry System
HWS	Hot Water System
HX	Heat Exchanger
I&C	Instrumentation and Control
I/O	Input/Output
IAS	Instrument Air System
IASCC	Irradiation Assisted Stress Corrosion Cracking
IBC	International Building Code
IC	Ion Chamber
IC	Isolation Condenser
ICD	Interface Control Diagram
ICS	Isolation Condenser System
IE	Inspection and Enforcement
IEB	Inspection and Enforcement Bulletin
IED	Instrument and Electrical Diagram
IEEE	Institute of Electrical and Electronic Engineers
IGSCC	Intergranular Stress Corrosion Cracking
IIS	Iron Injection System
ILRT	Integrated Leak Rate Test
IOP	Integrated Operating Procedure
IMC	Induction Motor Controller
IMCC	Induction Motor Controller Cabinet
IRM	Intermediate Range Monitor
ISA	Instrument Society of America
ISI	In-Service Inspection
ISLT	In-Service Leak Test
ISM	Independent Support Motion
ISMA	Independent Support Motion Response Spectrum Analysis
ISO	International Standards Organization
ITA	Inspections, Tests or Analyses
ITAAC	Inspections, Tests, Analyses and Acceptance Criteria
ITA	Initial Test Program
LAPP	Loss of Alternate Preferred Power

Global Abbreviations And Acronyms List

Term	Definition
LCO	Limiting Conditions for Operation
LCW	Low Conductivity Waste
LD	Logic Diagram
LDA	Lay down Area
LD&IS	Leak Detection and Isolation System
LERF	Large early release frequency
LFCV	Low Flow Control Valve
LHGR	Linear Heat Generation Rate
LLRT	Local Leak Rate Test
LMU	Local Multiplexer Unit
LO	Dirty/Clean Lube Oil Storage Tank
LOCA	Loss-of-Coolant-Accident
LOFW	Loss-of-feedwater
LOOP	Loss of Offsite Power
LOPP	Loss of Preferred Power
LP	Low Pressure
LPCI	Low Pressure Coolant Injection
LPCRD	Locking Piston Control Rod Drive
LPMS	Loose Parts Monitoring System
LPRM	Local Power Range Monitor
LPSP	Low Power Setpoint
LWMS	Liquid Waste Management System
MAAP	Modular Accident Analysis Program
MAPLHGR	Maximum Average Planar Linear Head Generation Rate
MAPRAT	Maximum Average Planar Ratio
MBB	Motor Built-In Brake
MCC	Motor Control Center
MCES	Main Condenser Evacuation System
MCPR	Minimum Critical Power Ratio
MCR	Main Control Room
MCRP	Main Control Room Panel
MELB	Moderate Energy Line Break
MLHGR	Maximum Linear Heat Generation Rate
MMI	Man-Machine Interface
MMIS	Man-Machine Interface Systems
MOV	Motor-Operated Valve
MPC	Maximum Permissible Concentration
MPL	Master Parts List
MS	Main Steam

Global Abbreviations And Acronyms List

Term	**Definition**
MSIV	Main Steam Isolation Valve
MSL	Main Steamline
MSLB	Main Steamline Break
MSLBA	Main Steamline Break Accident
MSR	Moisture Separator Reheater
MSV	Mean Square Voltage
MT	Main Transformer
MTTR	Mean Time To Repair
MWS	Makeup Water System
NBR	Nuclear Boiler Rated
NBS	Nuclear Boiler System
NCIG	Nuclear Construction Issues Group
NDE	Nondestructive Examination
NE-DCIS	Non-Essential Distributed Control and Information System
NDRC	National Defense Research Committee
NDT	Nil Ductility Temperature
NFPA	National Fire Protection Association
NIST	National Institute of Standard Technology
NMS	Neutron Monitoring System
NOV	Nitrogen Operated Valve
NPHS	Normal Power Heat Sink
NPSH	Net Positive Suction Head
NRC	Nuclear Regulatory Commission
NRHX	Non-Regenerative Heat Exchanger
NS	Non-seismic (non-seismic Category I)
NSSS	Nuclear Steam Supply System
NT	Nitrogen Storage Tank
NTSP	Nominal Trip Setpoint
O&M	Operation and Maintenance
O-RAP	Operational Reliability Assurance Program
OBCV	Overboard Control Valve
OBE	Operating Basis Earthquake
OGS	Offgas System
OHLHS	Overhead Heavy Load Handling System
OIS	Oxygen Injection System
OLMCPR	Operating Limit Minimum Critical Power Ratio
OLU	Output Logic Unit
OOS	Out-of-service
ORNL	Oak Ridge National Laboratory

Global Abbreviations And Acronyms List

Term	**Definition**
OSC	Operational Support Center
OSHA	Occupational Safety and Health Administration
OSI	Open Systems Interconnect
P&ID	Piping and Instrumentation Diagram
PA/PL	Page/Party-Line
PABX	Private Automatic Branch (Telephone) Exchange
PAM	Post Accident Monitoring
PAR	Passive Autocatalytic Recombiner
PAS	Plant Automation System
PASS	Post Accident Sampling Subsystem of Containment Monitoring System
PCC	Passive Containment Cooling
PCCS	Passive Containment Cooling System
PCT	Peak cladding temperature
PCV	Primary Containment Vessel
PFD	Process Flow Diagram
PGA	Peak Ground Acceleration
PGCS	Power Generation and Control Subsystem of Plant Automation System
PH	Pump House
PL	Parking Lot
PM	Preventive Maintenance
PMCS	Performance Monitoring and Control Subsystem of NE-DCIS
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PQCL	Product Quality Check List
PRA	Probabilistic Risk Assessment
PRMS	Process Radiation Monitoring System
PRNM	Power Range Neutron Monitoring
PS	Plant Stack
PSD	Power Spectra Density
PSS	Process Sampling System
PSWS	Plant Service Water System
PT	Pressure Transmitter
PWR	Pressurized Water Reactor
QA	Quality Assurance
QAPD	Quality Assurance Program Document
RACS	Rod Action Control Subsystem
RAM	Reliability, Availability and Maintainability
RAPI	Rod Action and Position Information
RAT	Reserve Auxiliary Transformer

Global Abbreviations And Acronyms List

Term	Definition
RB	Reactor Building
RBC	Rod Brake Controller
RBCC	Rod Brake Controller Cabinet
RBCWS	Reactor Building Chilled Water Subsystem
RBHV	Reactor Building HVAC
RBS	Rod Block Setpoint
RBV	Reactor Building Vibration
RC&IS	Rod Control and Information System
RCC	Remote Communication Cabinet
RCCV	Reinforced Concrete Containment Vessel
RCCWS	Reactor Component Cooling Water System
RCPB	Reactor Coolant Pressure Boundary
RCS	Reactor Coolant System
RDA	Rod Drop Accident
RDC	Resolver-to-Digital Converter
REPAVS	Refueling and Pool Area Ventilation Subsystem of Fuel Building HVAC
RFP	Reactor Feed Pump
RG	Regulatory Guide
RHR	Residual heat removal (function)
RHX	Regenerative Heat Exchanger
RMS	Root Mean Square
RMS	Radiation Monitoring Subsystem
RMU	Remote Multiplexer Unit
RO	Reverse Osmosis
ROM	Read-only Memory
RPS	Reactor Protection System
RPV	Reactor Pressure Vessel
RRPS	Reference Rod Pull Sequence
RSM	Rod Server Module
RSPC	Rod Server Processing Channel
RSS	Remote Shutdown System
RSSM	Reed Switch Sensor Module
RSW	Reactor Shield Wall
RTIF	Reactor Trip and Isolation Function(s)
RT_{NDT}	Reference Temperature of Nil-Ductility Transition
RTP	Reactor Thermal Power
RW	Radwaste Building
RWCU/SDC	Reactor Water Cleanup/Shutdown Cooling
RWE	Rod Withdrawal Error

Global Abbreviations And Acronyms List

Term	Definition
RWM	Rod Worth Minimizer
SA	Severe Accident
SAR	Safety Analysis Report
SB	Service Building
S/C	Digital Gamma-Sensitive GM Detector
SC	Suppression Chamber
S/D	Scintillation Detector
S/DRSRO	Single/Dual Rod Sequence Restriction Override
S/N	Signal-to-Noise
S/P	Suppression Pool
SAS	Service Air System
SB&PC	Steam Bypass and Pressure Control System
SBO	Station Blackout
SBWR	Simplified Boiling Water Reactor
SCEW	System Component Evaluation Work
SCRRI	Selected Control Rod Run-in
SDC	Shutdown Cooling
SDM	Shutdown Margin
SDS	System Design Specification
SEOA	Sealed Emergency Operating Area
SER	Safety Evaluation Report
SF	Service Water Building
SFP	Spent fuel pool
SIL	Service Information Letter
SIT	Structural Integrity Test
SIU	Signal Interface Unit
SJAE	Steam Jet Air Ejector
SLC	Standby Liquid Control
SLCS	Standby Liquid Control System
SLMCPR	Safety Limit Minimum Critical Power Ratio
SMU	SSLC Multiplexing Unit
SOV	Solenoid Operated Valve
SP	Setpoint
SPC	Suppression Pool Cooling
SPDS	Safety Parameter Display System
SPTMS	Suppression Pool Temperature Monitoring Subsystem of Containment Monitoring System
SR	Surveillance Requirement
SRM	Source Range Monitor
SRNM	Startup Range Neutron Monitor

Global Abbreviations And Acronyms List

Term	Definition
SRO	Senior Reactor Operator
SRP	Standard Review Plan
SRS	Software Requirements Specification
SRSRO	Single Rod Sequence Restriction Override
SRSS	Sum of the squares
SRV	Safety Relief Valve
SRVDL	Safety relief valve discharge line
SSAR	Standard Safety Analysis Report
SSC(s)	Structure, System and Component(s)
SSE	Safe Shutdown Earthquake
SSLC	Safety System Logic and Control
SSPC	Steel Structures Painting Council
ST	Spare Transformer
STP	Sewage Treatment Plant
STRAP	Scram Time Recording and Analysis Panel
STRP	Scram Time Recording Panel
SV	Safety Valve
SWH	Static water head
SWMS	Solid Waste Management System
SY	Switch Yard
TAF	Top of Active Fuel
TASS	Turbine Auxiliary Steam System
TB	Turbine Building
TBCE	Turbine Building Compartment Exhaust
TBE	Turbine Building Exhaust
TBLOE	Turbine Building Lube Oil Area Exhaust
TBS	Turbine Bypass System
TBHV	Turbine Building HVAC
TBV	Turbine Bypass Valve
TC	Training Center
TCCWS	Turbine Component Cooling Water System
TCS	Turbine Control System
TCV	Turbine Control Valve
TDH	Total Developed Head
TEMA	Tubular Exchanger Manufacturers' Association
TFSP	Turbine first stage pressure
TG	Turbine Generator
TGSS	Turbine Gland Seal System
THA	Time-history accelerograph

Global Abbreviations And Acronyms List

Term	Definition
TLOS	Turbine Lubricating Oil System
TLU	Trip Logic Unit
TMI	Three Mile Island
TMSS	Turbine Main Steam System
TRM	Technical Requirements Manual
TS	Technical Specification(s)
TSC	Technical Support Center
TSI	Turbine Supervisory Instrument
TSV	Turbine Stop Valve
UBC	Uniform Building Code
UHS	Ultimate heat sink
UL	Underwriter's Laboratories Inc.
UPS	Uninterruptible Power Supply
USE	Upper Shelf Energy
USM	Uniform Support Motion
USMA	Uniform support motion response spectrum analysis
USNRC	United States Nuclear Regulatory Commission
USS	United States Standard
UV	Ultraviolet
V&V	Verification and Validation
Vac / VAC	Volts Alternating Current
Vdc / VDC	Volts Direct Current
VDU	Video Display Unit
VW	Vent Wall
VWO	Valves Wide Open
WD	Wash Down Bays
WH	Warehouse
WS	Water Storage
WT	Water Treatment
WW	Wetwell
XMFR	Transformer
ZPA	Zero period acceleration

17. QUALITY ASSURANCE

17.1 QUALITY ASSURANCE DURING DESIGN AND CONSTRUCTION

17.1.1 Organization

See Section 1 of Reference 17.1-1.

This section complies with Basic Requirement 1 and Supplement 1S-1 of ANSI/ASME NQA-1-1983.

The following additional information describes the relationship between GE Nuclear Energy (GENE) and its Team Members.

GENE, with the support of ESBWR Team Members, is designing the ESBWR. The designs, specifications, and drawings are based upon various joint development and engineering studies performed by GENE and its Team Members.

The GENE design organization has the responsibility to issue each specification and drawing. While engineering documents reflect design input from responsible Team Members, GENE is responsible for the design and the supporting calculations and records for the ESBWR Project, and the content of each document is reviewed and approved by GENE.

17.1.2 Quality Assurance Program

See Section 2 of Reference 17.1-1.

This section complies with Basic Requirement 2 and Supplements 2S-1, 2S-2 and 2S-3 of ANSI/ASME NQA-1-1983 and NQA-1a-1983.

The following additional information describes the relationship between GENE and its Team Members.

GENE and each of its Team Members have their own quality assurance program as described in Reference 17.1-2. GENE performed a review and evaluation of the QA programs of each of the Team Members to assure that the engineering designs and documentation produced by the Team Members meet the requirements of the GENE quality program and the applicable requirements of Reference 17.1-3. Design information coming from Team Members meeting these requirements may be used in the final design of the ESBWR. Team Members not meeting these requirements may provide consultation to the ESBWR designers.

GENE performs an annual review to assure that the quality systems are being implemented. Team Members are committed to correct discrepancies noted during these reviews.

The identification of safety-related structures, systems and components (Q list) to be controlled by the quality assurance program is shown in Table 3.2-1.

17.1.3 Design Control

See Section 3 of Reference 17.1-1.

This section complies with Basic Requirement 3 and Supplement 3S-1 of ANSI/ASME NQA-1-1983 as modified by the NRC-accepted alternate position identified in Table 2-1 of Reference 17.1-1 relating to NRC Regulatory Guide 1.64, Revision 2.

The following additional information describes the relationship between GENE and its Team Members.

GENE and its Team Members control the review and approval of ESBWR design documents using the engineering review memorandum (ERM). The lead design organization prepares the document and circulates it internally for engineering review and approval according to its own design control procedures. It is then distributed by ERM to the design organizations of the other responsible team members for their review of technical content and design interfaces. All comments resulting from this process must be resolved. The design is then independently verified before issue as a numeric revision. Issues discovered in the verification process may require additional review to assure control of design interfaces. After resolution of all comments and the completion of independent design verification, evidence of the verification is entered into the design records of the responsible design organization. The document is finalized and issued by GENE.

Changes to ESBWR documents are also approved by GENE and, as required, by its Team Members. The changed document's revision status is advanced. The changed document is circulated for review, verification, and approval to all parties that performed the original review, verification, and approval.

17.1.4 Procurement Document Control

See Section 4 of Reference 17.1-1.

This section complies with Basic Requirement 4 and Supplement 4S-1 of ANSI/ASME NQA-1-1983.

17.1.5 Instruction, Procedures, and Drawings

See Section 5 of Reference 17.1-1.

This section complies with Basic Requirement 5 of ANSI/ASME NQA-1-1983.

17.1.6 Document Control

See Section 6 of Reference 17.1-1.

This section complies with Basic Requirement 6 of ANSI/ASME NQA-1-1983.

The following additional information describes the relationship between GENE and its Team Members.

All ESBWR numeric revision documents produced by GENE and its Team Members are entered on the ESBWR Master Parts List (MPL). These documents are under GENE configuration control. Changes to these documents also require verification and GENE review and approval before they are entered into the GENE document control system and applied to the MPL.

17.1.7 Control of Purchased Material, Equipment, and Services

See Section 7 of Reference 17.1-1.

This section complies with Basic Requirement 7 and Supplement 7S-1 of ANSI/ASME NQA-1-1983.

17.1.8 Identification and Control of Materials, Parts, and Components

See Section 8 of Reference 17.1-1.

This section complies with Basic Requirement 8 and Supplement 8S-1 of ANSI/ASME NQA-1-1983.

17.1.9 Control of Special Processes

See Section 9 of Reference 17.1-1.

This section complies with Basic Requirement 9 and Supplement 9S-1 of ANSI/ASME NQA-1-1983.

17.1.10 Inspection

See Section 10 of Reference 17.1-1.

This section complies with Basic Requirement 10 and Supplement 10S-1 of ANSI/ASME NQA-1-1983 and NQA-1a-1983 as modified by the NRC-accepted alternate position identified in Table 2-1 of Reference 17.1-1 relating to NRC Regulatory Guide 1.116, Revision O-R.

17.1.11 Test Control

See Section 11 of Reference 17.1-1.

This section complies with Basic Requirement 11 and Supplement 11S-1 of ANSI/ASME NQA-1-1983 as modified by the NRC-accepted alternate position identified in Table 2-1 of Reference 17.1-1 relating to NRC Regulatory Guide 1.116, Revision O-R.

17.1.12 Control of Measuring and Test Equipment

See Section 12 of Reference 17.1-1.

This section complies with Basic Requirement 12 and Supplement 12S-1 of ANSI/ASME NQA-1-1983.

17.1.13 Handling, Storage, and Shipping

See Section 13 of Reference 17.1-1.

This section complies with Basic Requirement 13 and Supplement 13S-1 of ANSI/ASME NQA-1-1983 as modified by the NRC-accepted alternate position identified in Table 2-1 of Reference 17.1-1 relating to NRC Regulatory Guide 1.38, Revision 2.

17.1.14 Inspection, Test, and Operating Status

See Section 14 of Reference 17.1-1.

This section complies with Basic Requirement 14 of ANSI/ASME NQA-1-1983.

17.1.15 Nonconforming Materials, Parts, or Components

See Section 15 of Reference 17.1-1.

This section complies with Basic Requirement 15 and Supplement 15S-1 of ANSI/ASME NQA-1-1983.

17.1.16 Corrective Action

See Section 16 of Reference 17.1-1.

This section complies with Basic Requirement 16 of ANSI/ASME NQA-1-1983.

17.1.17 Quality Assurance Records

See Section 17 of Reference 17.1-1.

This section complies with Basic Requirement 17, Supplement 17S-1 of ANSI/ASME NQA-1-1983.

17.1.18 Audits

See Section 18 of Reference 17.1-1.

This section complies with Basic Requirement 18 of ANSI/ASME NQA-1-1983 and NQA-1a-1983.

17.1.19 References

17.1-1 GE Nuclear Energy, "GE Nuclear Energy Quality Assurance Program Description," NEDO-11209-04A (NRC accepted), March 1989.

17.1-2 GE Nuclear Energy, "ESBWR Design and Certification Program Quality Assurance Plan," NEDG-33181, Revision 0, June 2005.

17.1-3 ANSI/ASME, "QA Program Requirements for Nuclear Facilities," ANSI/ASME NQA-1-1983 and ANSI/ASME 1a-1983 Addenda.

17.2 QUALITY ASSURANCE DURING THE OPERATIONS PHASE

QA responsibilities during the plant construction and operations phases are Combined Operating License (COL) licensee scope.

17.3 QUALITY ASSURANCE PROGRAM DOCUMENT

The project overall Quality Assurance Program Document (QAPD) from the applicant is a COL applicant/licensee responsibility. The QAPD applied by the Design Team during the engineering and construction phases is described in Section 17.1.

17.4 RELIABILITY ASSURANCE PROGRAM DURING DESIGN PHASE

This section presents the ESBWR Design Reliability Assurance Program (D-RAP).

17.4.1 Introduction

The ESBWR D-RAP is a program utilized during detailed design and specific equipment selection phases to assure that the important ESBWR reliability assumptions of the probabilistic risk assessment (PRA) will be considered throughout the plant life. The plant owner/operator uses the D-RAP for those risk-significant structures, systems and components, if any, that are not covered by the GENE D-RAP and an Operational Reliability Assurance Program (O-RAP) that tracks equipment reliability to demonstrate that the plant is being operated and maintained consistent with PRA assumptions so that overall risk is not unknowingly degraded.

The PRA evaluates the plant response to initiating events to ensure plant damage has a very low probability and risk to the public. Input to the PRA includes details of the plant design and assumptions about the reliability of the plant risk-significant structures, systems and components (SSCs) throughout plant life. Section 19.5 identifies certain risk-significant SSCs. The results of Section 19.5 can be used as a starting point for the D-RAP.

The D-RAP includes the design evaluation of the ESBWR. It identifies relevant aspects of plant operation, maintenance, and performance monitoring of important plant SSCs for owner/operator consideration in assuring safety of the equipment and limited risk to the public. The COL applicant will specify the policy and implement procedures for using the D-RAP information. See Subsection 17.4.13 for COL applicant information.

Also included in this explanation of the D-RAP is a descriptive example of how the D-RAP applies to one potentially important plant system, the Isolation Condenser System (ICS). The ICS example shows how the principles of D-RAP will be applied to other systems identified by the PRA as being significant with respect to risk.

17.4.2 Scope

The ESBWR D-RAP will include the future design evaluation of the ESBWR, and it will identify relevant aspects of plant operation, maintenance, and performance monitoring of plant risk-significant SSCs. The PRA for the ESBWR and other industry sources will be used to identify and prioritize those SSCs that are important to prevent or mitigate plant transients or other events that could present a risk to the public.

17.4.3 Purpose

The purpose of the D-RAP is to ensure that the plant safety, as estimated by the PRA, is maintained as the detailed design evolves through the implementation and procurement phases, and that pertinent information is provided in the design documentation to the future owner/operator so that equipment reliability, as it affects plant safety, can be maintained through operation and maintenance during the entire plant life.

17.4.4 Objective

The objective of the D-RAP is to identify those plant SSCs that are significant contributors to risk, as shown by the PRA or other sources, and to assure that, during the implementation phase, the plant design continues to utilize risk-significant SSCs whose reliability is commensurate with the PRA assumptions. The D-RAP will also identify key assumptions regarding any operation, maintenance and monitoring activities that the owner/operator should consider in developing its O-RAP to assure that such SSCs can be expected to operate throughout plant life with reliability consistent with that assumed in the PRA.

A major factor in plant reliability assurance is risk-focused maintenance, by which maintenance resources are focused on those SSCs that enable the ESBWR systems to fulfill their safety functions and on SSCs whose failure may directly initiate challenges to safety-related systems. All plant modes are considered, including equipment directly relied upon in emergency operating procedures (EOPs). Such a focus on maintenance will help to maintain an acceptably low level of risk, consistent with the PRA.

17.4.5 GENE Organization for D-RAP

The D-RAP process definition and the PRA were performed by GENE.

Responsibility for the design of key equipment, components and subsystems ~~is~~ shared by GENE together with external organizations, including the architect engineer. The manager assigned the responsibility of managing and integrating the D-RAP Program will have direct access to the ESBWR Project Manager and will be kept abreast of D-RAP critical items, program needs and status. He has organizational freedom to:

- Identify D-RAP problems;
- Initiate, recommend or provide solutions to problems through designated organizations;
- Verify implementation of solutions; and
- Function as an integral part of the final design process.

The combined operating license applicant will need to supply a D-RAP organization description at the time of application for those risk-significant SSCs that are designed or procured by the applicant.

17.4.6 SSC Identification/Prioritization

The PRA is the primary source for identifying risk-significant SSCs that should be given special consideration during the detailed design and procurement phases and/or considered for inclusion in the O-RAP. The method by which the PRA is used to identify risk-significant SSCs is described in Chapter 19. It is also possible that some risk-significant SSCs will be identified from sources other than the PRA, such as nuclear plant operating experience, other industrial experience, and relevant component failure databases.

17.4.7 Design Considerations

The reliability of risk-significant SSCs, which are identified by the PRA and other sources, will be evaluated at the detailed design stage (by the COL applicant/licensee) by appropriate design reviews and reliability analyses. Current databases are used to identify appropriate values for failure rates of equipment as designed, and these failure rates will be compared with those used in the PRA. Normally the failure rates are similar, but in some cases they may differ because of recent design or data base changes. Whenever failure rates of designed risk-significant SSCs are significantly greater than those assumed in the PRA, an evaluation is performed to determine if the equipment is acceptable or if it must be redesigned to achieve a lower failure rate.

For those risk-significant SSCs, as indicated by PRA or other sources, component redesign (including selection of a different component) is considered as a way to reduce the core damage frequency (CDF) contribution. (If the system unavailability or the CDF is acceptably low, less effort is expended toward redesign.) If there are practical ways to redesign a risk-significant SSC, it is redesigned and the change in system fault tree results is calculated. Following the redesign phase, dominant SSC failure modes are identified so that protection against such failure modes can be accomplished by appropriate activities during plant life.

PRA or other design documents identifies the risk-significant SSCs and their associated failure modes and reliability assumptions, including any pertinent bases and uncertainties considered in the PRA. This information is also provided for incorporation into the O-RAP to help assure that PRA results will be achieved over the life of the plant. This information can be used by the owner/operator for establishing appropriate reliability targets and the associated maintenance practices for achieving them.

17.4.8 Defining Failure Modes

The determination of dominant failure modes of risk-significant SSCs include historical information, analytical models and existing requirements. Many BWR systems and components have compiled a significant historical record, so an evaluation of that record is performed.

For those SSCs for which there is not an adequate historical basis to identify critical failure modes, an analytical approach is necessary.

The failure modes identified are then reviewed with respect to the existing maintenance activities in the industry and the maintenance requirements.

17.4.9 Operational Reliability Assurance Activities

Once the dominant failure modes are determined for risk-significant SSCs, an assessment is required to determine suggested O-RAP activities that assure acceptable performance during plant life. Such activities may consist of periodic surveillance inspections or tests, monitoring of SSC performance, and/or periodic preventive maintenance (Reference 17.4-1 provides general guidance). Some SSCs may require a combination of activities to assure that their performance is consistent with that assumed in the PRA.

Periodic testing of SSCs may include startup of standby systems, surveillance testing of instrument circuits to assure that they respond to appropriate signals, and inspection of SSCs (such as tanks and pipes) to show that they are available to perform as designed. Performance monitoring, including condition monitoring, can consist of measurement of output (such as pump flow rate or heat exchanger temperatures), measurement of magnitude of an important variable (such as vibration or temperature), and testing for abnormal conditions (such as oil degradation or local hot spots).

Periodic preventive maintenance is an activity performed at regular intervals to preclude problems that could occur before the next preventive maintenance (PM) interval. This could be regular oil changes, replacement of seals and gaskets, or refurbishment of equipment subject to wear or age related degradation.

Planned maintenance activities will be integrated with the regular operating plans so that they do not disrupt normal operation. Maintenance that is performed more frequently than refueling outages must be planned so as to not disrupt operation or be likely to cause reactor scram, engineered safety feature (ESF) actuation, or abnormal transients. Maintenance planned for performance during refueling outages must be conducted in such a way that it has little or no effect on plant safety, outage length or other maintenance work.

The COL applicant shall provide a complete O-RAP to be reviewed by the NRC. See Subsection 17.4.13 for COL applicant information.

17.4.10 Owner/Operator's Reliability Assurance Program

The O-RAP is prepared and implemented by the ESBWR owner/operator, and uses the information provided by GENE. This information should help the owner/operator determine activities that should be included in the O-RAP. Examples of elements that might be included in an O-RAP are as follows:

- **Reliability Performance Monitoring:** Measurement of the performance of equipment to determine that it is accomplishing its goals and/or continue to operate with low probability of failure.
- **Reliability Methodology:** Methods by which the plant owner/operator can compare plant data to the SSC data in the PRA.
- **Problem Prioritization:** Identification, for each of the risk-significant SSCs, of the importance of that item as a contributor to its system unavailability and assignment of priorities to problems that are detected with such equipment.
- **Root Cause Analysis:** Determination, for problems that occur regarding reliability of risk-significant SSCs, of the root causes; those causes which, after correction, does not recur to again degrade the reliability of equipment.
- **Corrective Action Determination:** Identification of corrective actions needed to restore equipment to its required functional capability and reliability, based on the results of problem identification and root cause analysis.
- **Corrective Action Implementation:** Carrying out identified corrective action on risk-significant equipment to restore equipment to its intended function in such a way that plant safety is not compromised during work.
- **Corrective Action Verification:** Post-corrective action tasks to be followed after maintenance on risk-significant equipment to assure that such equipment performs its intended functions.
- **Plant Aging:** Some of the risk-significant equipment is expected to undergo age related degradation and require equipment replacement or refurbishment.
- **Feedback to Designer:** The plant owner/operator periodically compares performance of risk-significant equipment to that specified in the PRA and D-RAP, as mentioned in item 1, above, and, at its discretion, can feed back SSC performance data to plant or equipment designers in those cases that consistently show performance below that specified.

- **Programmatic Interfaces:** Reliability assurance interfaces related to the work of the several organizations and personnel groups working on risk-significant SSCs.

The plant owner/operator's O-RAP addresses the interfaces with construction, startup testing, operations, maintenance, engineering, safety, licensing, quality assurance and procurement of initial and replacement equipment.

17.4.11 D-RAP Implementation

A prototypical example of implementation of the D-RAP is given for the Isolation Condenser System (ICS) in SBWR SAR Subsection 17.3.11 (Reference 17.4-2). This is being used to guide early design work in the ESBWR.

17.4.12 Glossary of Terms

Core Damage Frequency — As calculated by the probabilistic risk assessment.

Design Reliability Assurance Program — Performed by the plant designer to assure the plant is designed so that it can be operated and maintained in such a way that the reliability assumptions of the probabilistic risk assessment apply throughout plant life.

Fussell-Vesely Importance — A measure of the component contribution to core damage frequency. Numerically, the percentage contribution of the component to CDF.

Owner/Operator — The utility or other organization that owns and operates the ESBWR following construction.

Operational Reliability Assurance Program — Performed by the plant owner/operator to assure the plant is operated and maintained safely and in such a way that the reliability assumptions of the PRA apply throughout plant life.

Piece-part — A portion of a (risk-significant) component whose failure would cause the failure of the component as a whole. The precise definition of a “piece-part” varies between component types, depending upon their complexity.

Probabilistic Risk Assessment — Performed to identify and quantify the risk associated with the ESBWR.

Risk-Significant — Those structures, systems and components that are identified as contributing significantly to the core damage frequency.

Structures, Systems and Components — Identified as being important to plant operation and safety.

17.4.13 COL Information

17.4.13.1 Policy and Implementation Procedures for D-RAP

The COL applicant/licensee will specify the policy and implementation procedures for using D-RAP information (Subsection 17.4.1).

17.4.13.2 D-RAP Organization

The COL licensee, completing its detailed design and equipment selection during the design phase, will submit its specific D-RAP organization for NRC review (Subsection 17.4.5).

17.4.13.3 Provision for O-RAP

The COL licensee will provide a complete O-RAP to be reviewed by the NRC (Subsection 17.4.9).

17.4.14 References

17.4-1 USNRC, E. V. Lofgren, et al., “A Process for Risk-Focused Maintenance,” SAIC, NUREG/CR-5695, March 1991.

17.4-2 GE Nuclear Energy, “Application for Design Certification of the Simplified Boiling Water Reactor (SBWR),” MFN No. 161-92, Project No. 681, SLK-9289, dated 27 August 1992.