



## **ESBWR Design Control Document** *Tier 2*

### Table Of Contents

## Contents

1. Introduction and General Description of Plant.....	1.1-1
1.1 Introduction.....	1.1-1
1.1.1 Format and Content.....	1.1-1
1.1.2 General Description .....	1.1-1
1.1.2.1 ESBWR Standard Plant Scope.....	1.1-1
1.1.2.2 Type of License Request.....	1.1-2
1.1.2.3 Number of Plant Units .....	1.1-2
1.1.2.4 Description of Location .....	1.1-2
1.1.2.5 Type of Nuclear Steam Supply .....	1.1-2
1.1.2.6 Type of Containment .....	1.1-2
1.1.2.7 Rated Core Thermal Power.....	1.1-2
1.1.3 COL Information .....	1.1-3
1.1.4 References.....	1.1-3
1.2 General Plant Description.....	1.2-1
1.2.1 Principal Design Criteria.....	1.2-1
1.2.1.1 General Power Generation (Nonsafety) Design Criteria .....	1.2-1
1.2.1.2 General Safety Design Criteria .....	1.2-2
1.2.1.3 Nuclear System Criteria.....	1.2-4
1.2.1.4 Electrical Power Systems Criteria .....	1.2-5
1.2.1.5 Auxiliary Systems Criteria.....	1.2-5
1.2.1.6 Shielding and Access Control Criteria.....	1.2-5
1.2.1.7 Power Conversion Systems Criteria .....	1.2-5
1.2.1.8 Nuclear System Process Control Criteria .....	1.2-6
1.2.1.9 Electrical Power System Process Control Criteria.....	1.2-6
1.2.2 Plant Description.....	1.2-6
1.2.2.1 Nuclear Steam Supply.....	1.2-6
1.2.2.1.1 Reactor Pressure Vessel and Internals .....	1.2-6
1.2.2.1.2 Nuclear Boiler System .....	1.2-10
1.2.2.1.3 RPV Natural Circulation Process.....	1.2-15
1.2.2.2 Controls and Instrumentation.....	1.2-15
1.2.2.2.1 Rod Control and Information System .....	1.2-15
1.2.2.2.2 Control Rod Drive System.....	1.2-17
1.2.2.2.3 Feedwater Control System.....	1.2-19
1.2.2.2.4 Standby Liquid Control System.....	1.2-21
1.2.2.2.5 Neutron Monitoring System .....	1.2-21
1.2.2.2.6 Remote Shutdown System .....	1.2-23
1.2.2.2.7 Reactor Protection System.....	1.2-23
1.2.2.2.8 Plant Automation System .....	1.2-24
1.2.2.2.9 Steam Bypass and Pressure Control System.....	1.2-25
1.2.2.2.10 Distributed Control and Information System.....	1.2-26
1.2.2.2.11 Leak Detection and Isolation System .....	1.2-26
1.2.2.2.12 Safety System Logic and Control System .....	1.2-27
1.2.2.2.13 Diverse Instrumentation and Controls .....	1.2-28

1.2.2.3 Radiation Monitoring Systems .....	1.2-30
1.2.2.3.1 Process Radiation Monitoring System.....	1.2-30
1.2.2.3.2 Area Radiation Monitoring System .....	1.2-33
1.2.2.4 Core Cooling Systems Used For Abnormal Events.....	1.2-33
1.2.2.4.1 Isolation Condenser System.....	1.2-33
1.2.2.4.2 Emergency Core Cooling System — Gravity-Driven Cooling System..	1.2-35
1.2.2.5 Reactor Servicing Equipment .....	1.2-36
1.2.2.5.1 Fuel Service Equipment.....	1.2-36
1.2.2.5.2 Miscellaneous Service Equipment.....	1.2-37
1.2.2.5.3 Reactor Pressure Vessel Servicing Equipment.....	1.2-37
1.2.2.5.4 RPV Internals Servicing Equipment.....	1.2-38
1.2.2.5.5 Refueling Equipment .....	1.2-38
1.2.2.5.6 Fuel Storage Facility .....	1.2-39
1.2.2.5.7 Under-Vessel Servicing Equipment.....	1.2-39
1.2.2.5.8 FMCRD Maintenance Area .....	1.2-40
1.2.2.5.9 Fuel Cask Cleaning.....	1.2-40
1.2.2.5.10 Fuel Transfer System.....	1.2-40
1.2.2.5.11 [Deleted] .....	1.2-42
1.2.2.6 Reactor Auxiliary Systems .....	1.2-42
1.2.2.6.1 Reactor Water Cleanup/Shutdown Cooling System.....	1.2-42
1.2.2.6.2 Fuel and Auxiliary Pools Cooling System.....	1.2-43
1.2.2.7 Control Panels.....	1.2-45
1.2.2.7.1 Main Control Room Panels.....	1.2-45
1.2.2.7.2 Radwaste Control Room Panels.....	1.2-45
1.2.2.7.3 Local Control Panels and Racks .....	1.2-45
1.2.2.8 Nuclear Fuel.....	1.2-45
1.2.2.8.1 Fuel Rods and Bundles .....	1.2-45
1.2.2.8.2 Fuel Channel .....	1.2-46
1.2.2.9 Control Rods .....	1.2-46
1.2.2.10 Radioactive Waste Management System.....	1.2-47
1.2.2.10.1 Liquid Waste Management System .....	1.2-47
1.2.2.10.2 Solid Waste Management System .....	1.2-47
1.2.2.10.3 Gaseous Waste Management System .....	1.2-48
1.2.2.11 Power Cycle.....	1.2-49
1.2.2.11.1 Turbine Main Steam System.....	1.2-49
1.2.2.11.2 Condensate and Feedwater System.....	1.2-50
1.2.2.11.3 Condensate Purification System .....	1.2-51
1.2.2.11.4 Main Turbine .....	1.2-51
1.2.2.11.5 Turbine Gland Seal System .....	1.2-51
1.2.2.11.6 Turbine Bypass System.....	1.2-52
1.2.2.11.7 Main Condenser .....	1.2-53
1.2.2.11.8 Circulating Water System.....	1.2-54
1.2.2.12 Station Auxiliaries .....	1.2-54
1.2.2.12.1 Makeup Water System.....	1.2-54
1.2.2.12.2 Condensate Storage and Transfer System.....	1.2-55
1.2.2.12.3 Reactor Component Cooling Water System.....	1.2-55

1.2.2.12.4 Turbine Component Cooling Water System.....	1.2-56
1.2.2.12.5 Chilled Water System .....	1.2-56
1.2.2.12.6 Oxygen Injection System.....	1.2-56
1.2.2.12.7 Plant Service Water System.....	1.2-56
1.2.2.12.8 Service Air System .....	1.2-57
1.2.2.12.9 Instrument Air System .....	1.2-57
1.2.2.12.10 High Pressure Nitrogen Supply System.....	1.2-57
1.2.2.12.11 Auxiliary Boiler System .....	1.2-58
1.2.2.12.12 [Deleted] .....	1.2-58
1.2.2.12.13 Hydrogen Water Chemistry System .....	1.2-58
1.2.2.12.14 Process Sampling System .....	1.2-58
1.2.2.12.15 Zinc Injection System .....	1.2-59
1.2.2.12.16 Freeze Protection .....	1.2-59
1.2.2.13 Station Electrical System .....	1.2-59
1.2.2.13.1 Electrical Power Distribution System.....	1.2-59
1.2.2.13.2 Electrical Penetrations .....	1.2-59
1.2.2.13.3 Direct Current Power Supply.....	1.2-60
1.2.2.13.4 Standby On-Site AC Power Supply.....	1.2-60
1.2.2.13.5 Uninterruptible AC Power Supply.....	1.2-61
1.2.2.13.6 [Deleted] .....	1.2-61
1.2.2.13.7 Communications System .....	1.2-61
1.2.2.13.8 Lighting Power Supply .....	1.2-61
1.2.2.14 Power Transmission.....	1.2-62
1.2.2.15 Containment and Environmental Control Systems.....	1.2-62
1.2.2.15.1 Containment System .....	1.2-62
1.2.2.15.2 Containment Vessel .....	1.2-64
1.2.2.15.3 Containment Internal Structures .....	1.2-64
1.2.2.15.4 Passive Containment Cooling System .....	1.2-65
1.2.2.15.5 Containment Inerting System .....	1.2-66
1.2.2.15.6 Drywell Cooling System.....	1.2-67
1.2.2.15.7 Containment Monitoring System.....	1.2-68
1.2.2.16 Structures and Servicing Systems.....	1.2-70
1.2.2.16.1 Cranes, Hoists and Elevators .....	1.2-70
1.2.2.16.2 Heating Ventilating and Air Conditioning.....	1.2-70
1.2.2.16.3 Fire Protection System.....	1.2-71
1.2.2.16.4 Equipment and Floor Drainage System.....	1.2-72
1.2.2.16.5 Reactor Building.....	1.2-72
1.2.2.16.6 Control Building .....	1.2-72
1.2.2.16.7 Fuel Building .....	1.2-72
1.2.2.16.8 Turbine Building.....	1.2-72
1.2.2.16.9 Radwaste Building.....	1.2-73
1.2.2.16.10 Other Building Structures .....	1.2-73
1.2.2.17 Intake Structure and Servicing Equipment .....	1.2-73
1.2.2.17.1 Intake and Discharge Structures .....	1.2-73
1.2.2.18 Yard Structures and Equipment.....	1.2-73
1.2.2.18.1 Oil Storage and Transfer System.....	1.2-73

1.2.2.18.2 Site Security .....	1.2-73
1.2.3 COL Information .....	1.2-74
1.2.4 References .....	1.2-74
1.3 Comparison Tables .....	1.3-1
1.3.1 COL Information .....	1.3-1
1.4 Identification of Agents and Contractors .....	1.4-1
1.5 Requirements for Further Technical Information .....	1.5-1
1.5.1 Evolutionary Design .....	1.5-1
1.5.2 Analysis and Design Tools .....	1.5-1
1.5.2.1 TRACG .....	1.5-2
1.5.2.2 Scope of Application of TRACG to ESBWR .....	1.5-3
1.5.3 Testing .....	1.5-4
1.5.3.1 Major ESBWR Unique Test Programs .....	1.5-6
1.5.4 References .....	1.5-8
1.6 Material Incorporated by Reference .....	1.6-1
1.7 Drawings and Other Detailed Information .....	1.7-1
1.7.1 Electrical, Instrumentation and Control Drawings .....	1.7-1
1.7.2 Piping and Instrumentation Diagrams .....	1.7-1
1.7.3 Other Detailed Information .....	1.7-1
1.7.4 COL Information .....	1.7-2
1.8 Interfaces With Standard Design .....	1.8-1
1.8.1 Identification of Nuclear Steam Supply System Safety-Related Interfaces .....	1.8-1
1.8.2 Identification of Balance of Plant Interfaces .....	1.8-1
1.8.2.1 Circulating Water System .....	1.8-1
1.8.2.2 Plant Service Water System .....	1.8-1
1.8.2.3 Off-site Electrical Power .....	1.8-1
1.8.2.4 Makeup Water System .....	1.8-1
1.8.2.5 Potable and Sanitary Water .....	1.8-2
1.8.2.6 Communications Systems .....	1.8-2
1.8.2.7 Station Water System .....	1.8-2
1.9 Conformance with Standard Review Plan and Applicability of Codes and Standards ..	1.9-1
1.9.1 Conformance with Standard Review Plan .....	1.9-1
1.9.2 Applicability to Regulatory Criteria .....	1.9-1
1.9.3 Applicability of Experience Information .....	1.9-1
1.9.4 COL information .....	1.9-1
1.9.5 References .....	1.9-1
1.10 Summary of COL Items .....	1.10-1
1.11 Technical Resolutions of Task Action Plan Items, New Generic Issues, New Generic Safety Issues and Chernobyl Issues .....	1.11-1
1.11.1 Approach .....	1.11-1
1.11.2 COL Information .....	1.11-1
1.11.3 References .....	1.11-1

Appendix 1A Response to TMI Related Matters.....	1A-1
1A.1 References.....	1A-1
Appendix 1B Plant Shielding to Provide Access to Areas and Protect Safety Equipment for Post-Accident Operation [II.B.2] .....	1B-1
1B.1 Introduction .....	1B-1
1B.2 Summary of Shielding Design Review .....	1B-1
1B.3 Containment Description and Post-Accident Operations.....	1B-2
1B.3.1 Description of Containment .....	1B-2
1B.3.2 Post-Accident Access of Areas and Systems .....	1B-3
1B.3.3 Post-Accident Operation .....	1B-3
1B.4 Design Review Bases.....	1B-4
1B.4.1 Radioactive Source Term and Dose Rates .....	1B-4
1B.4.2 Accidents Used as the Basis for the Specified Radioactivity Release .....	1B-4
1B.4.3 Availability of Offsite Power .....	1B-4
1B.4.4 Radiation Qualification Conditions.....	1B-5
1B.5 Results of the Review.....	1B-5
1B.5.1 Systems Required Post-Accident .....	1B-5
1B.5.1.1 Necessary Post-Accident Functions and Systems.....	1B-5
1B.5.1.2 Emergency Core Cooling and Residual Heat Removal Systems.....	1B-6
1B.5.1.3 Flammability Control.....	1B-7
1B.5.1.4 Fission Product Removal and Control System.....	1B-7
1B.5.1.5 Instrumentation and Control, Power and Habitability Systems .....	1B-7
1B.6 References .....	1B-8
Appendix 1C Industry Operating Experience.....	1C-1
1C.1 Evaluation.....	1C-1
1C.2 COL Information.....	1C-1
Appendix 1D [DELETED] .....	1D-1

2. Site Characteristics..... 2.0-1

    2.0 Introduction..... 2.0-1

        2.0.1 COL Information ..... 2.0-2

        2.0.2 References..... 2.0-2

Appendix 2A ARCON96 Source/Receptor Inputs ..... 2A-1

    2A.1 Scope ..... 2A-1

    2A.2 Methodology ..... 2A-1

    2A.3 COL Information..... 2A-3

    2A.4 References ..... 2A-3

3.	DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT, AND SYSTEMS.....	3.1-1
3.1	CONFORMANCE WITH NRC GENERAL DESIGN CRITERIA .....	3.1-1
3.1.1	Group I — Overall Requirements.....	3.1-1
3.1.1.1	Criterion 1 — Quality Standards and Records .....	3.1-1
3.1.1.2	Criterion 2 — Design Bases for Protection Against Natural Phenomena .....	3.1-2
3.1.1.3	Criterion 3 — Fire Protection .....	3.1-3
3.1.1.4	Criterion 4 — Environmental and Dynamic Effects Design Bases.....	3.1-4
3.1.1.5	Criterion 5 — Sharing of Structures, Systems, and Components.....	3.1-5
3.1.2	Group II — Protection by Multiple Fission Product Barriers.....	3.1-5
3.1.2.1	Criterion 10 — Reactor Design .....	3.1-5
3.1.2.2	Criterion 11 — Reactor Inherent Protection.....	3.1-6
3.1.2.3	Criterion 12 — Suppression of Reactor Power Oscillations .....	3.1-7
3.1.2.4	Criterion 13 — Instrumentation and Control.....	3.1-8
3.1.2.5	Criterion 14 — Reactor Coolant Pressure Boundary.....	3.1-10
3.1.2.6	Criterion 15 — Reactor Coolant System Design.....	3.1-11
3.1.2.7	Criterion 16 — Containment Design .....	3.1-12
3.1.2.8	Criterion 17 — Electric Power Systems .....	3.1-13
3.1.2.9	Criterion 18 — Inspection and Testing of Electric Power Systems .....	3.1-15
3.1.2.10	Criterion 19 — Control Room .....	3.1-16
3.1.3	Group III — Protection and Reactivity Control Systems .....	3.1-17
3.1.3.1	Criterion 20 — Protection System Functions .....	3.1-17
3.1.3.2	Criterion 21 — Protection System Reliability and Testability .....	3.1-19
3.1.3.3	Criterion 22 — Protection System Independence.....	3.1-20
3.1.3.4	Criterion 23 — Protection System Failure Modes.....	3.1-21
3.1.3.5	Criterion 24 — Separation of Protection and Control Systems.....	3.1-22
3.1.3.6	Criterion 25 — Protection System Requirements for Reactivity Control Malfunctions.....	3.1-23
3.1.3.7	Criterion 26 — Reactivity Control System Redundancy and Capability .....	3.1-24
3.1.3.8	Criterion 27 — Combined Reactivity Control Systems Capability.....	3.1-25
3.1.3.9	Criterion 28 — Reactivity Limits .....	3.1-26
3.1.3.10	Criterion 29 — Protection Against Anticipated Operational Occurrences...	3.1-28
3.1.4	Group IV — Fluid Systems .....	3.1-29
3.1.4.1	Criterion 30 — Quality of Reactor Coolant Pressure Boundary .....	3.1-29
3.1.4.2	Criterion 31 — Fracture Prevention of Reactor Coolant Pressure Boundary.....	3.1-30
3.1.4.3	Criterion 32 — Inspection of Reactor Coolant Pressure Boundary.....	3.1-31
3.1.4.4	Criterion 33 — Reactor Coolant Makeup.....	3.1-31
3.1.4.5	Criterion 34 — Residual Heat Removal .....	3.1-32
3.1.4.6	Criterion 35 — Emergency Core Cooling .....	3.1-33
3.1.4.7	Criterion 36 — Inspection of Emergency Core Cooling System .....	3.1-35
3.1.4.8	Criterion 37 — Testing of Emergency Core Cooling System .....	3.1-36
3.1.4.9	Criterion 38 — Containment Heat Removal .....	3.1-36
3.1.4.10	Criterion 39 — Inspection of Containment Heat Removal System.....	3.1-38
3.1.4.11	Criterion 40 — Testing of Containment Heat Removal System .....	3.1-38
3.1.4.12	Criterion 41 — Containment Atmosphere Cleanup.....	3.1-39



3.1.4.13 Criterion 42 — Inspection of Containment Atmosphere Cleanup Systems	3.1-40
3.1.4.14 Criterion 43 — Testing of Containment Atmosphere Cleanup Systems	3.1-40
3.1.4.15 Criterion 44 — Cooling Water	3.1-41
3.1.4.16 Criterion 45 — Inspection of Cooling Water System	3.1-42
3.1.4.17 Criterion 46 — Testing of Cooling Water System	3.1-42
3.1.5 Group V — Reactor Containment	3.1-43
3.1.5.1 Criterion 50 — Containment Design Basis	3.1-43
3.1.5.2 Criterion 51 — Fracture Prevention of Containment Pressure Boundary	3.1-44
3.1.5.3 Criterion 52 — Capability for Containment Leakage Rate Testing	3.1-44
3.1.5.4 Criterion 53 — Provisions for Containment Testing and Inspection	3.1-45
3.1.5.5 Criterion 54 — Piping Systems Penetrating Containment	3.1-45
3.1.5.6 Criterion 55 — Reactor Coolant Pressure Boundary Penetrating Containment	3.1-46
3.1.5.7 Criterion 56 — Primary Containment Isolation	3.1-47
3.1.5.8 Criterion 57 — Closed System Isolation Valves	3.1-48
3.1.6 Group VI — Fuel and Radioactivity Control	3.1-48
3.1.6.1 Criterion 60 — Control of Releases of Radioactive Materials to the Environment	3.1-48
3.1.6.2 Criterion 61 — Fuel Storage and Handling and Radioactivity Control	3.1-49
3.1.6.3 Criterion 62 — Prevention of Criticality in Fuel Storage and Handling	3.1-50
3.1.6.4 Criterion 63 — Monitoring Fuel and Waste Storage	3.1-51
3.1.6.5 Criterion 64 — Monitoring Radioactivity Releases	3.1-52
3.1.7 COL Information	3.1-52
3.2 CLASSIFICATION OF STRUCTURES, SYSTEMS AND COMPONENTS	3.2-1
3.2.1 Seismic Classification	3.2-1
3.2.2 System Quality Group Classification	3.2-2
3.2.2.1 Quality Group A	3.2-2
3.2.2.2 Quality Group B	3.2-2
3.2.2.3 Quality Group C	3.2-3
3.2.2.4 Quality Group D	3.2-4
3.2.3 Safety Classification	3.2-4
3.2.3.1 Safety Class 1	3.2-5
3.2.3.2 Safety Class 2	3.2-5
3.2.3.3 Safety Class 3	3.2-6
3.2.3.4 NonSafety-Related	3.2-7
3.2.4 COL Information	3.2-8
3.2.5 References	3.2-8
3.3 WIND AND TORNADO LOADINGS	3.3-1
3.3.1 Wind Loadings	3.3-1
3.3.1.1 Design Wind Velocity and Recurrence Interval	3.3-1
3.3.1.2 Determination of Applied Forces	3.3-1
3.3.1.3 Effect of Failures of Structures or Components Not Designed for Wind Loads	3.3-1
3.3.2 Tornado Loadings	3.3-2
3.3.2.1 Applicable Design Parameters	3.3-2
3.3.2.2 Determination of Forces on Structures	3.3-2

3.3.2.3 Effect of Failures of Structures or Components Not Designed for  
Tornado Loads ..... 3.3-2

3.3.3 References ..... 3.3-3

3.4 WATER LEVEL (FLOOD) DESIGN ..... 3.4-1

3.4.1 Flood Protection ..... 3.4-1

3.4.1.1 Flood Protection Summary ..... 3.4-2

3.4.1.2 Flood Protection From External Sources ..... 3.4-2

3.4.1.3 Internal Flooding Evaluation Criteria ..... 3.4-3

3.4.1.4 Evaluation of Internal Flooding ..... 3.4-4

3.4.2 Analysis Procedures ..... 3.4-7

3.4.3 COL Information ..... 3.4-8

3.4.4 References ..... 3.4-8

3.5 MISSILE PROTECTION ..... 3.5-1

3.5.1 Missile Selection and Description ..... 3.5-1

3.5.1.1 Internally Generated Missiles (Outside Containment) ..... 3.5-3

3.5.1.2 Internally Generated Missiles (Inside Containment) ..... 3.5-7

3.5.1.3 Turbine Missiles ..... 3.5-8

3.5.1.4 Missiles Generated by Natural Phenomena ..... 3.5-8

3.5.1.5 Site Proximity Missiles (Except Aircraft) ..... 3.5-8

3.5.1.6 Aircraft Hazards ..... 3.5-9

3.5.2 Structures, Systems, and Components to be Protected from Externally  
Generated Missiles ..... 3.5-9

3.5.3 Barrier Design Procedures ..... 3.5-9

3.5.3.1 Local Damage Prediction ..... 3.5-9

3.5.3.2 Overall Damage Prediction ..... 3.5-10

3.5.3.3 Impact of Failure of Nonsafety-Related Structures, Systems and  
Components ..... 3.5-10

3.5.4 COL Information ..... 3.5-10

3.5.5 References ..... 3.5-10

3.6 PROTECTION AGAINST DYNAMIC EFFECTS ASSOCIATED WITH THE  
POSTULATED RUPTURE OF PIPING ..... 3.6-1

3.6.1 Plant Design for Protection Against Postulated Piping Failures in Fluid  
Systems Inside and Outside of Containment ..... 3.6-1

3.6.1.1 Design Bases ..... 3.6-2

3.6.1.2 Description ..... 3.6-4

3.6.1.3 Design Evaluation ..... 3.6-4

3.6.2 Determination of Break Locations and Dynamic Effects Associated with the  
Postulated Rupture of Piping ..... 3.6-7

3.6.2.1 Criteria Used to Define Break and Crack Location and Configuration ..... 3.6-8

3.6.2.2 Analytic Methods to Define Blowdown Forcing Functions and Response  
Models ..... 3.6-16

3.6.2.3 Dynamic Analysis Methods to Verify Integrity and Operability ..... 3.6-17

3.6.2.4 Guard Pipe Assembly Design ..... 3.6-23

3.6.2.5 Pipe Break Analysis Results and Protection Methods ..... 3.6-23

3.6.3 (Deleted) ..... 3.6-24

3.6.3.1 (Deleted) ..... 3.6-24

3.6.3.2 (Deleted) .....	3.6-24
3.6.4 As-built Inspection of High-Energy Pipe Break Mitigation Features.....	3.6-24
3.6.5 COL Information .....	3.6-24
3.6.6 References.....	3.6-24
3.7 SEISMIC DESIGN .....	3.7-1
3.7.1 Seismic Design Parameters.....	3.7-2
3.7.1.1 Design Ground Motion .....	3.7-2
3.7.1.2 Percentage of Critical Damping Values.....	3.7-6
3.7.1.3 Supporting Media for Category I Structures.....	3.7-6
3.7.2 Seismic System Analysis .....	3.7-6
3.7.2.1 Seismic Analysis Methods.....	3.7-6
3.7.2.2 Natural Frequencies and Responses.....	3.7-10
3.7.2.3 Procedures Used for Analytical Modeling.....	3.7-10
3.7.2.4 Soil-Structure Interaction.....	3.7-12
3.7.2.5 Development of Floor Response Spectra.....	3.7-12
3.7.2.6 Three Components of Earthquake Motion.....	3.7-13
3.7.2.7 Combination of Modal Responses .....	3.7-13
3.7.2.8 Interaction of Non-Category I Structures with Seismic Category I Structures.....	3.7-16
3.7.2.9 Effects of Parameter Variations on Floor Response Spectra .....	3.7-17
3.7.2.10 Use of Equivalent Vertical Static Factors.....	3.7-17
3.7.2.11 Methods Used to Account for Torsional Effects .....	3.7-17
3.7.2.12 Comparison of Responses.....	3.7-17
3.7.2.13 Analysis Procedure for Damping.....	3.7-18
3.7.2.14 Determination of Seismic Category I Structure Overturning Moments .....	3.7-19
3.7.3 Seismic Subsystem Analysis.....	3.7-20
3.7.3.1 Seismic Analysis Methods.....	3.7-20
3.7.3.2 Determination of Number of Earthquake Cycles.....	3.7-21
3.7.3.3 Procedures Used for Analytical Modeling.....	3.7-21
3.7.3.4 Basis for Selection of Frequencies.....	3.7-23
3.7.3.5 Analysis Procedure for Damping.....	3.7-23
3.7.3.6 Three Components of Earthquake Motion.....	3.7-23
3.7.3.7 Combination of Modal Responses .....	3.7-23
3.7.3.8 Interaction of Other Systems with Seismic Category I Systems .....	3.7-23
3.7.3.9 Multiple-Supported Equipment and Components with Distinct Inputs.....	3.7-23
3.7.3.10 Use of Equivalent Vertical Static Factors.....	3.7-24
3.7.3.11 Torsional Effects of Eccentric Masses.....	3.7-24
3.7.3.12 Effect of Differential Building Movements.....	3.7-24
3.7.3.13 Seismic Category I Buried Piping, Conduits and Tunnels .....	3.7-25
3.7.3.14 Methods for Seismic Analysis of Seismic Category I Concrete Dams .....	3.7-26
3.7.3.15 Methods for Seismic Analysis of Above-Ground Tanks.....	3.7-26
3.7.3.16 Design of Small Branch and Small Bore Piping.....	3.7-27
3.7.3.17 Interaction of Other Piping with Seismic Category I Piping .....	3.7-28
3.7.4 Seismic Instrumentation.....	3.7-29
3.7.4.1 Comparison with Regulatory Guide 1.12 .....	3.7-30
3.7.4.2 Location and Description of Instrumentation .....	3.7-30
3.7.4.3 Control Room Operator Notification.....	3.7-31

3.7.4.4 Comparison of Measured and Predicted Responses .....	3.7-31
3.7.4.5 In-Service Surveillance .....	3.7-32
3.7.5 Site-Specific Information .....	3.7-32
3.7.6 References .....	3.7-32
3.8 SEISMIC CATEGORY I STRUCTURES .....	3.8-1
3.8.1 Concrete Containment .....	3.8-1
3.8.1.1 Description of the Containment .....	3.8-1
3.8.1.2 Applicable Codes, Standards, and Specifications .....	3.8-3
3.8.1.3 Loads and Load Combinations .....	3.8-4
3.8.1.4 Design and Analysis Procedures .....	3.8-6
3.8.1.5 Structural Acceptance Criteria .....	3.8-10
3.8.1.6 Material, Quality Control and Special Construction Techniques .....	3.8-10
3.8.1.7 Testing and In-service Inspection Requirements .....	3.8-13
3.8.2 Steel Components of the Reinforced Concrete Containment .....	3.8-16
3.8.2.1 Description of the Steel Containment Components .....	3.8-16
3.8.2.2 Applicable Codes, Standards, Specifications and Regulatory Guides .....	3.8-19
3.8.2.3 Loads and Load Combinations .....	3.8-19
3.8.2.4 Design and Analysis Procedures .....	3.8-19
3.8.2.5 Structural Acceptance Criteria .....	3.8-21
3.8.2.6 Materials, Quality Control, and Special Construction Techniques .....	3.8-22
3.8.2.7 Testing and In-service Inspection Requirements .....	3.8-22
3.8.3 Concrete and Steel Internal Structures of the Concrete Containment .....	3.8-23
3.8.3.1 Description of the Internal Structures .....	3.8-23
3.8.3.2 Applicable Codes, Standards, and Specifications .....	3.8-25
3.8.3.3 Loads and Load Combinations .....	3.8-26
3.8.3.4 Design and Analysis Procedures .....	3.8-26
3.8.3.5 Structural Acceptance Criteria .....	3.8-27
3.8.3.6 Materials, Quality Control, and Special Construction Techniques .....	3.8-28
3.8.3.7 Testing and In-service Inspection Requirements .....	3.8-30
3.8.3.8 Welding Methods and Acceptance Criteria for Structural and Building Steel .....	3.8-30
3.8.4 Other Seismic Category I Structures .....	3.8-30
3.8.4.1 Description of the Structures .....	3.8-31
3.8.4.2 Applicable Codes, Standards, and Specifications .....	3.8-34
3.8.4.3 Loads and Load Combinations .....	3.8-35
3.8.4.4 Design and Analysis Procedures .....	3.8-38
3.8.4.5 Structural Acceptance Criteria .....	3.8-38
3.8.4.6 Material, Quality Control and Special Construction Techniques .....	3.8-39
3.8.4.7 Testing and In-Service Inspection Requirements .....	3.8-40
3.8.5 Foundations .....	3.8-40
3.8.5.1 Description of the Foundations .....	3.8-41
3.8.5.2 Applicable Codes, Standards and Specifications .....	3.8-41
3.8.5.3 Loads and Load Combinations .....	3.8-41
3.8.5.4 Design and Analysis Procedures .....	3.8-42
3.8.5.5 Structural Acceptance Criteria .....	3.8-43
3.8.5.6 Materials, Quality Control, and Special Construction Techniques .....	3.8-44
3.8.5.7 Testing and In-Service Inspection Requirements .....	3.8-44

3.8.6 Special Topics ..... 3.8-44

    3.8.6.1 Foundation Waterproofing..... 3.8-44

    3.8.6.2 Site-Specific Physical Properties and Foundation Settlement ..... 3.8-44

    3.8.6.3 Structural Integrity Pressure Result ..... 3.8-44

    3.8.6.4 Identification of Seismic Category I Structures..... 3.8-44

3.9 Mechanical Systems and Components.....	3.9-1
3.9.1 Special Topics for Mechanical Components .....	3.9-1
3.9.1.1 Design Transients.....	3.9-1
3.9.1.2 Computer Programs Used in Analyses .....	3.9-2
3.9.1.3 Experimental Stress Analysis .....	3.9-2
3.9.1.4 Considerations for the Evaluation of Faulted Condition .....	3.9-2
3.9.2 Dynamic Testing and Analysis of Systems, Components and Equipment.....	3.9-5
3.9.2.1 Piping Vibration, Thermal Expansion and Dynamic Effects.....	3.9-5
3.9.2.1.1 Vibration and Dynamic Effects Testing .....	3.9-6
3.9.2.1.2 Thermal Expansion Testing.....	3.9-8
3.9.2.2 Seismic Qualification of Safety-Related Mechanical Equipment (Including Other RBV Induced Loads).....	3.9-10
3.9.2.2.1 Tests and Analysis Criteria and Methods .....	3.9-10
3.9.2.2.2 Qualification of Safety-Related Mechanical Equipment .....	3.9-11
3.9.2.3 Dynamic Response of Reactor Internals Under Operational Flow Transients and Steady-State Conditions .....	3.9-15
3.9.2.4 Initial Startup Flow Induced Vibration Testing of Reactor Internals .....	3.9-17
3.9.2.5 Dynamic System Analysis of Reactor Internals Under Faulted Conditions.....	3.9-18
3.9.2.6 Correlations of Reactor Internals Vibration Tests with the Analytical Results .....	3.9-19
3.9.3 ASME Code Class 1, 2 and 3 Components, Component Supports and Core Support Structures.....	3.9-20
3.9.3.1 Loading Combinations, Design Transients and Stress Limits .....	3.9-21
3.9.3.1.1 Plant Conditions.....	3.9-22
3.9.3.1.2 Inspections/Testing Following the Reactor Coolant System Exceeding Service Level B Pressure Limit.....	3.9-23
3.9.3.2 Reactor Pressure Vessel Assembly.....	3.9-24
3.9.3.3 Main Steam System Piping.....	3.9-24
3.9.3.4 Other Components .....	3.9-24
3.9.3.5 Valve Operability Assurance .....	3.9-26
3.9.3.5.1 Major Active Valves.....	3.9-27
3.9.3.5.2 Other Active Valves.....	3.9-28
3.9.3.6 Design and Installation of Pressure Relief Devices.....	3.9-31
3.9.3.7 Component Supports.....	3.9-32
3.9.3.7.1 Piping Supports.....	3.9-33
3.9.3.7.2 Reactor Pressure Vessel Sliding Supports.....	3.9-40
3.9.3.7.3 Reactor Pressure Vessel Stabilizer.....	3.9-40
3.9.3.7.4 Floor-Mounted Major Equipment.....	3.9-40
3.9.3.8 Other ASME III Component Supports .....	3.9-40
3.9.3.9 Threaded Fasteners – ASME Code Class 1, 2 and 3 .....	3.9-41
3.9.3.9.1 Material Selection .....	3.9-41
3.9.3.9.2 Special Materials Fabrication Processes and Special Controls.....	3.9-41
3.9.3.9.3 Preservice and Inservice Inspection Requirements.....	3.9-41
3.9.4 Control Rod Drive System.....	3.9-42

3.9.4.1	Descriptive Information on Control Rod Drive System .....	3.9-43
3.9.4.2	Applicable Control Rod Drive System Design Specification .....	3.9-43
3.9.4.3	Design Loads and Stress Limits .....	3.9-43
3.9.4.4	Control Rod Drive Performance Assurance Program .....	3.9-43
3.9.5	Reactor Pressure Vessel Internals .....	3.9-44
3.9.5.1	Core Support Structures .....	3.9-45
3.9.5.2	Internal Structures .....	3.9-46
3.9.5.3	Loading Conditions .....	3.9-49
3.9.5.4	Design Bases .....	3.9-49
3.9.6	Inservice Testing of Pumps and Valves .....	3.9-51
3.9.6.1	InService Testing Valves .....	3.9-52
3.9.6.1.1	Valve Exemptions .....	3.9-52
3.9.6.1.2	Valve Categories .....	3.9-53
3.9.6.1.3	Valve Functions .....	3.9-53
3.9.6.1.4	Valve Testing .....	3.9-54
3.9.6.1.5	Specific Valve Test Requirements .....	3.9-55
3.9.6.2	Inservice Testing of Pumps .....	3.9-57
3.9.6.3	Preservice Testing of Valves .....	3.9-57
3.9.6.4	Deferred Testing Justifications .....	3.9-57
3.9.6.5	Valve Replacement, Repair and Maintenance .....	3.9-57
3.9.6.6	10 CFR 50.55a Relief Requests and Code Cases .....	3.9-57
3.9.6.7	Inservice Testing Program Implementation .....	3.9-57
3.9.6.8	Non-Code Testing of Power-Operated Valves .....	3.9-58
3.9.7	Risk-Informed Inservice Testing .....	3.9-58
3.9.8	Risk-Informed Inservice Inspection of Piping .....	3.9-58
3.9.9	COL Information .....	3.9-58
3.9.10	References .....	3.9-59
3.10	Seismic and Dynamic Qualification of Mechanical and Electrical Equipment .....	3.10-1
3.10.1	Seismic and Dynamic Qualification Criteria .....	3.10-3
3.10.1.1	Selection of Qualification Method .....	3.10-3
3.10.1.2	Input Motion .....	3.10-3
3.10.1.3	Dynamic Qualification Program .....	3.10-3
3.10.1.4	Dynamic Qualification Report .....	3.10-3
3.10.2	Methods and Procedures for Qualifying Mechanical and Electrical Equipment .....	3.10-4
3.10.2.1	Qualification by Testing .....	3.10-4
3.10.2.2	Qualification by Analysis .....	3.10-7
3.10.2.3	Qualification by Combined Testing and Analysis .....	3.10-7
3.10.2.4	(Deleted) .....	3.10-9
3.10.3	Analysis or Testing of Electrical Equipment Supports .....	3.10-9
3.10.3.1	Nuclear Steam Supply System Electrical Equipment Supports (Other than Motors and Valve-Mounted Equipment) .....	3.10-9
3.10.3.2	Other Electrical Equipment Supports .....	3.10-10
3.10.3.3	Documentation of Testing or Analysis of Electrical Supports .....	3.10-11
3.10.4	COL Information .....	3.10-12

3.10.5 References..... 3.10-12

3.11 Environmental Qualification of Mechanical and Electrical Equipment..... 3.11-1

3.11.1 Description Requirements..... 3.11-1

3.11.1.1 Applicable Regulations and Standards ..... 3.11-2

3.11.1.2 General Requirements..... 3.11-4

3.11.1.3 Definitions..... 3.11-5

3.11.2 Equipment Identification ..... 3.11-6

3.11.3 Environmental Conditions ..... 3.11-6

3.11.3.1 General Requirements..... 3.11-6

3.11.3.2 Environmental Requirements..... 3.11-10

3.11.4 Qualification Program, Methods and Documentation ..... 3.11-11

3.11.4.1 Harsh Environment Qualification ..... 3.11-11

3.11.4.2 Mild Environment Qualification..... 3.11-12

3.11.4.3 Computer-based Instrumentation and Control Systems..... 3.11-12

3.11.4.4 Environmental Qualification Documentation ..... 3.11-13

3.11.5 Loss of Heating, Ventilating and Air Conditioning..... 3.11-14

3.11.6 Estimated Chemical and Radiation Environment..... 3.11-14

3.11.7 COL Information ..... 3.11-14

3.11.8 References..... 3.11-14



3A. SEISMIC SOIL-STRUCTURE INTERACTION ANALYSIS.....	3A-1
3A.1 Introduction.....	3A-1
3A.2 ESBWR Standard Plant Site Plan.....	3A-2
3A.3 Site Conditions.....	3A-4
3A.3.1 Generic Site Conditions.....	3A-4
3A.3.2 North Anna ESP Site Conditions.....	3A-4
3A.4 Input Motion and Damping Values.....	3A-7
3A.4.1 Input Motion.....	3A-7
3A.4.2 Damping Values.....	3A-7
3A.5 Soil-Structure Interaction Analysis Method.....	3A-8
3A.5.1 DAC3N Analysis Method.....	3A-8
3A.5.2 SASSI2000 Analysis Method.....	3A-8
3A.6 Soil-Structure Interaction Analysis Cases.....	3A-13
3A.7 Analysis Models.....	3A-16
3A.7.1 Method of Dynamic Structural Model Development.....	3A-16
3A.7.2 Lumped Mass-Beam Stick Model for SSI Analysis.....	3A-17
3A.7.3 SSI Model for SASSI2000 Analysis.....	3A-18
3A.8 Analysis Results.....	3A-51
3A.8.1 Effect of Soil Stiffness.....	3A-52
3A.8.2 Effect of Single Envelope Ground Motion.....	3A-52
3A.8.3 Effect of Updated Design of RSW and VW.....	3A-53
3A.8.4 Effect of Infill Concrete Stiffness of VW and D/F.....	3A-53
3A.8.5 Effect of Loss-of-Coolant-Accident (LOCA) Flooding.....	3A-54
3A.8.6 Effect of Layered Sites.....	3A-54
3A.8.7 Effect of Embedment.....	3A-54
3A.8.8 Effect of Lateral Soil Pressures.....	3A-55
3A.8.9 Effect of Concrete Cracking.....	3A-55
3A.8.10 Effect of Wall Out-of-plane Vibration.....	3A-56
3A.8.11 Effect of Structure-Structure Interaction.....	3A-56
3A.9 Site Envelope Seismic Responses.....	3A-179
3A.9.1 Enveloping Maximum Structural Loads.....	3A-179
3A.9.2 Enveloping Floor Response Spectra.....	3A-179
3B. CONTAINMENT HYDRODYNAMIC LOAD DEFINITIONS.....	3B-1
3B.1 Safety Relief Valve Loads.....	3B-1
3B.1.1 Oscillating Pressure Load Into the Suppression Pool from Safety Relief Valves.....	3B-1
3B.1.2 Pressure Time History.....	3B-1
3B.2 Accident Pressure Loads.....	3B-1
3B.3 COL Information.....	3B-2
3B.4 References.....	3B-2
3C. COMPUTER PROGRAMS USED IN THE DESIGN AND ANALYSIS OF SEISMIC CATEGORY I STRUCTURES.....	3C-1
3C.1 Introduction.....	3C-1

3C.2 Static and Dynamic Structural Analysis Program (NASTRAN) .....	3C-1
3C.2.1 Description .....	3C-1
3C.2.2 Validation .....	3C-1
3C.2.3 Extent of Application .....	3C-1
3C.3 ABAQUS and ANACAP-U .....	3C-1
3C.3.1 Description .....	3C-1
3C.3.2 Validation .....	3C-2
3C.3.3 Extent of Application .....	3C-2
3C.4 Concrete Element Cracking Analysis Program (SSDP-2D) .....	3C-2
3C.4.1 Description .....	3C-2
3C.4.2 Validation .....	3C-2
3C.4.3 Extent of Application .....	3C-2
3C.5 Heat Transfer Analysis Program (TEMCOM2).....	3C-3
3C.5.1 Description .....	3C-3
3C.5.2 Validation .....	3C-3
3C.5.3 Extent of Application .....	3C-3
3C.6 Static and Dynamic Structural Analysis Systems: ANSYS .....	3C-3
3C.6.1 Description .....	3C-3
3C.6.2 Validation .....	3C-3
3C.6.3 Extent of Application .....	3C-3
3C.7 Soil-Structure Interaction .....	3C-3
3C.7.1 Dynamic Soil-Structure Interaction Analysis Program—DAC3N .....	3C-3
3C.7.1.1 Description .....	3C-3
3C.7.1.2 Validation .....	3C-4
3C.7.1.3 Extent of Application .....	3C-4
3C.7.2 Dynamic Soil-Structure Interaction Analysis Program – SASSI2000.....	3C-4
3C.7.2.1 Description .....	3C-4
3C.7.2.2 Validation .....	3C-4
3C.7.2.3 Extent of Application .....	3C-4
3C.7.3 Free-Field Site Response Analysis – SHAKE .....	3C-4
3C.7.3.1 Description .....	3C-4
3C.7.3.2 Validation .....	3C-5
3C.7.3.3 Extent of Application .....	3C-5
3D. COMPUTER PROGRAMS USED IN THE DESIGN OF COMPONENTS, EQUIPMENT, AND STRUCTURES .....	3D-1
3D.1 Introduction .....	3D-1
3D.2 Fine Motion Control Rod Drive (FMCRD).....	3D-1
3D.2.1 ABAQUS .....	3D-1
3D.2.1.1 Description .....	3D-1
3D.2.1.2 Validation .....	3D-1
3D.2.1.3 Extent of Application .....	3D-1
3D.2.2 ANSYS.....	3D-1
3D.2.2.1 Description .....	3D-1
3D.2.2.2 Validation .....	3D-1
3D.2.2.3 Extent of Application .....	3D-1

3D.3 Reactor Pressure Vessel and Internals .....	3D-2
3D.3.1 ANSYS.....	3D-2
3D.3.1.1 Description.....	3D-2
3D.3.1.2 Validation.....	3D-2
3D.3.1.3 Extent of Application.....	3D-2
3D.3.2 Dynamic Stress Analysis of Axisymmetric Structures Under Arbitrary Loading - ASHSD2.....	3D-2
3D.3.2.1 Description.....	3D-2
3D.3.2.2 Validation.....	3D-3
3D.3.2.3 Extent of Application.....	3D-3
3D.3.3 EVA3T.....	3D-3
3D.3.3.1 Description.....	3D-3
3D.3.3.2 Validation.....	3D-3
3D.3.3.3 Extent of Application.....	3D-3
3D.3.4 TACF .....	3D-3
3D.3.4.1 Description.....	3D-3
3D.3.4.2 Validation.....	3D-3
3D.3.4.3 Extent of Application.....	3D-3
3D.3.5 ABAQUS .....	3D-4
3D.3.5.1 Description.....	3D-4
3D.3.5.2 Validation.....	3D-4
3D.3.5.3 Extent of Application.....	3D-4
3D.3.6 FEMFL.....	3D-4
3D.3.6.1 Description.....	3D-4
3D.3.6.2 Validation.....	3D-4
3D.3.6.3 Extent of Application.....	3D-4
3D.3.7 SEISM.....	3D-4
3D.3.7.1 Description.....	3D-4
3D.3.7.2 Validation.....	3D-5
3D.3.7.3 Extent of Application.....	3D-5
3D.3.8 PVElite .....	3D-5
3D.3.8.1 Description.....	3D-5
3D.3.8.2 Validation.....	3D-5
3D.3.8.3 Extent of Application.....	3D-5
3D.3.9 ANSYS Workbench.....	3D-5
3D.3.9.1 Description.....	3D-5
3D.3.9.2 Validation.....	3D-5
3D.3.9.3 Extent of Application.....	3D-5
3D.4 Piping.....	3D-6
3D.4.1 Piping Analysis Program – PISYS.....	3D-6
3D.4.1.1 Description.....	3D-6
3D.4.1.2 Validation.....	3D-6
3D.4.1.3 Extent of Application.....	3D-6
3D.4.2 Component Analysis - ANSI7 .....	3D-6
3D.4.2.1 Description.....	3D-6
3D.4.2.2 Validation.....	3D-6

3D.4.2.3 Extent of Application .....	3D-7
3D.4.3 (Deleted).....	3D-7
3D.4.4 Dynamic Forcing Functions.....	3D-7
3D.4.4.1 Relief Valve Discharge Pipe Forces Computer Program – RVFOR .....	3D-7
3D.4.4.2 Turbine Stop Valve Closure – TSFOR .....	3D-7
3D.4.4.3 (Deleted).....	3D-8
3D.4.4.4 (Deleted).....	3D-8
3D.4.5 (Deleted).....	3D-8
3D.4.6 Response Spectra Generation.....	3D-8
3D.4.6.1 ERSIN Computer Program .....	3D-8
3D.4.6.2 RINEX Computer Program.....	3D-8
3D.4.6.3 (Deleted).....	3D-8
3D.4.6.4 (Deleted).....	3D-8
3D.4.7 Pipe Dynamic Analysis (PDA) Program .....	3D-9
3D.4.7.1 Description.....	3D-9
3D.4.7.2 Validation.....	3D-9
3D.4.7.3 Extent of Application.....	3D-9
3D.4.8 Thermal Transient Program – LION.....	3D-9
3D.4.8.1 Description.....	3D-9
3D.4.8.2 Validation.....	3D-9
3D.4.8.3 Extent of Application.....	3D-9
3D.4.9 Engineering Analysis System - ANSYS .....	3D-9
3D.4.9.1 Description.....	3D-9
3D.4.9.2 Validation.....	3D-10
3D.4.9.3 Extent of Application.....	3D-10
3D.4.10 Piping Analysis Program – EZPYP .....	3D-10
3D.4.10.1 Description.....	3D-10
3D.4.10.2 Validation.....	3D-10
3D.4.10.3 Extent of Application.....	3D-10
3D.4.11 Pipe Support Structural Analysis and Design Verification Computer Program – E/PD STRUDL.....	3D-10
3D.4.11.1 Description.....	3D-10
3D.4.11.2 Validation.....	3D-11
3D.4.11.3 The Extent of Application.....	3D-11
3D.5 Pumps and Motors .....	3D-11
3D.5.1 Structural Analysis Program - SAP4G.....	3D-11
3D.5.1.1 Description.....	3D-11
3D.5.1.2 Validation.....	3D-11
3D.5.1.3 Extent of Application.....	3D-11
3D.5.2 (Deleted).....	3D-11
3D.6 COL Information.....	3D-11
3D.7 References.....	3D-11
3E. (Deleted).....	3E-1
3F. RESPONSE OF STRUCTURES TO CONTAINMENT LOADS.....	3F-1
3F.1 Scope.....	3F-1

3F.2 Dynamic Response ..... 3F-1  
3F.2.1 Classification of Analytical Procedure ..... 3F-1  
3F.2.2 Analysis Models ..... 3F-1  
3F.2.3 Load Application ..... 3F-2  
3F.2.4 Analysis Method ..... 3F-4  
3F.3 Containment Loads Analysis Results ..... 3F-4

3G. DESIGN DETAILS AND EVALUATION RESULTS OF SEISMIC CATEGORY I STRUCTURES .....	3G-1
3G.1 Reactor Building .....	3G-1
3G.1.1 Objective and Scope.....	3G-1
3G.1.2 Conclusions .....	3G-1
3G.1.3 Structural Description .....	3G-2
3G.1.3.1 Description of the Reactor Building .....	3G-2
3G.1.3.1.1 Reactor Building Structure.....	3G-2
3G.1.3.1.2 Containment and Containment Structure .....	3G-2
3G.1.3.1.3 Reactor Building Structure/Containment Structure Connections .....	3G-3
3G.1.3.1.4 Containment Internal Structures .....	3G-3
3G.1.4 Analytical Models .....	3G-3
3G.1.4.1 Structural Models .....	3G-3
3G.1.4.2 Foundation Models .....	3G-4
3G.1.5 Structural Analysis and Design .....	3G-5
3G.1.5.1 Site Design Parameters .....	3G-5
3G.1.5.2 Design Loads, Load Combinations, and Material Properties .....	3G-5
3G.1.5.2.1 Design Loads.....	3G-5
3G.1.5.2.1.1 Dead Load (D) and Live Load (L and Lo).....	3G-5
3G.1.5.2.1.2 Snow and Rain Load .....	3G-5
3G.1.5.2.1.3 Lateral Soil Pressure at Rest .....	3G-5
3G.1.5.2.1.4 Wind Load (W) .....	3G-6
3G.1.5.2.1.5 Tornado Load ( $W_t$ ) .....	3G-6
3G.1.5.2.1.6 Thermal Loads .....	3G-6
3G.1.5.2.1.7 Pressure Loads .....	3G-6
3G.1.5.2.1.8 Condensation Oscillation and Chugging Loads.....	3G-6
3G.1.5.2.1.9 Safety Relief Valve Loads .....	3G-7
3G.1.5.2.1.10 Steam Tunnel Subcompartment Pressure .....	3G-7
3G.1.5.2.1.11 Subcompartment Pressure in Other Compartments .....	3G-7
3G.1.5.2.1.12 Annulus Pressurization Loads.....	3G-7
3G.1.5.2.1.13 Design Seismic Loads .....	3G-7
3G.1.5.2.2 Load Combinations and Acceptance Criteria .....	3G-7
3G.1.5.2.2.1 Reinforced Concrete Containment Vessel .....	3G-8
3G.1.5.2.2.2 Steel Containment Components.....	3G-8
3G.1.5.2.2.3 Containment Internal Structures .....	3G-8
3G.1.5.2.2.4 Reactor Building Concrete Structures Including Pool Girders.....	3G-8
3G.1.5.2.3 Material Properties .....	3G-8
3G.1.5.2.3.1 Concrete .....	3G-8
3G.1.5.2.3.2 Reinforcing Steel.....	3G-9
3G.1.5.2.3.3 Structural Steel.....	3G-9
3G.1.5.3 Stability Requirements .....	3G-9
3G.1.5.4 Structural Design Evaluation .....	3G-9
3G.1.5.4.1 Containment Structure .....	3G-10
3G.1.5.4.1.1 Containment Wall Including RPV Pedestal.....	3G-10

3G.1.5.4.1.2 Containment Top Slab and Suppression Pool Slab.....	3G-11
3G.1.5.4.1.3 Containment Foundation Mat .....	3G-11
3G.1.5.4.1.4 Drywell Head .....	3G-11
3G.1.5.4.1.5 PCCS Condenser.....	3G-13
3G.1.5.4.2 Containment Internal Structures .....	3G-13
3G.1.5.4.2.1 Diaphragm Floor .....	3G-14
3G.1.5.4.2.2 Vent Wall Structure .....	3G-14
3G.1.5.4.2.3 Reactor Shield Wall .....	3G-15
3G.1.5.4.2.4 RPV Support Bracket.....	3G-15
3G.1.5.4.2.5 Gravity-Driven Cooling System Pool .....	3G-15
3G.1.5.4.3 Reactor Building .....	3G-15
3G.1.5.4.3.1 RB Shear Walls.....	3G-16
3G.1.5.4.3.2 RB Foundation Mat Outside Containment.....	3G-16
3G.1.5.4.3.3 RB Floor Slabs.....	3G-16
3G.1.5.4.3.4 Pool Girders .....	3G-16
3G.1.5.4.3.5 Main Steam Tunnel Floors and Walls.....	3G-16
3G.1.5.5 Foundation Stability.....	3G-17
3G.1.5.5.1 Effect of Basemat Uplift .....	3G-17
3G.1.5.5.2 Effect of Horizontal Variation of Soil Spring.....	3G-18
3G.1.5.5.3 Effect of Construction Sequence.....	3G-18
3G.1.5.5.4 Foundation Settlement .....	3G-18
3G.1.5.6 Tornado Missile Evaluation .....	3G-18
3G.1.6 References.....	3G-19
3G.2 Control Building .....	3G-190
3G.2.1 Objective and Scope.....	3G-190
3G.2.2 Conclusions.....	3G-190
3G.2.3 Structural Description .....	3G-190
3G.2.4 Analytical Models .....	3G-190
3G.2.4.1 Structural Model .....	3G-190
3G.2.4.2 Foundation Models .....	3G-191
3G.2.5 Structural Analysis and Design.....	3G-191
3G.2.5.1 Site Design Parameters .....	3G-191
3G.2.5.2 Design Loads, Load Combinations, and Material Properties .....	3G-191
3G.2.5.2.1 Design Loads.....	3G-191
3G.2.5.2.1.1 Dead Load (D) and Live Load (L and Lo).....	3G-191
3G.2.5.2.1.2 Snow and Rain Load .....	3G-191
3G.2.5.2.1.3 Lateral Soil Pressure at Rest .....	3G-192
3G.2.5.2.1.4 Wind Load (W) .....	3G-192
3G.2.5.2.1.5 Tornado Load (Wt) .....	3G-192
3G.2.5.2.1.6 Thermal Load (To and Ta).....	3G-192
3G.2.5.2.1.7 Design Seismic Loads.....	3G-192
3G.2.5.2.2 Load Combinations and Acceptance Criteria .....	3G-192
3G.2.5.2.3 Material Properties.....	3G-193
3G.2.5.3 Stability Requirements.....	3G-193
3G.2.5.4 Structural Design Evaluation .....	3G-193

3G.2.5.4.1 Shear Walls .....	3G-193
3G.2.5.4.2 Floor Slabs .....	3G-193
3G.2.5.4.3 Foundation Mat .....	3G-193
3G.2.5.5 Foundation Stability .....	3G-194
3G.2.5.5.1 Foundation Settlement .....	3G-194
3G.2.5.6 Tornado Missile Evaluation .....	3G-194
3G.3 Fuel Building.....	3G-242
3G.3.1 Objective and Scope.....	3G-242
3G.3.2 Conclusions.....	3G-242
3G.3.3 Structural Description .....	3G-242
3G.3.4 Analytical Models .....	3G-242
3G.3.5 Structural Analysis and Design.....	3G-243
3G.3.5.1 Site Design Parameters .....	3G-243
3G.3.5.2 Design Loads, Load Combinations, and Material Properties .....	3G-243
3G.3.5.2.1 Design Loads.....	3G-243
3G.3.5.2.1.1 Dead Load (D) and Live Load (L and Lo).....	3G-243
3G.3.5.2.1.2 Snow and Rain Load.....	3G-243
3G.3.5.2.1.3 Lateral Soil Pressure at Rest .....	3G-243
3G.3.5.2.1.4 Wind Load (W) .....	3G-243
3G.3.5.2.1.5 Tornado Load (Wt) .....	3G-243
3G.3.5.2.1.6 Thermal Load.....	3G-243
3G.3.5.2.1.7 Design Seismic Loads.....	3G-244
3G.3.5.2.2 Load Combinations and Acceptance Criteria .....	3G-244
3G.3.5.2.3 Material Properties.....	3G-244
3G.3.5.3 Stability Requirements.....	3G-244
3G.3.5.4 Structural Design Evaluation .....	3G-244
3G.3.5.4.1 Shear Walls and Spent Fuel Pool Walls.....	3G-245
3G.3.5.4.2 Floor Slabs .....	3G-245
3G.3.5.4.3 Foundation Mat .....	3G-245
3G.3.5.5 Foundation Stability.....	3G-245
3G.3.5.6 Tornado Missile Evaluation .....	3G-245
3G.4 FireWater Service Complex.....	3G-270
3G.4.1 Objective and Scope.....	3G-270
3G.4.2 Conclusion .....	3G-270
3G.4.3 Structural Description .....	3G-270
3G.4.4 Analytical Models .....	3G-270
3G.4.4.1 Structural Model .....	3G-270
3G.4.4.2 Foundation Models .....	3G-271
3G.4.5 Structural Analysis and Design.....	3G-271
3G.4.5.1 Site Design Parameters .....	3G-271
3G.4.5.2 Design Loads, Load Combinations, and Material Properties .....	3G-271
3G.4.5.2.1 Design Loads.....	3G-271
3G.4.5.2.1.1 Dead Load (D) and Live Load (L and Lo).....	3G-271
3G.4.5.2.1.2 Snow and Rain Load.....	3G-271



3G.4.5.2.1.3 Lateral Soil Pressure .....	3G-271
3G.4.5.2.1.4 Wind Load (W) .....	3G-271
3G.4.5.2.1.5 Tornado Load (Wt) .....	3G-272
3G.4.5.2.1.6 Thermal Load (To).....	3G-272
3G.4.5.2.1.7 Design Seismic Loads.....	3G-272
3G.4.5.2.2 Load Combinations and Acceptance Criteria .....	3G-272
3G.4.5.2.3 Material Properties.....	3G-272
3G.4.5.3 Stability Requirements.....	3G-272
3G.4.5.4 Structural Design Evaluation .....	3G-272
3G.4.5.4.1 Shear Walls .....	3G-273
3G.4.5.4.2 Roof Floor Slabs .....	3G-273
3G.4.5.4.3 Foundation Mat.....	3G-273
3G.4.5.4.4 Shear Key.....	3G-273
3G.4.5.5 Foundation Stability.....	3G-274
3G.4.5.5.1 Foundation Settlement .....	3G-274
3G.4.5.6 Tornado Missile Evaluation.....	3G-274
3H. EQUIPMENT QUALIFICATION DESIGN ENVIRONMENTAL CONDITIONS.....	3H-1
3H.1 Introduction.....	3H-1
3H.2 Plant Zones.....	3H-1
3H.2.1 Containment Vessel .....	3H-1
3H.2.2 Outside Containment Vessel.....	3H-1
3H.3 Environmental Conditions .....	3H-2
3H.3.1 Plant Normal Operating Conditions.....	3H-2
3H.3.2 Accident Conditions.....	3H-2
3H.3.2.1 Transient Room Temperature Analysis .....	3H-2
3H.3.3 Water Quality.....	3H-4
3H.3.4 Locations of Safety-Related Equipment.....	3H-4
3H.3.5 Mild Environment Conditions .....	3H-5
3H.3.6 COL Information.....	3H-5
3H.4 References.....	3H-5
3I. DESIGNATED NEDE-24326-1-P MATERIAL WHICH MAY NOT CHANGE WITHOUT PRIOR NRC APPROVAL .....	3I-1
3I.1 General Requirements for Dynamic Testing.....	3I-1
3I.2 Product and Assembly Testing.....	3I-2
3I.3 Multiple-Frequency Tests.....	3I-2
3I.4 Single- and Multi-axis Tests.....	3I-3
3I.5 Single Frequency Tests.....	3I-3
3I.6 Damping .....	3I-3
3I.7 Qualification Determination.....	3I-3
3I.8 Dynamic Qualification by Analysis .....	3I-4
3I.9 Required Response Spectra .....	3I-4

3I.10 Time History Analysis..... 3I-4

3I.11 References ..... 3I-5

3J. EVALUATION OF POSTULATED RUPTURES IN HIGH ENERGY PIPES..... 3J-1

3J.1 Background and Scope..... 3J-1

3J.2 Identification of Rupture Locations and Rupture Geometry..... 3J-1

    3J.2.1 Ruptures in Containment Penetration Area..... 3J-1

    3J.2.2 Ruptures in Areas other than Containment Penetration..... 3J-2

    3J.2.3 Determination of the Type of Pipe Break ..... 3J-2

3J.3 Design and Selection of Pipe Whip Restraints..... 3J-2

    3J.3.1 Preliminary Selection of Pipe Whip Restraint ..... 3J-2

    3J.3.2 Preparation of Simplified Computer Model of Piping-Pipe Whip Restraint System.. 3J-2

    3J.3.3 Piping Dynamic Analysis..... 3J-2

    3J.3.4 Selection of Pipe Whip Restraint for Pipe Whip Restraint Analysis ..... 3J-3

3J.4 Pipe Rupture Evaluation..... 3J-3

    3J.4.1 General Approach..... 3J-3

    3J.4.2 Procedure For Dynamic Time-History Analysis With Simplified Model ..... 3J-4

        3J.4.2.1 Modeling of Piping System..... 3J-4

        3J.4.2.2 Dynamic Analysis of Simplified Piping Model ..... 3J-4

    3J.4.3 Procedure For Dynamic Time-History Analysis Using Detailed Piping Model..... 3J-5

        3J.4.3.1 Modeling of Piping System..... 3J-5

        3J.4.3.2 Dynamic Analysis using Detail Piping Model ..... 3J-5

3J.5 Jet Impingement on Safety-related Piping ..... 3J-5

3K. RESOLUTION OF INTERSYSTEM LOSS-OF-COOLANT-ACCIDENT..... 3K-1

3K.1 Introduction..... 3K-1

3K.2 Regulatory Positions ..... 3K-1

3K.3 Boundary Limits of Ultimate Rupture Strength..... 3K-2

3K.4 Evaluation Procedure ..... 3K-2

3K.5 Systems Evaluated ..... 3K-2

3K.6 Piping Design Pressure for Ultimate Rupture Strength Compliance..... 3K-3

3K.7 Applicability of Ultimate Rupture Strength Non-piping Components ..... 3K-3

3K.8 Results..... 3K-3

3K.9 Valve Misalignment Due To Operator Error ..... 3K-3

3K.10 Summary ..... 3K-4

3K.11 References..... 3K-4

ULTIMATE RUPTURE STRENGTH SYSTEM BOUNDARY EVALUATION..... 3K-5

    3KA.1 Control Rod Drive System..... 3K-5

        3KA.1.1 System URS Boundary Description..... 3K-5

        3KA.1.2 Downstream Interfaces..... 3K-5

        3KA.1.3 Low-Pressure Piping Systems and Components Designed to URS Pressure .... 3K-6

    3KA.2 Standby Liquid Control System ..... 3K-7

3KA.2.1 System URS Boundary Description..... 3K-7

3KA.2.2 Downstream interfaces..... 3K-7

3KA.2.3 Low Pressure Piping Systems and Components Designed to URS Pressure.... 3K-7

3KA.3 Reactor Water Cleanup/Shutdown Cooling System ..... 3K-8

3KA.3.1 System URS Boundary Description..... 3K-8

3KA.3.2 Downstream Interfaces..... 3K-8

3KA.3.3 Low-Pressure Piping Systems and Components Designed to URS Pressure .... 3K-8

3KA.4 Fuel And Auxiliary Pools Cooling System..... 3K-9

3KA.4.1 System URS Boundary Description..... 3K-9

3KA.4.2 Downstream Interfaces..... 3K-9

3KA.4.3 Low-Pressure Piping Systems and Components Designed to URS Pressure .. 3K-10

3KA.5 Nuclear Boiler System ..... 3K-11

3KA.5.1 System URS Boundary Description..... 3K-11

3KA.5.2 Downstream Interfaces..... 3K-11

3KA.5.3 Low-Pressure Piping Systems and Components Designed to URS Pressure .. 3K-11

3KA.6 Condensate And Feedwater System..... 3K-12

3KA.6.1 System URS Boundary Description..... 3K-12

3KA.6.2 Downstream Interfaces..... 3K-12

3KA.6.3 Low-Pressure Piping Systems and Components Designed to URS Pressure .. 3K-12

3L. REACTOR INTERNALS FLOW INDUCED VIBRATION PROGRAM ..... 3L-1

3L.1 Introduction ..... 3L-1

3L.2 Reactor Internal Components FIV Evaluation ..... 3L-2

3L.2.1 Evaluation Process – Part 1 ..... 3L-2

3L.2.2 Evaluation Process – Part 2 ..... 3L-4

3L.2.3 Design and Materials Evaluation..... 3L-5

3L.3 Chimney Assembly and SLC Internal Piping Evaluation ..... 3L-6

3L.3.1 Design and Materials..... 3L-6

3L.3.2 Prior Operating Experience ..... 3L-6

3L.3.3 Testing and Two-phase Flow Analysis ..... 3L-6

3L.3.4 SLC Internal Piping Evaluation..... 3L-7

3L.4 Steam Dryer Evaluation Program..... 3L-8

3L.4.1 Steam Dryer Design and Performance ..... 3L-8

3L.4.2 Materials and Fabrication ..... 3L-8

3L.4.3 Load Combinations ..... 3L-9

3L.4.4 Fluid Loads on the Steam Dryer..... 3L-9

3L.4.5 Structural Evaluation ..... 3L-9

3L.4.6 Instrumentation and Startup Testing ..... 3L-10

3L.5 Startup Test Program..... 3L-13

3L.5.1 Component Selections..... 3L-13

3L.5.2 Sensor Locations ..... 3L-13

3L.5.3 Test Conditions..... 3L-13

3L.5.4 Data Reduction Methods .....	3L-14
3L.5.4.1 Time History Analysis.....	3L-14
3L.5.4.2 Frequency Analysis .....	3L-15
3L.5.5 Data Evaluation Methods .....	3L-16
3L.5.5.1 Finite Element Models .....	3L-16
3L.5.5.1.1 Chimney Head and Steam Separators .....	3L-16
3L.5.5.1.2 Shroud and Chimney .....	3L-16
3L.5.5.1.3 Steam Dryer.....	3L-17
3L.5.5.1.4 Standby Liquid Control Lines .....	3L-18
3L.5.5.2 Stress Evaluation .....	3L-18
3L.5.5.2.1 Methods I and II .....	3L-21
3L.5.5.2.2 Method III.....	3L-23
3L.5.5.3 Stress Evaluation Steam Dryer.....	3L-24
3L.6 References .....	3L-27

4.1 Summary Description .....	4.1-1
4.1.1 Reactor Pressure Vessel .....	4.1-1
4.1.2 Reactor Internal Components .....	4.1-1
4.1.2.1 Reactor Core .....	4.1-1
4.1.3 Reactivity Control Systems .....	4.1-3
4.1.3.1 Operation .....	4.1-3
4.1.3.2 Description of Control Rods .....	4.1-3
4.1.3.3 Supplementary Reactivity Control .....	4.1-3
4.1.4 Analysis Techniques .....	4.1-3
4.1.4.1 Reactor Internal Components .....	4.1-3
4.1.4.2 Fuel Design Analysis .....	4.1-5
4.1.4.3 Reactor Systems Dynamics .....	4.1-5
4.1.4.4 Nuclear Analysis .....	4.1-5
4.1.4.5 Neutron Fluence Calculations .....	4.1-5
4.1.4.6 Thermal-Hydraulic Calculations .....	4.1-5
4.1.5 COL Information .....	4.1-5
4.1.6 References .....	4.1-5
4.2 Fuel System Design .....	4.2-1
4.2.1 Design Bases .....	4.2-1
4.2.1.1 Fuel Assembly .....	4.2-1
4.2.1.2 Control Rods .....	4.2-4
4.2.2 Description and Design Drawings .....	4.2-4
4.2.2.1 Fuel Assembly .....	4.2-4
4.2.2.2 Control Rods .....	4.2-6
4.2.3 Fuel Assembly Design Evaluations .....	4.2-6
4.2.3.1 Evaluation Methods .....	4.2-6
4.2.3.2 Cladding Strain .....	4.2-7
4.2.3.3 Fuel Rod Internal Pressure .....	4.2-7
4.2.3.4 Fuel Pellet Temperature .....	4.2-7
4.2.3.5 Cladding Fatigue Analysis .....	4.2-8
4.2.3.6 Cladding Creep Collapse .....	4.2-8
4.2.3.7 Fuel Rod Stress Analysis .....	4.2-8
4.2.3.8 Thermal and Mechanical Overpowers .....	4.2-8
4.2.3.9 Fretting Wear .....	4.2-8
4.2.3.10 Water Rods .....	4.2-8
4.2.3.11 Tie Plates .....	4.2-9
4.2.3.12 Spacers .....	4.2-9
4.2.3.13 Channel .....	4.2-9
4.2.3.14 Conclusions .....	4.2-10
4.2.4 Control Rod Design Evaluations .....	4.2-10
4.2.4.1 SCRAM .....	4.2-10
4.2.4.2 Seismic .....	4.2-10
4.2.4.3 Stuck Rod .....	4.2-11

4.2.4.4 Absorber Burn-Up Related Loads .....	4.2-11
4.2.4.5 Load Combinations and Fatigue .....	4.2-11
4.2.4.6 Handling Loads .....	4.2-11
4.2.4.7 Hydraulics .....	4.2-11
4.2.4.8 Materials .....	4.2-11
4.2.4.9 Nuclear Performance .....	4.2-12
4.2.4.10 Mechanical Compatibility .....	4.2-12
4.2.5 Testing, Inspection, and Surveillance Plans .....	4.2-12
4.2.6 COL Information .....	4.2-13
4.2.7 References .....	4.2-13
4.3 Nuclear Design .....	4.3-1
4.3.1 Design Basis .....	4.3-1
4.3.1.1 Negative Reactivity Feedback Bases .....	4.3-1
4.3.1.2 Control Requirements (Shutdown Margins) .....	4.3-1
4.3.1.3 Control Requirements (Overpower Bases) .....	4.3-1
4.3.1.4 Control Requirements (Standby Liquid Control System) .....	4.3-2
4.3.1.5 Stability Bases .....	4.3-2
4.3.2 Nuclear Design Analytical Methods .....	4.3-2
4.3.2.1 Steady-State Nuclear Methods .....	4.3-2
4.3.2.2 Reactivity Coefficient Methods .....	4.3-4
4.3.2.3 Stability Methods .....	4.3-5
4.3.3 Nuclear Design Evaluation .....	4.3-5
4.3.3.1 Nuclear Design Description .....	4.3-6
4.3.3.2 Negative Reactivity Feedback Evaluation .....	4.3-6
4.3.3.3 Control Requirements Evaluation .....	4.3-8
4.3.3.4 Criticality of Reactor During Refueling Evaluation .....	4.3-9
4.3.3.5 Power Distribution Evaluation .....	4.3-10
4.3.3.6 Stability Evaluation .....	4.3-10
4.3.4 (Deleted) .....	4.3-11
4.3.5 COL Information .....	4.3-11
4.3.6 References .....	4.3-11
4.4 Thermal and Hydraulic Design .....	4.4-1
4.4.1 Reactor Core Thermal and Hydraulic Design Basis .....	4.4-1
4.4.1.1 Critical Power Bases .....	4.4-1
4.4.1.2 Void Fraction Distribution Bases .....	4.4-2
4.4.1.3 Core Pressure Drop and Hydraulic Loads Bases .....	4.4-2
4.4.1.4 Core Coolant Flow Distribution Bases .....	4.4-2
4.4.1.5 Fuel Heat Transfer Bases .....	4.4-2
4.4.1.6 Maximum Linear Heat Generation Rate Bases .....	4.4-2
4.4.1.7 Summary of Design Bases .....	4.4-3
4.4.2 Reactor Core Thermal and Hydraulic Methods .....	4.4-3
4.4.2.1 Critical Power Methods .....	4.4-3
4.4.2.2 Void Fraction Distribution Methods .....	4.4-4
4.4.2.3 Core Pressure Drop and Hydraulic Loads Methods .....	4.4-4

4.4.2.4 Core Coolant Flow Distribution Methods.....	4.4-8
4.4.2.5 Fuel Heat Transfer Methods .....	4.4-8
4.4.2.6 Maximum Linear Heat Generation Rate Methods.....	4.4-8
4.4.3 Reactor Core Thermal and Hydraulic Evaluations .....	4.4-8
4.4.3.1 Critical Power Evaluations .....	4.4-8
4.4.3.2 Void Fraction Distribution Evaluations .....	4.4-9
4.4.3.3 Core Pressure Drop and Hydraulic Loads Evaluations.....	4.4-9
4.4.3.4 Core Coolant Flow Distribution Evaluations.....	4.4-10
4.4.3.5 Fuel Heat Transfer Evaluations .....	4.4-10
4.4.3.6 Maximum Linear Heat Generation Rate Evaluations.....	4.4-10
4.4.4 Description of the Thermal–Hydraulic Design of the Reactor Coolant System.....	4.4-10
4.4.4.1 Plant Configuration Data .....	4.4-10
4.4.4.2 Operating Restrictions on Pumps.....	4.4-10
4.4.4.3 Power/Flow Operating Map.....	4.4-11
4.4.4.4 Temperature-Power Operating Map .....	4.4-11
4.4.4.5 Load Following Characteristics .....	4.4-11
4.4.4.6 Thermal-Hydraulic Characteristics Summary Tables.....	4.4-11
4.4.4.7 Inadequate Core Cooling (ICC) Monitoring System .....	4.4-11
4.4.5 Loose-Parts Monitoring System .....	4.4-11
4.4.6 Testing and Verification .....	4.4-12
4.4.7 COL Information .....	4.4-12
4.4.8 References.....	4.4-12
4.5 Reactor Materials.....	4.5-1
4.5.1 Control Rod Drive System Structural Materials.....	4.5-1
4.5.1.1 Material Specifications .....	4.5-1
4.5.1.2 Austenitic Stainless Steel Components.....	4.5-1
4.5.1.3 Other Materials .....	4.5-2
4.5.1.4 Cleaning and Cleanliness Control.....	4.5-2
4.5.2 Reactor Internal Materials.....	4.5-3
4.5.2.1 Material Specifications .....	4.5-3
4.5.2.2 Controls on Welding.....	4.5-3
4.5.2.3 Non-Destructive Examination .....	4.5-4
4.5.2.4 Fabrication and Processing of Austenitic Stainless Steel—Regulatory Guide Conformance .....	4.5-5
4.5.2.5 Other Materials .....	4.5-5
4.5.3 COL Information .....	4.5-6
4.5.4 References.....	4.5-6
4.6 Functional Design of Reactivity Control System .....	4.6-1
4.6.1 Information for Control Rod Drive System.....	4.6-1
4.6.1.1 Design Bases.....	4.6-1
4.6.1.2 Description .....	4.6-2
4.6.2 Evaluations of the CRD System .....	4.6-19
4.6.2.1 Safety Evaluation .....	4.6-19

4.6.3 Testing and Verification of the CRDs .....	4.6-24
4.6.3.1 Factory Quality Control Tests .....	4.6-24
4.6.3.2 Functional Tests .....	4.6-25
4.6.3.3 Operational Tests .....	4.6-25
4.6.3.4 Acceptance Tests .....	4.6-25
4.6.3.5 Surveillance Tests .....	4.6-26
4.6.4 Information for Combined Performance of Reactivity Control Systems .....	4.6-27
4.6.4.1 Vulnerability to Common Mode Failures .....	4.6-27
4.6.4.2 Accidents Taking Credit for Multiple Reactivity Systems .....	4.6-27
4.6.5 Evaluation of Combined Performance .....	4.6-27
4.6.6 COL Information .....	4.6-27
4.6.7 References .....	4.6-27
4A. Typical Control Rod Patterns and Associated Power Distribution for ESBWR .....	4A-1
4A.1 Introduction .....	4A-1
4A.2 Results of Core Simulation Studies .....	4A-1
4A.3 COL Information .....	4A-1
4A.4 References .....	4A-1
4B. Fuel Licensing Acceptance Criteria .....	4B-1
4B.1 General Criteria .....	4B-1
4B.2 Thermal-Mechanical .....	4B-1
4B.3 Nuclear .....	4B-4
4B.4 (Deleted) .....	4B-5
4B.5 (Deleted) .....	4B-5
4B.6 Critical Power .....	4B-5
4B.7 (Deleted) .....	4B-6
4B.8 (Deleted) .....	4B-6
4B.9 (Deleted) .....	4B-6
4B.10 (Deleted) .....	4B-6
4B.11 COL Information .....	4B-6
4B.12 References .....	4B-6
4C. Control Rod Licensing Acceptance Criteria .....	4C-1
4C.1 General Criteria .....	4C-1
4C.2 Basis for Acceptance Criteria .....	4C-1
4C.3 COL Information .....	4C-2
4C.4 References .....	4C-2
4D. Stability Evaluation .....	4D-1
4D.1 Stability Performance During Power Operation .....	4D-1
4D.1.1 Stability Criteria .....	4D-1
4D.1.2 Analysis Methods .....	4D-2
4D.1.3 Steady State Stability Performance .....	4D-3



4D.1.3.1 Baseline Analysis.....	4D-3
4D.1.4 Statistical Analysis of ESBWR Stability .....	4D-4
4D.1.4.1 Channel Decay Ratio Statistical Analysis.....	4D-4
4D.1.4.2 Core Wide Decay Ratio Statistical Analysis.....	4D-4
4D.1.4.3 Regional Decay Ratio Statistical Analysis.....	4D-5
4D.1.4.4 Comparison with Design Limits .....	4D-5
4D.1.5 Stability Performance During AOOs .....	4D-5
4D.1.6 Stability Performance for Initial Core and Feedwater Temperature Operating Domain.....	4D-6
4D.1.7 Stability Performance During Anticipated Transients Without Scram.....	4D-7
4D.2 Stability Performance During Plant Startup.....	4D-7
4D.2.1 Phenomena Governing Oscillations during Startup.....	4D-7
4D.2.2 TRACG Analysis of Typical Startup Trajectories .....	4D-10
4D.2.2.1 ESBWR Plant Startup .....	4D-10
4D.2.2.2 TRACG Calculations for Simulated Startup Scenarios .....	4D-11
4D.2.2.3 TRACG Calculation of ESBWR Startup with Neutronic Feedback.....	4D-12
4D.3 Defense-In-Depth Stability Solution.....	4D-13
4D.3.1 Design Approach.....	4D-14
4D.3.2 Solution Description .....	4D-14
4D.3.2.1 System Input and LPRM Assignment.....	4D-15
4D.3.2.2 Defense-In-Depth Algorithms.....	4D-15
4D.3.2.3 System Operability.....	4D-17
4D.3.3 Backup Stability Protection .....	4D-17
4D.3.3.1 Backup Stability Protection Boundary Generation.....	4D-18
4D.3.3.2 Operator Action.....	4D-18
4D.3.3.3 BSP Reload Application .....	4D-18
4D.4 COL Information.....	4D-18
4D.5 References.....	4D-18

5. Reactor Coolant System and Connected Systems .....	5.1-1
5.1 Summary Description .....	5.1-1
5.1.1 Schematic Flow Diagrams .....	5.1-3
5.1.2 Piping and Instrumentation Schematics .....	5.1-3
5.1.3 Elevation Schematics .....	5.1-3
5.1.4 COL Information .....	5.1-3
5.1.5 References .....	5.1-3
5.2 Integrity of Reactor Coolant Pressure Boundary .....	5.2-1
5.2.1 Compliance with Codes and Code Cases .....	5.2-1
5.2.1.1 Compliance with 10 CFR 50.55a .....	5.2-1
5.2.1.2 Applicable Code Cases .....	5.2-1
5.2.2 Overpressure Protection .....	5.2-2
5.2.2.1 Design Basis .....	5.2-4
5.2.2.2 System Description .....	5.2-5
5.2.2.3 Safety Evaluation .....	5.2-8
5.2.2.4 Testing and Inspection Requirements .....	5.2-11
5.2.2.5 Instrumentation Requirements .....	5.2-12
5.2.3 Reactor Coolant Pressure Boundary Materials .....	5.2-12
5.2.3.1 Material Specifications .....	5.2-13
5.2.3.2 Compatibility with Reactor Coolant .....	5.2-13
5.2.3.3 Fabrication and Processing of Ferritic Materials .....	5.2-19
5.2.3.4 Fabrication and Processing of Austenitic Stainless Steels .....	5.2-21
5.2.4 Preservice and In-service Inspection and Testing of Reactor Coolant Pressure Boundary .....	5.2-23
5.2.4.1 Class 1 System Boundary .....	5.2-24
5.2.4.2 Accessibility .....	5.2-25
5.2.4.3 Examination Categories and Methods .....	5.2-27
5.2.4.4 Inspection Intervals .....	5.2-30
5.2.4.5 Evaluation of Examination Results .....	5.2-30
5.2.4.6 System Leakage and Hydrostatic Pressure Tests .....	5.2-30
5.2.4.7 Code Exemptions .....	5.2-31
5.2.4.8 Code Cases .....	5.2-31
5.2.4.9 Preservice Examination .....	5.2-31
5.2.4.10 Relief Requests .....	5.2-32
5.2.4.11 COL Information for Preservice and In-service Inspection and Testing of Reactor Coolant Pressure Boundary .....	5.2-32
5.2.5 Reactor Coolant Pressure Boundary Leakage Detection .....	5.2-32
5.2.5.1 Leakage Detection Methods .....	5.2-34
5.2.5.2 Leak Detection Instrumentation and Monitoring .....	5.2-36
5.2.5.3 Display and Indications in the Main Control Room .....	5.2-40
5.2.5.4 Limits for Reactor Coolant Leakage Rates Within the Drywell .....	5.2-40
5.2.5.5 Criteria to Evaluate the Adequacy and Margin of Leak Detection System .....	5.2-41
5.2.5.6 Separation of Identified and Unidentified Leakages in the Containment .....	5.2-41

5.2.5.7 Testing, Calibration and Inspection Requirements .....	5.2-41
5.2.5.8 Regulatory Guide 1.45 Compliance.....	5.2-41
5.2.5.9 COL Information for Leak Detection Monitoring.....	5.2-42
5.2.6 COL Information .....	5.2-43
5.2.7 References.....	5.2-43
5.3 Reactor Vessel .....	5.3-1
5.3.1 Reactor Vessel Materials .....	5.3-1
5.3.1.1 Materials Specifications.....	5.3-1
5.3.1.2 Special Procedures Used for Manufacturing and Fabrication .....	5.3-1
5.3.1.3 Special Methods for Nondestructive Examination .....	5.3-2
5.3.1.4 Special Controls for Ferritic and Austenitic Stainless Steels.....	5.3-3
5.3.1.5 Fracture Toughness.....	5.3-4
5.3.1.6 Material Surveillance .....	5.3-6
5.3.1.7 Reactor Vessel Fasteners .....	5.3-8
5.3.1.8 COL Information for Reactor Vessel Material Surveillance Program .....	5.3-9
5.3.2 Pressure/Temperature Limits.....	5.3-9
5.3.2.1 Limit Curves .....	5.3-10
5.3.2.2 Operating Procedures.....	5.3-12
5.3.3 Reactor Vessel Integrity.....	5.3-12
5.3.3.1 Design Bases.....	5.3-14
5.3.3.2 Description.....	5.3-15
5.3.3.3 Materials of Construction .....	5.3-17
5.3.3.4 Inspection Requirements.....	5.3-18
5.3.3.5 Shipment and Installation .....	5.3-18
5.3.3.6 Operating Conditions .....	5.3-19
5.3.3.7 In-service Surveillance.....	5.3-19
5.3.4 COL Information .....	5.3-19
5.3.5 References.....	5.3-20
5.4 Component and Subsystem Design .....	5.4-1
5.4.1 Reactor Recirculation System.....	5.4-1
5.4.1.1 Pump Flywheel Integrity (PWR) .....	5.4-1
5.4.2 Steam Generators (PWR).....	5.4-1
5.4.2.1 Steam Generator Materials.....	5.4-1
5.4.2.2 Steam Generator Tube In-service Inspection.....	5.4-1
5.4.3 Reactor Coolant Piping.....	5.4-1
5.4.4 Main Steamline Flow Restrictors.....	5.4-1
5.4.4.1 Safety Design Bases.....	5.4-1
5.4.4.2 Description.....	5.4-1
5.4.4.3 Safety Evaluation .....	5.4-2
5.4.4.4 Inspection and Testing .....	5.4-2
5.4.4.5 Instrumentation Requirements .....	5.4-2
5.4.5 Nuclear Boiler System Isolation .....	5.4-3
5.4.5.1 Design Bases.....	5.4-3

5.4.5.2 Main Steamlines Isolation.....	5.4-4
5.4.5.3 Feedwater Lines Isolation.....	5.4-7
5.4.5.4 Safety Evaluation.....	5.4-8
5.4.5.5 Testing and Inspection Requirements.....	5.4-10
5.4.5.6 Instrumentation Requirements.....	5.4-10
5.4.6 Isolation Condenser System.....	5.4-11
5.4.6.1 Design Bases.....	5.4-12
5.4.6.2 System Description.....	5.4-13
5.4.6.3 Safety Evaluation.....	5.4-19
5.4.6.4 Testing and Inspection Requirements.....	5.4-20
5.4.6.5 Instrumentation Requirements.....	5.4-21
5.4.7 Residual Heat Removal System.....	5.4-22
5.4.8 Reactor Water Cleanup/Shutdown Cooling System.....	5.4-23
5.4.8.1 Reactor Water Cleanup Function.....	5.4-24
5.4.8.2 Shutdown Cooling Function.....	5.4-31
5.4.9 Main Steamlines and Feedwater Piping.....	5.4-34
5.4.9.1 Design Bases.....	5.4-34
5.4.9.2 Description.....	5.4-35
5.4.9.3 Safety Evaluation.....	5.4-36
5.4.9.4 Testing and Inspection Requirements.....	5.4-36
5.4.9.5 Instrumentation Requirements.....	5.4-37
5.4.10 Pressurizer.....	5.4-37
5.4.11 Pressurizer Relief Discharge System.....	5.4-37
5.4.12 Reactor Coolant System High Point Vents.....	5.4-37
5.4.12.1 Operation of RPV Head Vent System.....	5.4-39
5.4.12.2 Safety Evaluation.....	5.4-39
5.4.12.3 Inspection and Testing Requirements.....	5.4-39
5.4.13 Safety and Relief Valves and Depressurization Valves.....	5.4-39
5.4.13.1 Design Bases.....	5.4-40
5.4.13.2 Description.....	5.4-40
5.4.13.3 Safety Evaluation.....	5.4-42
5.4.13.4 Testing and Inspection Requirements.....	5.4-42
5.4.13.5 Instrumentation Requirements.....	5.4-43
5.4.14 Component Supports.....	5.4-43
5.4.14.1 Safety Design Bases.....	5.4-43
5.4.14.2 Description.....	5.4-43
5.4.14.3 Safety Evaluation.....	5.4-43
5.4.14.4 Testing and Inspection Requirements.....	5.4-44
5.4.14.5 Instrumentation Requirements.....	5.4-44
5.4.15 COL Information.....	5.4-44
5.4.16 References.....	5.4-44

6.0 General.....	6.0-1
6.1 Design Basis Accident Engineered Safety Feature Materials.....	6.1-1
6.1.1 Metallic Materials.....	6.1-1
6.1.1.1 Materials Selection and Fabrication.....	6.1-2
6.1.1.2 Compatibility of Construction Materials with Core Cooling Water and Containment Sprays.....	6.1-2
6.1.1.3 Controls for Austenitic Stainless Steel.....	6.1-2
6.1.1.4 Composition, Compatibility and Stability of Containment and Core Coolants.....	6.1-3
6.1.2 Organic Materials.....	6.1-3
6.1.2.1 Protective Coatings.....	6.1-3
6.1.2.2 Other Organic Materials.....	6.1-4
6.1.2.3 Evaluation.....	6.1-4
6.1.3 COL Information.....	6.1-4
6.1.4 References.....	6.1-4
6.2 Containment Systems.....	6.2-1
6.2.1 Containment Functional Design.....	6.2-1
6.2.1.1 Pressure Suppression Containment.....	6.2-1
6.2.1.2 Containment Subcompartments.....	6.2-19
6.2.1.3 Mass and Energy Release Analyses for Postulated Loss-of- Coolant Accidents.....	6.2-21
6.2.1.4 Mass and Energy Release Analysis for Postulated Secondary System Pipe Ruptures Inside Containment (PWR).....	6.2-23
6.2.1.5 Maximum Containment Pressure Analysis for Performance Capability Studies on Emergency Core Cooling System (PWR).....	6.2-23
6.2.1.6 Testing and Inspection.....	6.2-23
6.2.1.7 Instrumentation Requirements.....	6.2-23
6.2.2 Passive Containment Cooling System.....	6.2-24
6.2.2.1 Design Basis.....	6.2-25
6.2.2.2 System Description.....	6.2-26
6.2.2.3 Design Evaluation.....	6.2-28
6.2.2.4 Testing and Inspection Requirements.....	6.2-29
6.2.2.5 Instrumentation Requirements.....	6.2-29
6.2.3 Reactor Building Functional Design.....	6.2-29
6.2.3.1 Design Bases.....	6.2-31
6.2.3.2 Design Description.....	6.2-31
6.2.3.3 Design Evaluation.....	6.2-33
6.2.3.4 Tests and Inspections.....	6.2-34
6.2.3.5 Instrumentation Requirements.....	6.2-34
6.2.4 Containment Isolation Function.....	6.2-34
6.2.4.1 Design Bases.....	6.2-35
6.2.4.2 System Design.....	6.2-37
6.2.4.3 Design Evaluation.....	6.2-41

6.2.4.4 Test and Inspections.....	6.2-48
6.2.5 Combustible Gas Control in Containment.....	6.2-49
6.2.5.1 Design Bases.....	6.2-49
6.2.5.2 Containment Inerting System .....	6.2-51
6.2.5.3 Containment Atmosphere Monitoring.....	6.2-54
6.2.5.4 Containment Overpressure Protection.....	6.2-56
6.2.5.5 Post-Accident Radiolytic Oxygen Generation.....	6.2-57
6.2.6 Containment Leakage Testing .....	6.2-58
6.2.6.1 Containment Integrated Leakage Rate Test (Type A) .....	6.2-59
6.2.6.2 Containment Penetration Leakage Rate Test (Type B) .....	6.2-63
6.2.6.3 Containment Isolation Valve Leakage Rate Test (Type C).....	6.2-64
6.2.6.4 Scheduling and Reporting of Periodic Tests.....	6.2-65
6.2.6.5 (Deleted) .....	6.2-66
6.2.7 Fracture Prevention of Containment Pressure Boundary.....	6.2-66
6.2.8 COL Information .....	6.2-66
6.2.9 References.....	6.2-66
6.3 Emergency Core Cooling Systems .....	6.3-1
6.3.1 Design Bases and Summary Description.....	6.3-2
6.3.1.1 Design Bases.....	6.3-2
6.3.1.2 Summary Descriptions of ECCS .....	6.3-4
6.3.2 System Design .....	6.3-4
6.3.2.1 Equipment and Component Descriptions .....	6.3-4
6.3.2.2 Applicable Codes and Classifications.....	6.3-5
6.3.2.3 Materials Specifications and Compatibility.....	6.3-5
6.3.2.4 System Reliability .....	6.3-5
6.3.2.5 Protection Provisions .....	6.3-5
6.3.2.6 Manual Actions.....	6.3-6
6.3.2.7 Gravity-Driven Cooling System .....	6.3-6
6.3.2.8 Automatic Depressurization System.....	6.3-14
6.3.2.9 Isolation Condenser System.....	6.3-16
6.3.2.10 Standby Liquid Control System.....	6.3-16
6.3.3 ECCS Performance Evaluation.....	6.3-17
6.3.3.1 ECCS Bases for Technical Specifications .....	6.3-17
6.3.3.2 Acceptance Criteria for ECCS Performance.....	6.3-17
6.3.3.3 Single-Failure Considerations.....	6.3-18
6.3.3.4 System Performance During the Accident.....	6.3-19
6.3.3.5 Use of Dual Function Components for ECCS .....	6.3-19
6.3.3.6 Limits on ECCS Parameters .....	6.3-19
6.3.3.7 ECCS Performance Analysis for LOCA.....	6.3-19
6.3.3.8 ECCS-LOCA Performance Analysis Conclusions .....	6.3-22
6.3.4 ECCS Performance Tests.....	6.3-22
6.3.4.1 Reliability Tests and Inspections .....	6.3-22
6.3.5 Instrumentation Requirements.....	6.3-23
6.3.6 COL Information .....	6.3-23

6.3.7 References.....	6.3-23
6.4 Control Room Habitability Systems.....	6.4-1
6.4.1 Design Bases.....	6.4-3
6.4.1.1 Safety Design Basis.....	6.4-3
6.4.1.2 Power Generation Design Bases.....	6.4-4
6.4.2 System Design.....	6.4-4
6.4.3 Control Room Habitability Area.....	6.4-5
6.4.4 System Operation Procedures.....	6.4-8
6.4.5 Design Evaluations.....	6.4-10
6.4.6 Life Support.....	6.4-12
6.4.7 Testing and Inspection.....	6.4-12
6.4.8 Instrumentation Requirements.....	6.4-13
6.4.9 COL Information.....	6.4-14
6.4.10 References.....	6.4-14
6.5 Atmosphere Cleanup Systems.....	6.5-1
6.5.1 Containment Spray Systems.....	6.5-1
6.5.2 Fission Product Control Systems and Structures.....	6.5-1
6.5.2.1 General.....	6.5-1
6.5.2.2 Containment.....	6.5-1
6.5.2.3 Reactor Building.....	6.5-2
6.5.2.4 Radwaste Building.....	6.5-3
6.5.2.5 Turbine Building.....	6.5-3
6.5.3 Ice Condenser as a Fission Product Control System.....	6.5-3
6.5.4 Suppression Pool as a Fission Product Cleanup System.....	6.5-3
6.5.5 COL Information.....	6.5-3
6.5.6 References.....	6.5-3
6.6 Preservice and Inservice Inspection and Testing of Class 2 and 3 Components and Piping.....	6.6-1
6.6.1 Class 2 and 3 System Boundaries.....	6.6-1
6.6.1.1 Class 2 System Boundary Description.....	6.6-2
6.6.1.2 Class 3 System Boundary Description.....	6.6-2
6.6.2 Accessibility.....	6.6-3
6.6.3 Examination Categories and Methods.....	6.6-4
6.6.3.1 Examination Categories.....	6.6-4
6.6.3.2 Examination Methods.....	6.6-4
6.6.4 Inspection Intervals.....	6.6-6
6.6.5 Evaluation of Examination Results.....	6.6-6
6.6.6 System Pressure Tests.....	6.6-7
6.6.6.1 System Leakage Test.....	6.6-7
6.6.6.2 Hydrostatic Pressure Tests.....	6.6-7
6.6.7 Augmented Inservice Inspections.....	6.6-7

6.6.8 Code Exemptions ..... 6.6-8

6.6.9 Code Cases..... 6.6-8

6.6.10 Plant Specific PSI/ISI Program Information..... 6.6-8

    6.6.10.1 Relief Requests ..... 6.6-8

    6.6.10.2 Code Edition ..... 6.6-8

6.6.11 COL Information ..... 6.6-8

6.6.12 References..... 6.6-8



7. Instrumentation and Control Systems.....	7.1-1
7.1 Introduction.....	7.1-1
7.1.1 Distributed Control and Information System.....	7.1-1
7.1.2 Q-DCIS General Description Summary .....	7.1-2
7.1.2.1 Q-DCIS Safety-Related Design Bases Summary .....	7.1-5
7.1.2.2 Q-DCIS Power Generation (Nonsafety-Related) Design Bases Summary .....	7.1-5
7.1.2.3 Q-DCIS Safety Evaluation Summary .....	7.1-5
7.1.2.4 Q-DCIS Regulatory Requirements Conformance Summary .....	7.1-5
7.1.2.5 Q-DCIS Testing and Inspection Requirements Summary .....	7.1-6
7.1.2.6 Q-DCIS Operator Interface Requirements Summary .....	7.1-6
7.1.2.7 Q-DCIS Boundary Summary .....	7.1-7
7.1.2.8 Q-DCIS Major Systems Description Summary .....	7.1-7
7.1.3 Q-DCIS Specifics.....	7.1-11
7.1.3.1 Q-DCIS Design Bases.....	7.1-12
7.1.3.2 Q-DCIS Description.....	7.1-13
7.1.3.3 Q-DCIS Safety Evaluation.....	7.1-18
7.1.3.4 Q-DCIS Testing and Inspection Requirements.....	7.1-25
7.1.3.5 Q-DCIS Instrumentation and Control Requirements.....	7.1-28
7.1.3.6 Q-DCIS Boundaries.....	7.1-29
7.1.4 N-DCIS General Description Summary .....	7.1-29
7.1.4.1 N-DCIS Safety-Related Design Bases Summary .....	7.1-31
7.1.4.2 N-DCIS Nonsafety-Related Design Bases Summary .....	7.1-31
7.1.4.3 N-DCIS Safety Evaluation Summary .....	7.1-32
7.1.4.4 N-DCIS Regulatory Requirements Conformance Summary .....	7.1-33
7.1.4.5 N-DCIS Testing and Inspection Requirements Summary .....	7.1-33
7.1.4.6 N-DCIS Operator Interface Requirements Summary .....	7.1-33
7.1.4.7 N-DCIS System Boundaries .....	7.1-34
7.1.4.8 N-DCIS Major Systems Description Summary .....	7.1-34
7.1.5 N-DCIS Specifics.....	7.1-36
7.1.5.1 N-DCIS Design Bases.....	7.1-37
7.1.5.2 N-DCIS Description.....	7.1-40
7.1.5.3 N-DCIS Safety Evaluation.....	7.1-60
7.1.5.4 N-DCIS Testing and Inspection Requirements.....	7.1-63
7.1.5.5 N-DCIS Instrumentation and Control Requirements.....	7.1-64
7.1.5.6 N-DCIS Major System Interfaces.....	7.1-65
7.1.6 General DCIS Conformance to Regulatory Requirements and Industry Codes and Standards .....	7.1-68
7.1.6.1 Code of Federal Regulations.....	7.1-68
7.1.6.2 General Design Criteria .....	7.1-70
7.1.6.3 Staff Requirements Memorandum.....	7.1-70
7.1.6.4 Regulatory Guides .....	7.1-70
7.1.6.5 Branch Technical Positions.....	7.1-75
7.1.6.6 Industry Standards .....	7.1-77
7.1.7 COL Information .....	7.1-91
7.1.8 References.....	7.1-91

7.2 Reactor Trip System .....	7.2-1
7.2.1 Reactor Protection System .....	7.2-1
7.2.1.1 System Bases .....	7.2-1
7.2.1.2 System Description .....	7.2-3
7.2.1.3 Safety Evaluation .....	7.2-17
7.2.1.4 Testing and Inspection Requirements .....	7.2-24
7.2.1.5 Instrumentation and Control Requirements .....	7.2-25
7.2.2 Neutron Monitoring System .....	7.2-32
7.2.2.1 System Design Bases .....	7.2-32
7.2.2.2 System Description .....	7.2-37
7.2.2.3 Safety Evaluation .....	7.2-46
7.2.2.4 Testing and Inspection Requirements .....	7.2-51
7.2.2.5 Instrumentation and Control Requirements .....	7.2-52
7.2.3 Suppression Pool Temperature Monitoring .....	7.2-55
7.2.3.1 System Design Bases .....	7.2-55
7.2.3.2 System Description .....	7.2-56
7.2.3.3 Safety Evaluation .....	7.2-57
7.2.3.4 Testing and Inspection Requirements .....	7.2-61
7.2.3.5 Instrumentation and Controls Requirements .....	7.2-61
7.2.4 COL Information .....	7.2-62
7.2.5 References .....	7.2-62
7.3 Engineered Safety Features Systems .....	7.3-1
7.3.1 Emergency Core Cooling System .....	7.3-1
7.3.1.1 Automatic Depressurization System .....	7.3-1
7.3.1.2 Gravity-Driven Cooling System .....	7.3-11
7.3.2 Passive Containment Cooling System .....	7.3-24
7.3.3 Leak Detection and Isolation System .....	7.3-24
7.3.3.1 System Design Bases .....	7.3-25
7.3.3.2 System Description .....	7.3-26
7.3.3.3 Safety Evaluation .....	7.3-27
7.3.3.4 Testing and Inspection Requirements .....	7.3-33
7.3.3.5 Instrumentation and Controls Requirements .....	7.3-33
7.3.4 Control Room Habitability System .....	7.3-34
7.3.4.1 System Design Bases .....	7.3-34
7.3.4.2 System Description .....	7.3-34
7.3.4.3 Safety Evaluation .....	7.3-37
7.3.4.4 Testing and Inspection Requirements .....	7.3-42
7.3.4.5 Instrumentation and Control Requirements .....	7.3-42
7.3.5 Safety System Logic and Control/Engineered Safety Features .....	7.3-42
7.3.5.1 System Design Bases .....	7.3-42
7.3.5.2 System Description .....	7.3-43
7.3.5.3 Safety Evaluation .....	7.3-46
7.3.5.4 Testing and Inspection Requirements .....	7.3-52
7.3.5.5 Instrumentation and Controls Requirements .....	7.3-53
7.3.6 Containment System Wetwell-to-Drywell Vacuum Breaker Isolation Function .....	7.3-54

7.3.6.1 System Design Bases .....	7.3-54
7.3.6.2 System Description .....	7.3-54
7.3.6.3 Safety Evaluation .....	7.3-56
7.3.6.4 Testing and Inspection Requirements .....	7.3-60
7.3.6.5 Instrumentation and Control Requirements .....	7.3-60
7.3.7 COL Information .....	7.3-61
7.3.8 References .....	7.3-61
7.4 Safety-Related Safe Shutdown and Nonsafety-Related Cold Shutdown Systems .....	7.4-1
7.4.1 Standby Liquid Control System .....	7.4-1
7.4.1.1 System Design Bases .....	7.4-1
7.4.1.2 System Description .....	7.4-2
7.4.1.3 Safety Evaluation .....	7.4-3
7.4.1.4 Testing and Inspection Requirements .....	7.4-9
7.4.1.5 Instrumentation and Control Requirements .....	7.4-9
7.4.2 Remote Shutdown System .....	7.4-10
7.4.2.1 System Design Bases .....	7.4-10
7.4.2.2 System Description .....	7.4-10
7.4.2.3 Safety Evaluation .....	7.4-12
7.4.2.4 Testing and Inspection Requirements .....	7.4-15
7.4.2.5 Instrumentation and Control Requirements .....	7.4-15
7.4.3 Reactor Water Cleanup/Shutdown Cooling System .....	7.4-15
7.4.3.1 System Design Bases .....	7.4-15
7.4.3.2 System Description .....	7.4-17
7.4.3.3 Safety Evaluation .....	7.4-19
7.4.3.4 Testing and Inspection Requirements .....	7.4-21
7.4.3.5 Instrumentation and Control Requirements .....	7.4-21
7.4.4 Isolation Condenser System .....	7.4-21
7.4.4.1 System Design Bases .....	7.4-21
7.4.4.2 System Description .....	7.4-22
7.4.4.3 Safety Evaluation .....	7.4-22
7.4.4.4 Testing and Inspection Requirements .....	7.4-27
7.4.4.5 Instrumentation and Control Requirements .....	7.4-27
7.4.5 COL Information .....	7.4-28
7.4.6 References .....	7.4-28
7.5 Safety-Related and Nonsafety-Related Information Systems .....	7.5-1
7.5.1 Post Accident Monitoring Instrumentation .....	7.5-1
7.5.1.1 System Design Bases .....	7.5-1
7.5.1.2 System Descriptions .....	7.5-2
7.5.1.3 Safety Evaluation .....	7.5-2
7.5.1.4 Testing and Inspection Requirements .....	7.5-9
7.5.1.5 Instrumentation and Controls Requirements .....	7.5-9
7.5.2 Containment Monitoring System .....	7.5-9
7.5.2.1 System Design Bases .....	7.5-10
7.5.2.2 System Description .....	7.5-11
7.5.2.3 Safety Evaluation .....	7.5-13
7.5.2.4 Testing and Inspection Requirements .....	7.5-17

7.5.2.5 Instrumentation and Control Requirements .....	7.5-18
7.5.3 Process Radiation Monitoring System .....	7.5-18
7.5.3.1 Design Bases .....	7.5-19
7.5.3.2 System Description .....	7.5-19
7.5.3.3 Safety Evaluation .....	7.5-19
7.5.3.4 Testing and Inspection Requirements .....	7.5-24
7.5.3.5 Instrumentation and Control Requirements .....	7.5-24
7.5.4 Area Radiation Monitoring System .....	7.5-24
7.5.4.1 Design Bases .....	7.5-24
7.5.4.2 System Description .....	7.5-24
7.5.4.3 Safety Evaluation .....	7.5-24
7.5.4.4 Testing and Inspection Requirements .....	7.5-26
7.5.4.5 Instrumentation and Control Requirements .....	7.5-26
7.5.5 Pool Monitoring Subsystems .....	7.5-26
7.5.5.1 System Design Bases .....	7.5-28
7.5.5.2 System Description .....	7.5-28
7.5.5.3 Safety Evaluation .....	7.5-28
7.5.5.4 Testing and Inspection Requirements .....	7.5-28
7.5.5.5 Instrumentation and Control Requirements .....	7.5-28
7.5.6 (Deleted) .....	7.5-29
7.5.7 COL Information .....	7.5-29
7.5.8 References .....	7.5-29
7.6 Interlock Systems .....	7.6-1
7.6.1 High Pressure/Low Pressure Interlock Systems .....	7.6-1
7.6.1.1 System Design Bases .....	7.6-1
7.6.1.2 System Description .....	7.6-2
7.6.1.3 Safety Evaluation .....	7.6-5
7.6.1.4 Testing and Inspection Requirements .....	7.6-10
7.6.1.5 Instrumentation and Control Requirements .....	7.6-10
7.6.2 (Deleted) .....	7.6-10
7.6.2.1 (Deleted) .....	7.6-10
7.6.3 COL Information .....	7.6-10
7.6.4 References .....	7.6-11
7.7 Control Systems .....	7.7-1
7.7.1 Nuclear Boiler System .....	7.7-1
7.7.1.1 System Design Bases .....	7.7-2
7.7.1.2 System Description .....	7.7-3
7.7.1.3 Safety Evaluation .....	7.7-5
7.7.1.4 Testing and Inspection Requirements .....	7.7-9
7.7.1.5 Instrumentation and Control Requirements .....	7.7-9
7.7.2 Rod Control and Information System .....	7.7-9
7.7.2.1 System Design Bases .....	7.7-10
7.7.2.2 System Description .....	7.7-11
7.7.2.3 Safety Evaluation .....	7.7-26
7.7.2.4 Testing and Inspection Requirements .....	7.7-27
7.7.2.5 Instrumentation and Control Requirements .....	7.7-28

7.7.3 Feedwater Control System.....	7.7-28
7.7.3.1 System Design Bases.....	7.7-29
7.7.3.2 System Description.....	7.7-30
7.7.3.3 Safety Evaluation.....	7.7-33
7.7.3.4 Testing and Inspection Requirements.....	7.7-35
7.7.3.5 Instrumentation and Control Requirements.....	7.7-35
7.7.4 Plant Automation System.....	7.7-37
7.7.4.1 System Design Bases.....	7.7-37
7.7.4.2 System Description.....	7.7-37
7.7.4.3 Safety Evaluation.....	7.7-38
7.7.4.4 Testing and Inspection Requirements.....	7.7-39
7.7.4.5 Instrumentation and Control Requirements.....	7.7-39
7.7.5 Steam Bypass and Pressure Control System.....	7.7-40
7.7.5.1 System Design Bases.....	7.7-40
7.7.5.2 System Description.....	7.7-40
7.7.5.3 Safety Evaluation.....	7.7-43
7.7.5.4 Testing and Inspection Requirements.....	7.7-44
7.7.5.5 Instrumentation and Control Requirements.....	7.7-44
7.7.5.6 Major Instrument Interfaces with SB&PC System.....	7.7-45
7.7.6 Neutron Monitoring System - Nonsafety-Related Subsystems.....	7.7-47
7.7.6.1 System Design Bases.....	7.7-47
7.7.6.2 System Description.....	7.7-48
7.7.6.3 Safety Evaluation.....	7.7-50
7.7.6.4 Testing and Inspection Requirements.....	7.7-51
7.7.6.5 Instrumentation and Control Requirements.....	7.7-51
7.7.7 Containment Inerting System.....	7.7-52
7.7.7.1 System Design Bases.....	7.7-52
7.7.7.2 System Description.....	7.7-52
7.7.7.3 Safety Evaluation.....	7.7-52
7.7.7.4 Testing and Inspection Requirements.....	7.7-53
7.7.7.5 Instrumentation and Control Requirements.....	7.7-54
7.7.8 COL Information.....	7.7-56
7.7.9 References.....	7.7-56
7.8 Diverse Instrumentation and Control Systems.....	7.8-1
7.8.1 System Description.....	7.8-1
7.8.1.1 Anticipated Transients Without Scram Mitigation Functions.....	7.8-2
7.8.1.2 Diverse Instrumentation and Control.....	7.8-6
7.8.1.3 Diverse Manual Controls and Displays.....	7.8-10
7.8.2 Common Mode Failure Defenses Within Safety-Related System Design.....	7.8-11
7.8.2.1 Design Techniques for Optimizing Safety-Related Hardware and Software.....	7.8-11
7.8.2.2 Defense Against Common Mode Failure.....	7.8-12
7.8.3 Safety Evaluation.....	7.8-13
7.8.3.1 Code of Federal Regulations.....	7.8-14
7.8.3.2 General Design Criteria.....	7.8-15
7.8.3.3 Staff Requirements Memorandum.....	7.8-15

7.8.3.4 Regulatory Guides ..... 7.8-16

7.8.3.5 Branch Technical Position ..... 7.8-18

7.8.4 Testing and Inspection Requirements ..... 7.8-19

7.8.5 Instrumentation and Control Requirements ..... 7.8-19

7.8.6 COL Information ..... 7.8-20

7.8.7 References ..... 7.8-20

7.9 (Deleted) ..... 7.9-1

7A. (Deleted)..... 7A-1

7B. (Deleted)..... 7B-1

**8. Electric Power**..... 8.1-1

    8.1 Introduction..... 8.1-1

        8.1.1 General..... 8.1-1

        8.1.2 Utility Power Grid and Offsite Power System Descriptions ..... 8.1-1

            8.1.2.1 Utility Power Grid Description..... 8.1-1

            8.1.2.2 Offsite Power System Description..... 8.1-1

        8.1.3 Onsite Electric Power System..... 8.1-2

            8.1.3.1 Onsite AC Power System ..... 8.1-2

            8.1.3.2 Onsite DC Power System ..... 8.1-2

        8.1.4 Safety-Related Loads ..... 8.1-3

        8.1.5 Design Basis..... 8.1-3

            8.1.5.1 Offsite Power ..... 8.1-3

            8.1.5.2 Onsite Power..... 8.1-4

        8.1.6 Compliance to Regulatory Requirements and Guidelines ..... 8.1-9

        8.1.7 COL Information ..... 8.1-9

        8.1.8 References..... 8.1-9

    8.2 Offsite Power Systems..... 8.2-1

        8.2.1 Description..... 8.2-1

            8.2.1.1 Transmission System ..... 8.2-1

            8.2.1.2 Offsite Power System ..... 8.2-1

        8.2.2 Analysis..... 8.2-2

            8.2.2.1 Reliability and Stability Analysis ..... 8.2-2

            8.2.2.2 Regulatory Analysis..... 8.2-2

        8.2.3 Design Bases Requirements..... 8.2-3

        8.2.4 COL Information ..... 8.2-4

            8.2.4-1-A Transmission System Description..... 8.2-4

            8.2.4-2-A Switchyard Description..... 8.2-4

            8.2.4-3-A Normal Preferred Power..... 8.2-4

            8.2.4-4-A Alternate Preferred Power..... 8.2-4

            8.2.4-5-A Protective Relaying..... 8.2-4

            8.2.4-6-A Switchyard DC Power..... 8.2-4

            8.2.4-7-A Switchyard AC Power..... 8.2-4

            8.2.4-8-A Switchyard Transformer Protection ..... 8.2-5

            8.2.4-9-A Stability and Reliability of the Offsite Transmission Power Systems ..... 8.2-5

            8.2.4-10-A Interface Requirements..... 8.2-5

        8.2.5 References..... 8.2-5

    8.3 Onsite Power Systems..... 8.3-1

        8.3.1 AC Power Systems ..... 8.3-1

            8.3.1.1 Description..... 8.3-1

            8.3.1.2 Analysis..... 8.3-14

            8.3.1.3 Physical Identification of Safety-Related Equipment..... 8.3-15

            8.3.1.4 Independence of Redundant Systems ..... 8.3-17

        8.3.2 DC Power Systems ..... 8.3-23

            8.3.2.1 Description..... 8.3-23

            8.3.2.2 Analysis..... 8.3-27

8.3.3 Fire Protection of Cable Systems ..... 8.3-29

    8.3.3.1 Resistance of Cables to Combustion..... 8.3-29

    8.3.3.2 Cables and Raceways..... 8.3-29

    8.3.3.3 Localization of Fires ..... 8.3-30

8.3.4 COL Information ..... 8.3-30

8.3.5 References..... 8.3-30

Appendix 8A Miscellaneous Electrical Systems ..... 8A-1

    8A.1 Station Grounding and Surge Protection ..... 8A-1

        8A.1.1 Description ..... 8A-1

        8A.1.2 Analysis..... 8A-2

    8A.2 Cathodic Protection..... 8A-3

        8A.2.1 Description ..... 8A-3

        8A.2.2 Analysis..... 8A-3

        8A.2.3 COL Information..... 8A-3

            8A.2.3-1-A Cathodic Protection System ..... 8A-3

    8A.3 Electric Heat Tracing ..... 8A-3

        8A.3.1 Description ..... 8A-3

        8A.3.2 Analysis..... 8A-3

    8A.4 References..... 8A-3



9.1 Fuel Storage and Handling.....	9.1-1
9.1.1 New Fuel Storage.....	9.1-1
9.1.1.1 Design Bases.....	9.1-1
9.1.1.2 Storage Design.....	9.1-2
9.1.1.3 Mechanical and Structural Design.....	9.1-2
9.1.1.4 Material Considerations.....	9.1-2
9.1.1.5 Dynamic and Impact Analysis.....	9.1-2
9.1.1.6 Facilities Description (New Fuel Storage).....	9.1-3
9.1.1.7 Safety Evaluation.....	9.1-3
9.1.2 Spent Fuel Storage.....	9.1-4
9.1.2.1 Design Bases.....	9.1-4
9.1.2.2 Nuclear Design.....	9.1-5
9.1.2.3 Storage Design.....	9.1-5
9.1.2.4 Mechanical and Structural Design.....	9.1-5
9.1.2.5 Thermal-Hydraulic Design.....	9.1-7
9.1.2.6 Material Considerations.....	9.1-7
9.1.2.7 Facilities Description (Spent Fuel Storage).....	9.1-7
9.1.2.8 Safety Evaluation.....	9.1-8
9.1.3 Fuel and Auxiliary Pools Cooling System.....	9.1-9
9.1.3.1 Design Bases.....	9.1-9
9.1.3.2 System Description.....	9.1-9
9.1.3.3 Safety Evaluation.....	9.1-17
9.1.3.4 Testing and Inspection Requirements.....	9.1-17
9.1.3.5 Instrumentation and Control.....	9.1-17
9.1.4 Light Load Handling System (Related to Refueling).....	9.1-19
9.1.4.1 Design Bases.....	9.1-19
9.1.4.2 System Description.....	9.1-20
9.1.4.3 Spent Fuel Cask.....	9.1-20
9.1.4.4 Overhead Bridge Cranes.....	9.1-20
9.1.4.5 Refueling Equipment.....	9.1-21
9.1.4.6 Fuel Servicing Equipment.....	9.1-22
9.1.4.7 Servicing Aids.....	9.1-23
9.1.4.8 Reactor Vessel Servicing Equipment.....	9.1-24
9.1.4.9 In-Vessel Servicing Equipment.....	9.1-26
9.1.4.10 Storage Equipment.....	9.1-26
9.1.4.11 Under-Vessel Servicing Equipment.....	9.1-26
9.1.4.12 Fuel Transfer System.....	9.1-27
9.1.4.13 Refueling Operations.....	9.1-28
9.1.4.14 Arrival of Fuel at Reactor Site.....	9.1-28
9.1.4.15 Reactor Preparation for Refueling.....	9.1-29
9.1.4.16 Refueling.....	9.1-30
9.1.4.17 Vessel Closure.....	9.1-30
9.1.4.18 Safety Evaluation of Fuel Handling System.....	9.1-31
9.1.4.19 Inspection and Testing Requirements.....	9.1-31

9.1.4.20 Instrumentation Requirements .....	9.1-32
9.1.5 Overhead Heavy Load Handling Systems (OHLHS) .....	9.1-32
9.1.5.1 Design Bases .....	9.1-32
9.1.5.2 General .....	9.1-32
9.1.5.3 Applicable Design Criteria for All OHLH Equipment .....	9.1-33
9.1.5.4 System Description .....	9.1-34
9.1.5.5 Fuel Building and Reactor Building Cranes .....	9.1-34
9.1.5.6 Other Overhead Load Handling System .....	9.1-34
9.1.5.7 Equipment Operating Procedures Maintenance and Service .....	9.1-36
9.1.5.8 Operational Responsibilities .....	9.1-36
9.1.5.9 Safety Evaluations .....	9.1-37
9.1.5.10 Inspection and Testing .....	9.1-37
9.1.5.11 Instrumentation Requirements .....	9.1-37
9.1.6 COL Information .....	9.1-37
9.1.7 References .....	9.1-38
9.2 Water Systems .....	9.2-1
9.2.1 Plant Service Water System .....	9.2-1
9.2.1.1 Design Bases .....	9.2-1
9.2.1.2 System Description .....	9.2-2
9.2.1.3 Safety Evaluation .....	9.2-4
9.2.1.4 Testing and Inspection Requirements .....	9.2-4
9.2.1.5 Instrumentation Requirements .....	9.2-4
9.2.1.6 COL Information .....	9.2-5
9.2.1.7 References .....	9.2-5
9.2.2 Reactor Component Cooling Water System .....	9.2-5
9.2.2.1 Design Bases .....	9.2-5
9.2.2.2 System Description .....	9.2-6
9.2.2.3 Safety Evaluation .....	9.2-8
9.2.2.4 Testing and Inspection Requirements .....	9.2-8
9.2.2.5 Instrumentation Requirements .....	9.2-8
9.2.2.6 COL Information .....	9.2-8
9.2.2.7 References .....	9.2-8
9.2.3 Makeup Water System .....	9.2-8
9.2.3.1 Design Bases .....	9.2-8
9.2.3.2 System Description .....	9.2-9
9.2.3.3 Safety Evaluation .....	9.2-10
9.2.3.4 Testing and Inspection Requirements .....	9.2-10
9.2.3.5 Instrumentation Requirements .....	9.2-10
9.2.3.6 COL Information .....	9.2-11
9.2.3.7 References .....	9.2-11
9.2.4 Potable and Sanitary Water Systems .....	9.2-11
9.2.5 Ultimate Heat Sink .....	9.2-11
9.2.5.1 COL Information .....	9.2-13
9.2.5.2 References .....	9.2-13

9.2.6 Condensate Storage and Transfer System.....	9.2-13
9.2.6.1 Design Bases.....	9.2-13
9.2.6.2 System Description.....	9.2-14
9.2.6.3 Safety Evaluation.....	9.2-15
9.2.6.4 Testing and Inspection Requirements.....	9.2-15
9.2.6.5 Instrumentation Requirements.....	9.2-15
9.2.6.6 COL Information.....	9.2-15
9.2.6.7 References.....	9.2-15
9.2.7 Chilled Water System.....	9.2-16
9.2.7.1 Design Bases.....	9.2-16
9.2.7.2 System Description.....	9.2-17
9.2.7.3 Safety Evaluation.....	9.2-19
9.2.7.4 Testing and Inspection Requirements.....	9.2-19
9.2.7.5 Instrumentation Requirements.....	9.2-20
9.2.7.6 COL Information.....	9.2-20
9.2.7.7 References.....	9.2-20
9.2.8 Turbine Component Cooling Water System.....	9.2-20
9.2.8.1 Design Bases.....	9.2-20
9.2.8.2 System Description.....	9.2-21
9.2.8.3 Safety Evaluation.....	9.2-22
9.2.8.4 Tests and Inspections.....	9.2-22
9.2.8.5 Instrumentation Requirements.....	9.2-22
9.2.8.6 COL Information.....	9.2-23
9.2.8.7 References.....	9.2-23
9.2.9 Hot Water System.....	9.2-23
9.2.10 Station Water System.....	9.2-23
9.2.10.1 Design Basis.....	9.2-23
9.2.10.2 System Description.....	9.2-23
9.2.10.3 Safety Evaluation.....	9.2-24
9.2.10.4 Testing and Inspection Requirements.....	9.2-24
9.2.10.5 Instrumentation Requirements.....	9.2-24
9.2.10.6 COL Information.....	9.2-24
9.2.10.7 References.....	9.2-24
9.3 Process Auxiliaries.....	9.3-1
9.3.1 Compressed Air Systems.....	9.3-1
9.3.2 Process Sampling System.....	9.3-1
9.3.2.1 Design Bases.....	9.3-1
9.3.2.2 System Description.....	9.3-2
9.3.2.3 Safety Evaluation.....	9.3-5
9.3.2.4 Tests and Inspections.....	9.3-5
9.3.2.5 Instrumentation Requirements.....	9.3-5
9.3.2.6 COL Information.....	9.3-6
9.3.2.7 References.....	9.3-6
9.3.3 Equipment and Floor Drain System.....	9.3-6
9.3.3.1 Design Bases.....	9.3-7

9.3.3.2 System Description .....	9.3-7
9.3.3.3 Safety Evaluation .....	9.3-9
9.3.3.4 Testing and Inspection Requirements .....	9.3-9
9.3.3.5 Instrumentation Requirements .....	9.3-9
9.3.3.6 COL Information .....	9.3-10
9.3.3.7 References .....	9.3-10
9.3.4 Chemical and Volume Control System.....	9.3-10
9.3.5 Standby Liquid Control System.....	9.3-10
9.3.5.1 Design Bases .....	9.3-10
9.3.5.2 System Description .....	9.3-11
9.3.5.3 Safety Evaluation .....	9.3-13
9.3.5.4 Testing and Inspection Requirements .....	9.3-15
9.3.5.5 Instrumentation Requirements .....	9.3-16
9.3.5.6 COL Information .....	9.3-17
9.3.5.7 References .....	9.3-17
9.3.6 Instrument Air System .....	9.3-17
9.3.6.1 Design Bases .....	9.3-17
9.3.6.2 System Description .....	9.3-17
9.3.6.3 Safety Evaluation .....	9.3-18
9.3.6.4 Inspection and Testing Requirements .....	9.3-18
9.3.6.5 Instrumentation Application .....	9.3-18
9.3.6.6 COL Information .....	9.3-19
9.3.6.7 References .....	9.3-19
9.3.7 Service Air System .....	9.3-19
9.3.7.1 Design Bases .....	9.3-19
9.3.7.2 System Description .....	9.3-20
9.3.7.3 Safety Evaluation .....	9.3-21
9.3.7.4 Inspection and Testing Requirements .....	9.3-21
9.3.7.5 Instrumentation Application .....	9.3-21
9.3.7.6 COL Information .....	9.3-21
9.3.7.7 References .....	9.3-21
9.3.8 High Pressure Nitrogen Supply System.....	9.3-22
9.3.8.1 Design Bases .....	9.3-22
9.3.8.2 System Description .....	9.3-22
9.3.8.3 Safety Evaluation .....	9.3-24
9.3.8.4 Inspection and Testing Requirements .....	9.3-24
9.3.8.5 Instrumentation Requirements .....	9.3-24
9.3.8.6 COL Information .....	9.3-24
9.3.8.7 References .....	9.3-24
9.3.9 Hydrogen Water Chemistry System .....	9.3-24
9.3.9.1 Design Bases .....	9.3-24
9.3.9.2 System Description .....	9.3-24
9.3.9.3 Safety Evaluation .....	9.3-25
9.3.9.4 Inspection and Testing Requirements .....	9.3-25
9.3.9.5 Instrumentation and Controls.....	9.3-25

9.3.9.6 COL Information .....	9.3-25
9.3.9.7 References .....	9.3-25
9.3.10 Oxygen Injection System .....	9.3-26
9.3.10.1 Design Bases .....	9.3-26
9.3.10.2 System Description .....	9.3-26
9.3.10.3 Safety Evaluation .....	9.3-27
9.3.10.4 Testing and Inspection Requirements .....	9.3-27
9.3.10.5 Instrumentation .....	9.3-27
9.3.10.6 COL Information .....	9.3-27
9.3.10.7 References .....	9.3-27
9.3.11 Zinc Injection System .....	9.3-27
9.3.11.1 Design Bases .....	9.3-27
9.3.11.2 System Description .....	9.3-28
9.3.11.3 Safety Evaluation .....	9.3-28
9.3.11.4 Test and Inspections .....	9.3-28
9.3.11.5 Instrumentation and Controls .....	9.3-28
9.3.11.6 COL Information .....	9.3-28
9.3.11.7 References .....	9.3-28
9.3.12 Auxiliary Boiler System .....	9.3-28
9.3.12.1 Design Basis .....	9.3-28
9.3.12.2 System Description .....	9.3-29
9.3.12.3 Safety Evaluation .....	9.3-30
9.3.12.4 Testing and Inspection Requirements .....	9.3-30
9.3.12.5 Instrumentation .....	9.3-30
9.3.12.6 COL Information .....	9.3-30
9.3.12.7 References .....	9.3-30
9.4 Heating, Ventilation, and Air Conditioning .....	9.4-1
9.4.1 Control Building HVAC System .....	9.4-1
9.4.1.1 Design Bases .....	9.4-3
9.4.1.2 System Description .....	9.4-6
9.4.1.3 Safety Evaluation .....	9.4-11
9.4.1.4 Testing and Inspection Requirements .....	9.4-11
9.4.1.5 Instrumentation Requirements .....	9.4-11
9.4.1.6 COL Information .....	9.4-12
9.4.1.7 References .....	9.4-12
9.4.2 Fuel Building HVAC System (FBVS) .....	9.4-12
9.4.2.1 Design Bases .....	9.4-13
9.4.2.2 System Description .....	9.4-14
9.4.2.3 Safety Evaluation .....	9.4-16
9.4.2.4 Testing and Inspection Requirements .....	9.4-16
9.4.2.5 Instrumentation Requirements .....	9.4-16
9.4.2.6 COL Information .....	9.4-17
9.4.2.7 References .....	9.4-17
9.4.3 Radwaste Building Heating, Ventilating and Air Conditioning System .....	9.4-17
9.4.3.1 Design Bases .....	9.4-18

9.4.3.2 System Description .....	9.4-19
9.4.3.3 Safety Evaluation .....	9.4-20
9.4.3.4 Testing and Inspection Requirements .....	9.4-20
9.4.3.5 Instrumentation Requirements .....	9.4-21
9.4.3.6 COL Information .....	9.4-21
9.4.3.7 References .....	9.4-21
9.4.4 Turbine Building HVAC System .....	9.4-22
9.4.4.1 Design Bases .....	9.4-22
9.4.4.2 System Description .....	9.4-23
9.4.4.3 Safety Evaluation .....	9.4-26
9.4.4.4 Tests and Inspections .....	9.4-26
9.4.4.5 Instrumentation Requirements .....	9.4-27
9.4.4.6 COL Information .....	9.4-27
9.4.4.7 References .....	9.4-27
9.4.5 Engineered Safety Feature Ventilation System .....	9.4-27
9.4.6 Reactor Building HVAC System .....	9.4-27
9.4.6.1 Design Bases .....	9.4-28
9.4.6.2 System Description .....	9.4-30
9.4.6.3 Safety Evaluation .....	9.4-33
9.4.6.4 Testing and Inspection Requirements .....	9.4-33
9.4.6.5 Instrumentation Requirements .....	9.4-33
9.4.6.6 COL Information .....	9.4-34
9.4.6.7 References .....	9.4-34
9.4.7 Electrical Building HVAC System .....	9.4-35
9.4.7.1 Design Bases .....	9.4-35
9.4.7.2 System Description .....	9.4-37
9.4.7.3 Safety Evaluation .....	9.4-39
9.4.7.4 Testing and Inspection Requirements .....	9.4-39
9.4.7.5 Instrumentation Requirements .....	9.4-39
9.4.7.6 COL Information .....	9.4-40
9.4.7.7 References .....	9.4-40
9.4.8 Drywell Cooling System .....	9.4-40
9.4.8.1 Design Basis .....	9.4-40
9.4.8.2 System Description .....	9.4-41
9.4.8.3 Safety Evaluation .....	9.4-42
9.4.8.4 Testing and Inspection Requirements .....	9.4-43
9.4.8.5 Instrumentation Requirements .....	9.4-43
9.4.8.6 COL Information .....	9.4-43
9.4.8.7 References .....	9.4-43
9.4.9 Containment Inerting System .....	9.4-43
9.4.10 HVAC Component Information .....	9.4-43
9.4.10.1 Filtration .....	9.4-43
9.4.10.2 Supply and Exhaust Fans .....	9.4-44
9.4.10.3 Heating Coils/Elements .....	9.4-44
9.4.10.4 Cooling Coils .....	9.4-45

9.4.10.5 Dampers ..... 9.4-45

9.4.10.6 Ductwork and Accessories..... 9.4-45

9.4.10.7 COL Information ..... 9.4-45

9.4.10.8 References..... 9.4-45

9.5 Other Auxiliary Systems..... 9.5-1

9.5.1 Fire Protection System..... 9.5-1

9.5.1.1 Design Bases..... 9.5-1

9.5.1.2 System Description ..... 9.5-3

9.5.1.3 Facility Features for Fire Protection ..... 9.5-3

9.5.1.4 Fire Protection Water Supply System..... 9.5-4

9.5.1.5 Firewater Supply Piping, Yard Piping, and Yard Hydrants..... 9.5-5

9.5.1.6 Manual Suppression Means ..... 9.5-6

9.5.1.7 Fixed Automatic Water Extinguishing Systems ..... 9.5-8

9.5.1.8 Foam System..... 9.5-8

9.5.1.9 Smoke Detection and Fire Alarm System..... 9.5-8

9.5.1.10 Fire Barriers ..... 9.5-9

9.5.1.11 Building Ventilation..... 9.5-10

9.5.1.12 Safety Evaluation ..... 9.5-12

9.5.1.13 Inspection and Testing Requirements ..... 9.5-21

9.5.1.14 Instrumentation Requirements ..... 9.5-21

9.5.1.15 Fire Protection Program..... 9.5-22

9.5.1.16 COL Information ..... 9.5-31

9.5.1.17 References..... 9.5-32

9.5.2 Communications System ..... 9.5-32

9.5.2.1 Design Bases..... 9.5-32

9.5.2.2 System Description ..... 9.5-33

9.5.2.3 Safety Evaluation ..... 9.5-37

9.5.2.4 Inspection and Testing Requirements ..... 9.5-37

9.5.2.5 COL Information ..... 9.5-37

9.5.2.6 References..... 9.5-38

9.5.3 Lighting System..... 9.5-38

9.5.3.1 Safety (10 CFR 50.2) Design Bases ..... 9.5-38

9.5.3.2 Power Generation Design Bases..... 9.5-39

9.5.3.3 System Description ..... 9.5-39

9.5.3.4 Safety Evaluation ..... 9.5-42

9.5.3.5 Tests and Inspections ..... 9.5-43

9.5.3.6 COL Information ..... 9.5-43

9.5.3.7 References..... 9.5-43

9.5.4 Diesel Generator Fuel Oil Storage and Transfer System..... 9.5-43

9.5.4.1 Design Bases..... 9.5-43

9.5.4.2 System Description ..... 9.5-45

9.5.4.3 Safety Evaluation ..... 9.5-48

9.5.4.4 Tests and Inspections ..... 9.5-48

9.5.4.5 Instrumentation Requirements ..... 9.5-49

9.5.4.6 COL Information ..... 9.5-49

9.5.4.7 References ..... 9.5-49

9.5.5 Diesel Generator Jacket Cooling Water System ..... 9.5-49

    9.5.5.1 Design Bases ..... 9.5-49

    9.5.5.2 System Description ..... 9.5-50

    9.5.5.3 Safety Evaluation ..... 9.5-51

    9.5.5.4 Tests and Inspection ..... 9.5-51

    9.5.5.5 Instrumentation Requirements ..... 9.5-51

    9.5.5.6 COL Information ..... 9.5-51

    9.5.5.7 References ..... 9.5-52

9.5.6 Diesel Generator Starting Air System ..... 9.5-52

    9.5.6.1 Design Bases ..... 9.5-52

    9.5.6.2 System Description ..... 9.5-52

    9.5.6.3 Safety Evaluation ..... 9.5-53

    9.5.6.4 Tests and Inspection ..... 9.5-53

    9.5.6.5 Instrumentation Requirements ..... 9.5-54

    9.5.6.6 COL Information ..... 9.5-54

    9.5.6.7 References ..... 9.5-54

9.5.7 Diesel Generator Lubrication System ..... 9.5-54

    9.5.7.1 Design Bases ..... 9.5-54

    9.5.7.2 System Description ..... 9.5-55

    9.5.7.3 Safety Evaluation ..... 9.5-55

    9.5.7.4 Tests and Inspection ..... 9.5-56

    9.5.7.5 Instrumentation Requirements ..... 9.5-56

    9.5.7.6 COL Information ..... 9.5-56

    9.5.7.7 References ..... 9.5-56

9.5.8 Diesel Generator Combustion Air Intake and Exhaust System ..... 9.5-56

    9.5.8.1 Design Bases ..... 9.5-56

    9.5.8.2 System Description ..... 9.5-57

    9.5.8.3 Safety Evaluation ..... 9.5-58

    9.5.8.4 Inspection and Testing Requirements ..... 9.5-58

    9.5.8.5 Instrumentation Requirements ..... 9.5-58

    9.5.8.6 COL Information ..... 9.5-58

    9.5.8.7 References ..... 9.5-58



9A. Fire Hazards Analysis .....	9A.1-1
9A.1 Introduction .....	9A.1-1
9A.2 Analysis Criteria .....	9A.2-1
9A.2.1 Codes and Standards .....	9A.2-1
9A.2.2 Fire Area Separation and Fire Equipment Drawings .....	9A.2-1
9A.2.3 Terminology .....	9A.2-1
9A.2.4 Acceptance Criteria .....	9A.2-3
9A.2.5 Systems Required to Achieve Safe Shutdown in the Event of Fire .....	9A.2-6
9A.2.6 Redundant Nonsafety-Related Systems and Equipment .....	9A.2-7
9A.3 Analysis Approach .....	9A.3-1
9A.3.1 Review Data .....	9A.3-1
9A.3.2 Steam Tunnel Barrier Exception .....	9A.3-2
9A.3.3 Exceptions to Separation Criteria .....	9A.3-2
9A.3.4 Exceptions to Penetration Requirements .....	9A.3-2
9A.3.5 Wall Deviations .....	9A.3-3
9A.3.6 Door Deviations .....	9A.3-3
9A.3.7 Basemats .....	9A.3-3
9A.3.8 Smoke Removal .....	9A.3-4
9A.4 Fire Hazard and Safe Shutdown Analysis Summary .....	9A.4-1
9A.4.1 Reactor Building .....	9A.4-1
9A.4.2 Fuel Building .....	9A.4-3
9A.4.3 Control Building .....	9A.4-4
9A.4.4 Turbine Building .....	9A.4-5
9A.4.5 Radwaste Building .....	9A.4-7
9A.4.6 Electrical Building .....	9A.4-8
9A.4.7 Yard .....	9A.4-9
9A.4.8 Service Building .....	9A.4-11
9A.4.9 Service Water/Water Treatment Building .....	9A.4-13
9A.4.10 Ancillary Diesel Building .....	9A.4-13
9A.4.11 Fire Pump Enclosure .....	9A.4-15
9A.5 Fire Protection Analyses by Room or Fire Zone .....	9A.5-1
9A.5.1 Reactor Building .....	9A.5-2
9A.5.2 Fuel Building .....	9A.5-2
9A.5.3 Control Building .....	9A.5-2
9A.5.4 Turbine Building .....	9A.5-2
9A.5.5 Radwaste Building .....	9A.5-2
9A.5.6 Electrical Building .....	9A.5-2
9A.5.7 Yard .....	9A.5-2
9A.5.8 Service Building .....	9A.5-2
9A.5.9 Service Water/Water Treatment Building .....	9A.5-3
9A.5.10 Ancillary Diesel Building .....	9A.5-3
9A.5.11 Fire Pump Enclosure .....	9A.5-3
9A.6 Special Cases .....	9A.6-1
9A.6.1 Piping Penetrations, Reactor Building .....	9A.6-1

9A.6.2 Fire Door Deviations..... 9A.6-1  
9A.6.3 Pipe Break Analyses ..... 9A.6-1  
9A.6.4 Fire Separation for Divisional Electrical Systems ..... 9A.6-1  
9A.6.5 Comparison to BTP SBLP 9.5-1 and Regulatory Guide 1.189 ..... 9A.6-8  
9A.6.6 Comparison to International Building Code ..... 9A.6-14  
9A.7 COL Information..... 9A.7-1

9B.1 Introduction ..... 2

9B.2 Fire Containment System ..... 2

9B.3 Fire Types ..... 2

9B.4 Fire Barriers..... 3

9B.5 Allowable Combustible Loading ..... 3

    9B.5.1 Permanent Loading ..... 3

    9B.5.2 Transient Combustibles ..... 6

    9B.5.3 Cable Trays ..... 7

9B.6 References ..... 10

10. Steam and Power Conversion System	10.1-1
10.1 Summary Description	10.1-1
10.1.1 Protective Features	10.1-2
10.1.2 COL Information	10.1-3
10.1.3 References	10.1-3
10.2 Turbine Generator	10.2-1
10.2.1 Design Bases	10.2-1
10.2.2 Description	10.2-2
10.2.3 Turbine Integrity	10.2-10
10.2.4 Evaluation	10.2-16
10.2.5 COL Information	10.2-17
10.2.6 References	10.2-17
10.3 Turbine Main Steam System	10.3-1
10.3.1 Design Bases	10.3-1
10.3.2 Description	10.3-3
10.3.3 Evaluation	10.3-4
10.3.4 Inspection and Testing Requirements	10.3-4
10.3.5 Water Chemistry (PWR)	10.3-4
10.3.6 Steam and Feedwater System Materials	10.3-5
10.3.7 COL Information	10.3-6
10.3.8 References	10.3-6
10.4 Other Features of Steam and Power Conversion System	10.4-1
10.4.1 Main Condenser	10.4-1
10.4.2 Main Condenser Evacuation System (MCES)	10.4-5
10.4.3 Turbine Gland Seal System	10.4-8
10.4.4 Turbine Bypass System	10.4-10
10.4.5 Circulating Water System	10.4-13
10.4.6 Condensate Purification System	10.4-16
10.4.7 Condensate and Feedwater System	10.4-20
10.4.8 Steam Generator Blowdown System (PWR)	10.4-27
10.4.9 Auxiliary Feedwater System (PWR)	10.4-27
10.4.10 COL Information	10.4-27
10.4.11 References	10.4-27

11. Radioactive Waste Management.....	11.1-1
11.1 Source Terms .....	11.1-1
11.1.1 Fission Products.....	11.1-1
11.1.2 Activation Products.....	11.1-3
11.1.3 Radionuclide Concentration Adjustment.....	11.1-4
11.1.4 Fuel Fission Production Inventory.....	11.1-5
11.1.5 Process Leakage Sources .....	11.1-5
11.1.6 COL Information .....	11.1-6
11.1.7 References.....	11.1-6
11.2 Liquid Waste Management System .....	11.2-1
11.2.1 Design Bases.....	11.2-1
11.2.2 System Description .....	11.2-2
11.2.2.1 Summary Description .....	11.2-2
11.2.2.2 System Operation.....	11.2-3
11.2.2.3 Detailed System Component Description.....	11.2-5
11.2.3 Safety Evaluation - Radioactive Releases.....	11.2-8
11.2.3.1 Safety Evaluation.....	11.2-8
11.2.3.2 Radioactive Releases .....	11.2-8
11.2.3.3 Dilution Factors .....	11.2-9
11.2.4 Testing and Inspection Requirements .....	11.2-9
11.2.5 Instrumentation Requirements.....	11.2-9
11.2.6 COL Information .....	11.2-9
11.2.7 References.....	11.2-10
11.3 Gaseous Waste Management System .....	11.3-1
11.3.1 Design Bases.....	11.3-1
11.3.2 Offgas System Description .....	11.3-2
11.3.2.1 Process Functions.....	11.3-2
11.3.2.2 Process Equipment.....	11.3-3
11.3.2.3 Process Facility.....	11.3-3
11.3.2.4 Releases.....	11.3-3
11.3.2.5 Process Design.....	11.3-4
11.3.2.6 Component Design.....	11.3-8
11.3.2.7 Seismic Design.....	11.3-11
11.3.3 Ventilation System.....	11.3-11
11.3.4 Radioactive Releases .....	11.3-12
11.3.5 Testing and Inspection Requirements.....	11.3-12
11.3.6 Instrumentation Requirements.....	11.3-12
11.3.7 Radioactive OffGas System Leak or Failure .....	11.3-13
11.3.7.1 Basis and Assumptions .....	11.3-13
11.3.7.2 Results.....	11.3-14
11.3.8 COL Information .....	11.3-14
11.3.9 References.....	11.3-14
11.4 Solid Waste Management System .....	11.4-1
11.4.1 SWMS Design Bases .....	11.4-1

11.4.2 System Description .....	11.4-3
11.4.2.1 Summary Description .....	11.4-3
11.4.2.2 System Operation.....	11.4-3
11.4.2.3 Detailed System Component Description.....	11.4-6
11.4.3 Safety Evaluation .....	11.4-8
11.4.4 Testing and Inspection Requirements .....	11.4-8
11.4.5 Instrumentation Requirements .....	11.4-8
11.4.6 COL Information .....	11.4-8
11.4.7 References.....	11.4-9
11.5 Process Radiation Monitoring System.....	11.5-1
11.5.1 Design Bases.....	11.5-1
11.5.1.1 Design Objectives.....	11.5-1
11.5.2 System Design Bases and Criteria.....	11.5-2
11.5.2.1 Radiation Monitors Required for Safety.....	11.5-3
11.5.2.2 Radiation Monitors Required for Plant Operation.....	11.5-4
11.5.3 Subsystem Description.....	11.5-4
11.5.3.1 Radiation Monitors Required for Safety.....	11.5-4
11.5.3.2 Radiation Monitors Required for Plant Operation.....	11.5-10
11.5.4 Regulatory Evaluation .....	11.5-19
11.5.4.1 Basis for Monitor Location Selection.....	11.5-19
11.5.4.2 Expected Radiation Levels .....	11.5-19
11.5.4.3 Instrumentation .....	11.5-19
11.5.4.4 Setpoints.....	11.5-20
11.5.4.5 Offsite Dose Calculation Manual.....	11.5-20
11.5.4.6 Process and Effluent Monitoring Program .....	11.5-20
11.5.4.7 Sensitivity or Subsystem Lower Limit of Detection.....	11.5-20
11.5.4.8 Site Specific Offsite Dose Calculation .....	11.5-21
11.5.4.9 Instrument Sensitivities.....	11.5-21
11.5.5 Process Monitoring and Sampling.....	11.5-21
11.5.5.1 Implementation of General Design Criterion 19 .....	11.5-21
11.5.5.2 Implementation of General Design Criterion 60 .....	11.5-21
11.5.5.3 Implementation of General Design Criterion 63 .....	11.5-21
11.5.5.4 Implementation of General Design Criterion 64 .....	11.5-22
11.5.5.5 Basis for Monitor Location Selection.....	11.5-23
11.5.5.6 Expected Radiation Levels .....	11.5-23
11.5.5.7 Instrumentation .....	11.5-23
11.5.5.8 Setpoints.....	11.5-23
11.5.5.9 Process and Post-Accident Sampling Programs – Regulatory Compliance.....	11.5-23
11.5.6 Calibration and Maintenance .....	11.5-23
11.5.6.1 Inspection and Tests.....	11.5-23
11.5.6.2 Calibration.....	11.5-25
11.5.6.3 Maintenance.....	11.5-25
11.5.6.4 IE Bulletin 80-10 Evaluation .....	11.5-25
11.5.6.5 Implementation of 10 CFR 20.1406 .....	11.5-26
11.5.7 COL Information .....	11.5-26
11.5.8 References.....	11.5-27

12. Radiation Protection.....	12.1-1
12.1 Ensuring That Occupational Radiation Exposures Are ALARA .....	12.1-1
12.1.1 Policy Considerations .....	12.1-1
12.1.1.1 Design and Construction Policies .....	12.1-1
12.1.1.2 Operational Policies .....	12.1-1
12.1.1.3 Compliance with 10 CFR 20 and Regulatory Guides 8.8, 8.10 and 1.8.....	12.1-1
12.1.1.3.1 Compliance with Regulatory Guide 8.8.....	12.1-1
12.1.1.3.2 Compliance with Regulatory Guide 8.10.....	12.1-1
12.1.1.3.3 Compliance with Regulatory Guide 1.8.....	12.1-2
12.1.2 Design Considerations .....	12.1-2
12.1.2.1 General Design Consideration for ALARA Exposures .....	12.1-2
12.1.2.2 Equipment Design Considerations for ALARA Exposures.....	12.1-3
12.1.2.2.1 General Design Criteria .....	12.1-3
12.1.2.2.2 Equipment Design Considerations to Limit Time Spent in Radiation Areas.....	12.1-3
12.1.2.2.3 Equipment Design Considerations to Limit Component Radiation Levels .....	12.1-3
12.1.2.3 Facility Layout General Design Considerations for Maintaining Radiation Exposures ALARA .....	12.1-3
12.1.2.3.1 Minimizing Personnel Time Spent in Radiation Areas .....	12.1-3
12.1.2.3.2 Minimizing Radiation Levels in Plant Access Areas and Vicinity of Equipment .....	12.1-4
12.1.3 Operational Considerations.....	12.1-5
12.1.4 COL Information .....	12.1-5
12.1.5 References.....	12.1-5
12.2 Plant Sources.....	12.2-1
12.2.1 Contained Sources .....	12.2-1
12.2.1.1 Primary Containment Source Terms.....	12.2-1
12.2.1.1.1 Reactor Vessel Core Sources .....	12.2-1
12.2.1.1.2 Other Radioactive Sources.....	12.2-2
12.2.1.2 Reactor Building and Fuel Building Source Terms.....	12.2-3
12.2.1.2.1 Other Sources.....	12.2-3
12.2.1.3 Turbine Building Source Terms.....	12.2-4
12.2.1.4 Radwaste Building Source Terms.....	12.2-5
12.2.1.5 Other Contained Sources .....	12.2-6
12.2.2 Airborne and Liquid Sources for Environmental Consideration .....	12.2-6
12.2.2.1 Airborne Releases Offsite.....	12.2-6
12.2.2.2 Airborne Dose Evaluation Offsite .....	12.2-7
12.2.2.3 Liquid Releases Offsite.....	12.2-7
12.2.2.4 Liquid Doses Offsite.....	12.2-7
12.2.3 Airborne Sources Onsite .....	12.2-8
12.2.3.1 Calculation of Airborne Radionuclides .....	12.2-8
12.2.3.2 Reactor Building .....	12.2-8
12.2.3.2.1 Airborne Sources During Normal Operation.....	12.2-8
12.2.3.2.2 Airborne Sources During Refueling .....	12.2-9

12.2.3.3 Fuel Building .....	12.2-9
12.2.3.4 Turbine Building .....	12.2-10
12.2.3.5 Radwaste Building .....	12.2-10
12.2.4 COL Information .....	12.2-11
12.2.5 References .....	12.2-11
12.3 Radiation Protection .....	12.3-1
12.3.1 Facility Design Features .....	12.3-1
12.3.1.1 Equipment Design for Maintaining Exposure ALARA .....	12.3-1
12.3.1.1.1 Pumps .....	12.3-2
12.3.1.1.2 Instrumentation .....	12.3-2
12.3.1.1.3 Heat Exchangers .....	12.3-2
12.3.1.1.4 Valves .....	12.3-3
12.3.1.1.5 Piping .....	12.3-3
12.3.1.1.6 Lighting .....	12.3-3
12.3.1.1.7 Floor Drains .....	12.3-3
12.3.1.1.8 Ventilation .....	12.3-4
12.3.1.2 Plant Design for Maintaining Exposure ALARA .....	12.3-4
12.3.1.2.1 Penetrations .....	12.3-4
12.3.1.2.2 Sample Stations .....	12.3-5
12.3.1.2.3 HVAC Systems .....	12.3-5
12.3.1.2.4 Piping .....	12.3-5
12.3.1.2.5 Equipment Layout .....	12.3-6
12.3.1.2.6 Contamination Control .....	12.3-6
12.3.1.3 Radiation Zoning .....	12.3-8
12.3.1.4 Implementation of ALARA .....	12.3-9
12.3.1.4.1 Reactor Water Cleanup / Shutdown Cooling System .....	12.3-9
12.3.1.4.2 Fuel and Auxiliary Pools Cooling System .....	12.3-9
12.3.1.4.3 Main Steam System .....	12.3-10
12.3.1.4.4 Inclined Fuel Transfer System (IFTS) .....	12.3-10
12.3.1.4.5 Radwaste Building Structure .....	12.3-11
12.3.2 Shielding .....	12.3-12
12.3.2.1 General Design Guides .....	12.3-12
12.3.2.2 Design Description .....	12.3-13
12.3.2.2.1 General Design Guides .....	12.3-13
12.3.2.2.2 Method of Shielding Design .....	12.3-14
12.3.2.2.3 Plant Shielding Description .....	12.3-15
12.3.3 Ventilation .....	12.3-16
12.3.3.1 Design Objectives .....	12.3-16
12.3.3.2 Design Description .....	12.3-17
12.3.3.2.1 Control Room Ventilation .....	12.3-17
12.3.3.2.2 Containment .....	12.3-17
12.3.3.2.3 Reactor Building .....	12.3-17
12.3.3.2.4 Radwaste Building .....	12.3-18
12.3.3.2.5 Fuel Building .....	12.3-18
12.3.3.3 Accident Conditions .....	12.3-19
12.3.4 Area Radiation and Airborne Radioactivity Monitoring Instrumentation .....	12.3-19



12.3.4.1 ARM System Description .....	12.3-20
12.3.4.2 ARM Detector Location and Sensitivity .....	12.3-21
12.3.4.3 Pertinent Design Parameters and Requirements .....	12.3-21
12.3.5 Post-Accident Access Requirements .....	12.3-22
12.3.6 Post-Accident Radiation Zone Maps and Mission Doses .....	12.3-23
12.3.7 COL Information .....	12.3-23
12.3.8 References .....	12.3-24
12.4 Dose Assessment .....	12.4-1
12.4.1 Reactor Operations and Surveillance .....	12.4-2
12.4.2 Routine Maintenance .....	12.4-3
12.4.3 Waste Processing .....	12.4-4
12.4.4 Refueling Operations .....	12.4-5
12.4.5 Inservice Inspection .....	12.4-6
12.4.6 Special Maintenance .....	12.4-7
12.4.7 Overall Plant Doses .....	12.4-11
12.4.8 COL Information .....	12.4-11
12.4.9 References .....	12.4-11
12.5 Operational Radiation Protection Program .....	12.5-20
12.5.1 Objectives .....	12.5-20
12.5.2 Equipment, Instrumentation, and Facilities .....	12.5-20
12.5.3 Operational Considerations .....	12.5-20
12.5.4 COL Information .....	12.5-20
12.5.5 References .....	12.5-21
12.6 Minimization of Contamination and radwaste generation .....	12.6-1
12.6.1 Minimization of Contamination to Facilitate Decommissioning .....	12.6-1
12.6.2 Minimization of Radioactive Waste Generation .....	12.6-2
12.6.3 COL Information .....	12.6-3
12.6.4 References .....	12.6-3
12A.1 Evaluation Parameters .....	12A-1
12A.2 Example Calculation .....	12A-2
12A.3 COL Information .....	12A-3
12A.4 References .....	12A-3
12B.1 Reactor Building Releases .....	12B-1
12B.2 Turbine Building Releases .....	12B-1
12B.3 Radwaste Building Releases .....	12B-2
12B.4 Mechanical Vacuum Pump Releases .....	12B-2
12B.5 Turbine Seal Releases .....	12B-2
12B.6 Offgas System Releases .....	12B-2
12B.7 Drywell Releases .....	12B-3

13.1 Organizational Structure Of Applicant .....	13.1-1
13.1.1 COL Information .....	13.1-1
13.1.2 References.....	13.1-1
13.2 Training.....	13.2-1
13.2.1 Reactor Operator Training .....	13.2-1
13.2.2 Training for Non-Licensed Plant Staff .....	13.2-1
13.2.3 Incorporation of Operating Experience .....	13.2-1
13.2.4 Training Requirements for Preoperational and Low-Power Testing.....	13.2-1
13.2.5 COL Information .....	13.2-1
13.2.6 References.....	13.2-2
13.3 Emergency Planning.....	13.3-1
13.3.1 Preliminary Planning .....	13.3-2
13.3.2 Emergency Plan .....	13.3-2
13.3.3 COL Information .....	13.3-2
13.3.4 References.....	13.3-2
13.4 Operational Program Implementation.....	13.4-1
13.4.1 COL Information .....	13.4-1
13.4.2 References.....	13.4-1
13.5 Plant Procedures.....	13.5-1
13.5.1 Administrative Procedures.....	13.5-1
13.5.2 Operating and Maintenance Procedures .....	13.5-1
13.5.3 COL Information .....	13.5-3
13.5.4 References.....	13.5-4
13.6 Physical Security.....	13.6-1
13.6.1 Preliminary Planning .....	13.6-1
13.6.1.1 Site Physical Security .....	13.6-1
13.6.2 Security Plan .....	13.6-4
13.6.3 COL Information .....	13.6-5
13.6.4 References.....	13.6-6

14. Initial Test Program .....	14.1-1
14.1 Initial Test Program For Preliminary Safety Analysis Reports .....	14.1-1
14.2 Initial Plant Test Program For Final Safety Analysis Reports.....	14.2-2
14.2.1 Summary of Test Program and Objectives .....	14.2-2
14.2.1.1 Construction Test Objectives.....	14.2-2
14.2.1.2 Preoperational Test Objectives .....	14.2-2
14.2.1.3 Startup Test Objectives.....	14.2-3
14.2.1.4 Organization and Staffing.....	14.2-3
14.2.2 Startup Admin Manual/Test Procedures/Program/Results/Reports.....	14.2-5
14.2.2.1 Startup Administrative Manual.....	14.2-5
14.2.2.2 Test Procedures.....	14.2-6
14.2.2.3 Conduct of Test Program.....	14.2-6
14.2.2.4 Review, Evaluation, and Approval of Test Results .....	14.2-7
14.2.2.5 Test Records.....	14.2-7
14.2.3 Test Program's Conformance with Regulatory Guides.....	14.2-7
14.2.4 Utilization of Reactor Operating and Testing Experience in the Development of Test Program.....	14.2-8
14.2.5 Use of Plant Operating and Emergency Procedures .....	14.2-8
14.2.6 Initial Fuel Loading and Initial Criticality .....	14.2-8
14.2.7 Test Program Schedule and Sequence .....	14.2-10
14.2.8 Individual Test Descriptions.....	14.2-11
14.2.8.1 Preoperational Test Procedures.....	14.2-11
14.2.8.1.1 Nuclear Boiler System Preoperational Test.....	14.2-11
14.2.8.1.2 Feedwater Control System Preoperational Test.....	14.2-12
14.2.8.1.3 Standby Liquid Control System Preoperational Test.....	14.2-14
14.2.8.1.4 Control Rod Drive System Preoperational Test.....	14.2-14
14.2.8.1.5 Rod Control and Information System Preoperational Test.....	14.2-16
14.2.8.1.6 Safety System Logic and Control Preoperational Test.....	14.2-16
14.2.8.1.7 DCIS System Preoperational Test .....	14.2-17
14.2.8.1.8 Leak Detection and Isolation System Preoperational Test .....	14.2-18
14.2.8.1.9 Reactor Protection System Preoperational Test.....	14.2-18
14.2.8.1.10 Neutron Monitoring System Preoperational Test .....	14.2-19
14.2.8.1.11 Plant Automation System Preoperational Test .....	14.2-20
14.2.8.1.12 Remote Shutdown System Preoperational Test.....	14.2-21
14.2.8.1.13 Reactor Water Cleanup/Shutdown Cooling System Preoperational Test .....	14.2-21
14.2.8.1.14 Fuel and Auxiliary Pools Cooling System Preoperational Test.....	14.2-22
14.2.8.1.15 Process Sampling System Preoperational Test.....	14.2-23
14.2.8.1.16 Process Radiation Monitoring System Preoperational Test.....	14.2-24
14.2.8.1.17 Area Radiation Monitoring System Preoperational Test.....	14.2-25
14.2.8.1.18 Containment Monitoring System Preoperational Test.....	14.2-25
14.2.8.1.19 Instrument Air and Service Air Systems Preoperational Tests.....	14.2-26
14.2.8.1.20 High Pressure Nitrogen Supply System Preoperational Test .....	14.2-27
14.2.8.1.21 Reactor Component Cooling Water System Preoperational Test.....	14.2-28
14.2.8.1.22 Makeup Water System Preoperational Test.....	14.2-29

14.2.8.1.23 (Deleted ) .....	14.2-30
14.2.8.1.24 Chilled Water System Preoperational Test .....	14.2-30
14.2.8.1.25 Heating, Ventilation, and Air Conditioning Systems Preoperational Test .....	14.2-31
14.2.8.1.26 Containment Inerting System Preoperational Test .....	14.2-32
14.2.8.1.27 Containment Isolation Valve Leakage Rate Tests .....	14.2-33
14.2.8.1.28 Containment Penetration Leakage Rate Tests .....	14.2-33
14.2.8.1.29 Containment Airlock Leakage Rate Tests .....	14.2-34
14.2.8.1.30 Containment Integrated Leakage Rate Test .....	14.2-34
14.2.8.1.31 Containment Structural Integrity Test .....	14.2-35
14.2.8.1.32 Overall Suppression Pool Bypass Leakage Test.....	14.2-35
14.2.8.1.33 Containment Isolation Valve Functional and Closure Timing Tests .....	14.2-36
14.2.8.1.34 Wetwell-to-Drywell Vacuum Breaker System Preoperational Test.....	14.2-36
14.2.8.1.35 DC Power Supply System Preoperational Test .....	14.2-37
14.2.8.1.36 AC Power Distribution System Preoperational Test .....	14.2-38
14.2.8.1.37 Standby Diesel Generator & AC Power System Preoperational Test.....	14.2-39
14.2.8.1.38 Plant Communications System Preoperational Test .....	14.2-40
14.2.8.1.39 Fire Protection System Preoperational Test.....	14.2-41
14.2.8.1.40 Radioactive Liquid Drainage and Transfer Systems Preoperational Tests.....	14.2-42
14.2.8.1.41 Fuel-Handling and Reactor Servicing Equipment Preoperational Test .....	14.2-43
14.2.8.1.42 Expansion, Vibration and Dynamic Effects Preoperational Test .....	14.2-44
14.2.8.1.43 Deleted .....	14.2-45
14.2.8.1.44 Condensate and Feedwater Systems Preoperational Test.....	14.2-45
14.2.8.1.45 Condensate Purification System Preoperational Test .....	14.2-46
14.2.8.1.46 Reactor Water Chemistry Control Systems Preoperational Test.....	14.2-47
14.2.8.1.47 Condenser Air Removal System Preoperational Test.....	14.2-47
14.2.8.1.48 Offgas System Preoperational Test.....	14.2-48
14.2.8.1.49 Condensate Storage and Transfer System Preoperational Test .....	14.2-49
14.2.8.1.50 Circulating Water System Preoperational Test.....	14.2-50
14.2.8.1.51 Plant Service Water System Preoperational Test.....	14.2-51
14.2.8.1.52 Turbine Component Cooling Water System Preoperational Test.....	14.2-52
14.2.8.1.53 Main Turbine Control System Preoperational Test .....	14.2-53
14.2.8.1.54 Main Turbine Bypass System Preoperational Test.....	14.2-54
14.2.8.1.55 Steam Bypass and Pressure Control (SB&PC) System Preoperational Test .....	14.2-54
14.2.8.1.56 Heater Drain and Vent System Preoperational Test .....	14.2-55
14.2.8.1.57 Extraction Steam System Preoperational Test.....	14.2-55
14.2.8.1.58 Moisture Separator Reheater System Preoperational Test.....	14.2-56
14.2.8.1.59 Main Turbine and Auxiliaries Preoperational Test.....	14.2-57
14.2.8.1.60 Main Generator and Auxiliary Systems Preoperational Test .....	14.2-58
14.2.8.1.61 Seismic Monitoring System Preoperational Test.....	14.2-58

14.2.8.1.62	Liquid and Solid Radwaste Systems Preoperational Tests .....	14.2-59
14.2.8.1.63	Isolation Condenser System Preoperational Test .....	14.2-60
14.2.8.1.64	Passive Containment Cooling System Preoperational Test .....	14.2-60
14.2.8.1.65	Gravity-Driven Cooling System Preoperational Test .....	14.2-61
14.2.8.1.66	Deleted .....	14.2-62
14.2.8.1.67	Ancillary Diesel Generator & AC Power System Preoperational Test .....	14.2-62
14.2.8.2	General Discussion of Startup Tests .....	14.2-63
14.2.8.2.1	Chemical and Radiochemical Measurements Test .....	14.2-64
14.2.8.2.2	Radiation Measurements Test .....	14.2-65
14.2.8.2.3	Fuel Loading Test .....	14.2-66
14.2.8.2.4	Full Core Shutdown Margin Demonstration Test .....	14.2-67
14.2.8.2.5	Control Rod Drive System Performance Test .....	14.2-67
14.2.8.2.6	Neutron Monitoring System Performance Test .....	14.2-69
14.2.8.2.7	Core Performance Test .....	14.2-70
14.2.8.2.8	Nuclear Boiler Process Monitoring Test .....	14.2-70
14.2.8.2.9	System Expansion Test .....	14.2-71
14.2.8.2.10	System Vibration Test .....	14.2-74
14.2.8.2.11	Reactor Internals Vibration Test (Initial Startup Flow-Induced Vibration Testing) .....	14.2-75
14.2.8.2.12	Feedwater Control Test .....	14.2-76
14.2.8.2.13	Pressure Control Test .....	14.2-77
14.2.8.2.14	Plant Automation and Control Test .....	14.2-78
14.2.8.2.15	Feedwater System Performance Test .....	14.2-79
14.2.8.2.16	Main Steam System Performance Test .....	14.2-79
14.2.8.2.17	Reactor Water Cleanup/Shutdown Cooling System Performance Test .....	14.2-80
14.2.8.2.18	Plant Service Water System Performance Test .....	14.2-80
14.2.8.2.19	HVAC System Performance Test .....	14.2-81
14.2.8.2.20	Turbine Valve Performance Test .....	14.2-81
14.2.8.2.21	Nuclear Boiler System Isolation Test .....	14.2-82
14.2.8.2.22	SRV Performance Test .....	14.2-83
14.2.8.2.23	Loss of Feedwater Heating Test .....	14.2-83
14.2.8.2.24	Feedwater Pump Trip Test .....	14.2-84
14.2.8.2.25	Shutdown From Outside the Main Control Room Test .....	14.2-85
14.2.8.2.26	Loss of Turbine Generator and Offsite Power Test .....	14.2-86
14.2.8.2.27	Turbine Trip and Generator Load Rejection Test .....	14.2-86
14.2.8.2.28	Reactor Full Isolation Test .....	14.2-87
14.2.8.2.29	Offgas System Test .....	14.2-88
14.2.8.2.30	Deleted .....	14.2-89
14.2.8.2.31	Concrete Penetration Temperature Surveys Test .....	14.2-89
14.2.8.2.32	Liquid Radwaste System Performance Test .....	14.2-89
14.2.8.2.33	Steam and Power Conversion System Performance Test .....	14.2-90
14.2.8.2.34	Isolation Condenser Performance Test .....	14.2-90
14.2.8.2.35	ESBWR First of a Kind Tests .....	14.2-91
14.2.9	Site-Specific Preoperational and Start up Tests .....	14.2-96

14.2.9.1 Site-Specific Preoperational Tests .....	14.2-97
14.2.9.2 Site Specific Startup Tests .....	14.2-97
14.2.10 COL Information .....	14.2-97
14.2.11 References.....	14.2-97
14.3 INSPECTIONS, TESTS, ANALYSES AND ACCEPTANCE CRITERIA .....	14.3-1
14.3.1 Tier 1, Section 1 - Introduction.....	14.3-2
14.3.2 Tier 1, Section 2 - Design Descriptions and ITAACs.....	14.3-2
14.3.2.1 Design Descriptions.....	14.3-3
14.3.2.2 Inspections, Tests, Analyses and Acceptance Criteria (ITAAC).....	14.3-7
14.3.3 Tier 1, Section 3 - Non-System Based Material .....	14.3-9
14.3.3.1 Design of Piping Systems and Components .....	14.3-10
14.3.3.2 Software Development.....	14.3-11
14.3.3.3 Human Factors Engineering .....	14.3-11
14.3.3.4 Radiation Protection.....	14.3-12
14.3.3.5 Initial Test Program .....	14.3-12
14.3.3.6 Design Reliability Assurance Program.....	14.3-13
14.3.3.7 Post-Accident Monitoring Instrumentation .....	14.3-13
14.3.3.8 Environmental Qualification of Mechanical and Electrical Equipment .....	14.3-13
14.3.4 Tier 1, Section 4 - Interface Material.....	14.3-13
14.3.5 Tier 1, Section 5 - Site Parameters.....	14.3-15
14.3.6 Tier 1 Generation Summary.....	14.3-15
14.3.7 Evaluation Process For Updating Design Descriptions and ITAAC .....	14.3-16
14.3.7.1 Generic Guidance.....	14.3-16
14.3.7.2 NRC Guidance .....	14.3-17
14.3.7.3 Criteria and Application Process .....	14.3-17
14.3.8 Overall ITAAC Content For Combined License Applications.....	14.3-19
14.3.9 Site-Specific ITAAC.....	14.3-20
14.3.10 COL Information .....	14.3-20
14.3.11 References.....	14.3-21
14.3A Design Acceptance Criteria ITAAC Closure Process.....	14.3A-1
14.3A.1 Design Acceptance Criteria ITAAC Closure Options .....	14.3A-2
14.3A.2 Design Acceptance Criteria ITAAC for Piping Design.....	14.3A-2
14.3A.3 Digital Instrumentation and Control Design Acceptance Criteria I TAAC Closure .....	14.3A-3
14.3A.4 Human Factors Engineering Design Acceptance Criteria ITAAC Closure.....	14.3A-4
14.3A.5 COL Information.....	14.3A-6
14.3A.6 References.....	14.3A-6

15.0 Analytical Approach.....	15.0-1
15.0.1 Classification and Selection of Events.....	15.0-2
15.0.1.1 Approach For Determining Event Classifications .....	15.0-3
15.0.1.2 Results of Event Classification Determinations .....	15.0-4
15.0.2 Abnormal Events To Be Evaluated.....	15.0-5
15.0.3 Determination of Safety Analysis Acceptance Criteria.....	15.0-6
15.0.3.1 Anticipated Operational Occurrences .....	15.0-6
15.0.3.2 Infrequent Events .....	15.0-8
15.0.3.3 Accidents.....	15.0-8
15.0.3.4 Special Events.....	15.0-9
15.0.4 Event Analysis Format.....	15.0-11
15.0.4.1 Identification of Causes .....	15.0-11
15.0.4.2 Sequence of Events and Systems Operations .....	15.0-12
15.0.4.3 Evaluation of Results .....	15.0-12
15.0.4.4 Barrier Performance.....	15.0-12
15.0.4.5 Radiological Consequences .....	15.0-12
15.0.5 Single Failure Criterion.....	15.0-12
15.0.5.1 Single Failures as Event Initiators .....	15.0-13
15.0.5.2 Application of Single Failure Criterion to Event Analysis.....	15.0-14
15.0.6 Combined License (COL) Information.....	15.0-14
15.0.7 References.....	15.0-14
15.1 Nuclear Safety Operational Analysis.....	15.1-1
15.1.1 Analytical Approach .....	15.1-1
15.1.1.1 NSOA Objective .....	15.1-1
15.1.1.2 NSOA Relationship to Safety Analysis .....	15.1-1
15.1.2 Method of Analysis.....	15.1-1
15.1.2.1 Operational Criteria.....	15.1-1
15.1.2.2 Analysis Assumptions and Initial Conditions.....	15.1-2
15.1.2.3 Event Analysis Rules .....	15.1-2
15.1.3 NSOA Results.....	15.1-3
15.1.3.1 Event Evaluations and Diagrams .....	15.1-3
15.1.3.2 Summary Matrices .....	15.1-3
15.1.4 Event Evaluations .....	15.1-3
15.1.5 COL Information .....	15.1-3
15.1.6 References.....	15.1-3
15.2 Analysis of Anticipated Operational Occurrences.....	15.2-1
15.2.0 Assumptions.....	15.2-1
15.2.1 Decrease In Core Coolant Temperature.....	15.2-1
15.2.1.1 Loss Of Feedwater Heating .....	15.2-1
15.2.2 Increase In Reactor Pressure.....	15.2-3
15.2.2.1 Closure of One Turbine Control Valve.....	15.2-3

15.2.2.2	Generator Load Rejection With Turbine Bypass .....	15.2-5
15.2.2.3	Generator Load Rejection With a Single Failure in the Turbine Bypass System .....	15.2-6
15.2.2.4	Turbine Trip With Turbine Bypass .....	15.2-8
15.2.2.5	Turbine Trip With a Single Failure in the Turbine Bypass System .....	15.2-9
15.2.2.6	Closure of One Main Steamline Isolation Valve .....	15.2-10
15.2.2.7	Closure of All Main Steamline Isolation Valves .....	15.2-11
15.2.2.8	Loss of Condenser Vacuum .....	15.2-12
15.2.2.9	Loss of Shutdown Cooling Function of RWCU/SDC .....	15.2-14
15.2.3	Reactivity and Power Distribution Anomalies .....	15.2-14
15.2.3.1	Control Rod Withdrawal Error During Startup .....	15.2-15
15.2.3.2	Control Rod Withdrawal Error During Power Operation .....	15.2-16
15.2.4	Increase in Reactor Coolant Inventory .....	15.2-17
15.2.4.1	Inadvertent Isolation Condenser Initiation .....	15.2-17
15.2.4.2	Runout of One Feedwater Pump .....	15.2-18
15.2.5	Decrease in Reactor Coolant Inventory .....	15.2-20
15.2.5.1	Opening of One Turbine Control or Bypass Valve .....	15.2-20
15.2.5.2	Loss of Non-Emergency AC Power to Station Auxiliaries .....	15.2-21
15.2.5.3	Loss of All Feedwater Flow .....	15.2-22
15.2.6	AOO Analysis Summary .....	15.2-23
15.2.7	COL Information .....	15.2-24
15.2.8	References .....	15.2-24
15.3	Analysis Of Infrequent Events .....	15.3-1
15.3.1	Loss of Feedwater Heating With Failure of SCRR1 and SRI .....	15.3-1
15.3.1.1	Identification of Causes .....	15.3-1
15.3.1.2	Sequence of Events and Systems Operation .....	15.3-2
15.3.1.3	Core and System Performance .....	15.3-2
15.3.1.4	Barrier Performance .....	15.3-3
15.3.1.5	Radiological Consequences .....	15.3-3
15.3.2	Feedwater Controller Failure – Maximum Flow Demand .....	15.3-4
15.3.2.1	Identification of Causes .....	15.3-4
15.3.2.2	Sequence of Events and Systems Operation .....	15.3-4
15.3.2.3	Core and System Performance .....	15.3-4
15.3.2.4	Barrier Performance .....	15.3-5
15.3.2.5	Radiological Consequences .....	15.3-5
15.3.3	Pressure Regulator Failure – Opening of All Turbine Control and Bypass Valves .....	15.3-5
15.3.3.1	Identification of Causes .....	15.3-5
15.3.3.2	Sequence of Events and Systems Operation .....	15.3-5
15.3.3.3	Core and System Performance .....	15.3-6
15.3.3.4	Barrier Performance .....	15.3-7
15.3.3.5	Radiological Consequences .....	15.3-7
15.3.4	Pressure Regulator Failure – Closure of All Turbine Control and Bypass Valves .....	15.3-7



15.3.4.1 Identification of Causes ..... 15.3-7

15.3.4.2 Sequence of Events and Systems Operation ..... 15.3-7

15.3.4.3 Core and System Performance ..... 15.3-8

15.3.4.4 Barrier Performance ..... 15.3-8

15.3.4.5 Radiological Consequences ..... 15.3-8

15.3.5 Generator Load Rejection With Total Turbine Bypass Failure ..... 15.3-9

15.3.5.1 Identification of Causes ..... 15.3-9

15.3.5.2 Sequence of Events and System Operation ..... 15.3-9

15.3.5.3 Core and System Performance ..... 15.3-10

15.3.5.4 Barrier Performance ..... 15.3-10

15.3.5.5 Radiological Consequences ..... 15.3-10

15.3.6 Turbine Trip With Total Turbine Bypass Failure ..... 15.3-11

15.3.6.1 Identification of Causes ..... 15.3-11

15.3.6.2 Sequence of Events and System Operation ..... 15.3-11

15.3.6.3 Core and System Performance ..... 15.3-12

15.3.6.4 Barrier Performance ..... 15.3-12

15.3.6.5 Radiological Consequences ..... 15.3-12

15.3.7 Control Rod Withdrawal Error During Refueling ..... 15.3-12

15.3.7.1 Identification of Causes ..... 15.3-12

15.3.7.2 Sequence of Events and Systems Operation ..... 15.3-13

15.3.7.3 Core and System Performance ..... 15.3-13

15.3.7.4 Barrier Performance ..... 15.3-14

15.3.7.5 Radiological Consequences ..... 15.3-14

15.3.8 Control Rod Withdrawal Error During Startup  
With Failure of Control Rod Block ..... 15.3-14

15.3.8.1 Identification of Causes ..... 15.3-14

15.3.8.2 Sequence of Events and Systems Operation ..... 15.3-15

15.3.8.3 Core and System Performance ..... 15.3-15

15.3.8.4 Barrier Performance ..... 15.3-16

15.3.9 Control Rod Withdrawal Error During Power  
Operation with ATLM Failure ..... 15.3-16

15.3.9.1 Identification of Causes ..... 15.3-16

15.3.9.2 Sequence of Events and System Operation ..... 15.3-17

15.3.9.3 Core and System Performance ..... 15.3-18

15.3.9.4 Barrier Performance ..... 15.3-18

15.3.9.5 Radiological Consequences ..... 15.3-18

15.3.10 Fuel Assembly Loading Error, Mislocated Bundle ..... 15.3-18

15.3.10.1 Identification of Causes ..... 15.3-18

15.3.10.2 Sequence of Events and Systems Operation ..... 15.3-18

15.3.10.3 Core and System Performance ..... 15.3-18

15.3.10.4 Barrier Performance ..... 15.3-19

15.3.10.5 Radiological Consequences ..... 15.3-19

15.3.11 Fuel Assembly Loading Error, Misoriented Bundle ..... 15.3-19

15.3.11.1 Identification of Causes ..... 15.3-19

15.3.11.2 Core and Barrier Performance ..... 15.3-20

15.3.11.3 Radiological Consequences ..... 15.3-20

15.3.12 Inadvertent SDC Function Operation ..... 15.3-21

    15.3.12.1 Identification of Causes ..... 15.3-21

    15.3.12.2 Sequence of Events and Systems Operation ..... 15.3-21

    15.3.12.3 Core and System Performance ..... 15.3-21

    15.3.12.4 Barrier Performance ..... 15.3-21

    15.3.12.5 Radiological Consequences ..... 15.3-21

15.3.13 Inadvertent Opening of a Safety Relief Valve ..... 15.3-22

    15.3.13.1 Identification of Causes ..... 15.3-22

    15.3.13.2 Sequence of Events and Systems Operation ..... 15.3-22

    15.3.13.3 Core and System Performance ..... 15.3-22

    15.3.13.4 Barrier Performance ..... 15.3-22

    15.3.13.5 Radiological Consequences ..... 15.3-22

15.3.14 Inadvertent Opening of a Depressurization Valve ..... 15.3-23

    15.3.14.1 Identification of Causes ..... 15.3-23

    15.3.14.2 Systems Operation and Sequence of Events ..... 15.3-23

    15.3.14.3 Core and System Performance ..... 15.3-23

    15.3.14.4 Barrier Performance ..... 15.3-24

    15.3.14.5 Radiological Consequences ..... 15.3-24

15.3.15 Stuck Open Safety Relief Valve ..... 15.3-24

    15.3.15.1 Identification of Causes ..... 15.3-24

    15.3.15.2 Sequence of Events and Systems Operation ..... 15.3-24

    15.3.15.3 Core and System Performance ..... 15.3-25

    15.3.15.4 Barrier Performance ..... 15.3-25

    15.3.15.5 Radiological Consequences ..... 15.3-25

15.3.16 Liquid-Containing Tank Failure ..... 15.3-25

    15.3.16.1 Identification of Causes ..... 15.3-25

    15.3.16.2 Sequence of Events and Systems Operations ..... 15.3-26

    15.3.16.3 Results ..... 15.3-26

15.3.17 COL Information ..... 15.3-27

15.3.18 References ..... 15.3-27

15.4 Analysis of Accidents ..... 15.4-1

    15.4.1 Fuel Handling Accident ..... 15.4-1

        15.4.1.1 Identification of Causes ..... 15.4-1

        15.4.1.2 Sequence of Events and Systems Operation ..... 15.4-1

        15.4.1.3 Core and System Performance ..... 15.4-1

        15.4.1.4 Barrier Performance ..... 15.4-3

        15.4.1.5 Radiological Consequences ..... 15.4-3

        15.4.1.6 Results ..... 15.4-4

        15.4.1.7 Assumptions Requiring Confirmation ..... 15.4-4

    15.4.2 Loss-of-Coolant Accident Containment Analysis ..... 15.4-4

    15.4.3 Loss-of-Coolant Accident ECCS Performance Analysis ..... 15.4-4

    15.4.4 Loss-of-Coolant Accident Inside Containment Radiological Analysis ..... 15.4-4

        15.4.4.1 Identification of Causes ..... 15.4-5

15.4.4.2	Sequence of Events and Systems Operation .....	15.4-5
15.4.4.3	Core and System Performance .....	15.4-6
15.4.4.4	Barrier Performance .....	15.4-7
15.4.4.5	Radiological Consequences .....	15.4-7
15.4.4.6	Results .....	15.4-16
15.4.4.7	Assumptions Requiring Confirmation .....	15.4-17
15.4.5	Main Steamline Break Accident Outside Containment .....	15.4-17
15.4.5.1	Identification of Causes .....	15.4-17
15.4.5.2	Sequence of Events and Systems Operation .....	15.4-17
15.4.5.3	Core and System Performance .....	15.4-18
15.4.5.4	Barrier Performance .....	15.4-18
15.4.5.5	Radiological Consequences .....	15.4-19
15.4.5.6	Results .....	15.4-20
15.4.5.7	Assumptions Requiring Confirmation .....	15.4-20
15.4.6	Control Rod Drop Accident .....	15.4-20
15.4.6.1	Features of the ESBWR Fine Motion Control Rod Drives .....	15.4-20
15.4.6.2	Identification of Causes .....	15.4-21
15.4.6.3	Sequence of Events and System Operation .....	15.4-21
15.4.6.4	Core and System Performance .....	15.4-21
15.4.6.5	Barrier Performance .....	15.4-22
15.4.6.6	Radiological Consequences .....	15.4-22
15.4.7	Feedwater Line Break Outside Containment .....	15.4-22
15.4.7.1	Identification of Causes .....	15.4-22
15.4.7.2	Sequence of Events and System Operation .....	15.4-23
15.4.7.3	Core and System Performance .....	15.4-23
15.4.7.4	Barrier Performance .....	15.4-24
15.4.7.5	Radiological Consequences .....	15.4-24
15.4.7.6	Results .....	15.4-25
15.4.7.7	Assumptions Requiring Confirmation .....	15.4-26
15.4.8	Failure of Small Line Carrying Primary Coolant Outside Containment .....	15.4-26
15.4.8.1	Identification of Causes .....	15.4-26
15.4.8.2	Sequence of Events and Systems Operations .....	15.4-26
15.4.8.3	Core and System Performance .....	15.4-27
15.4.8.4	Barrier Performance .....	15.4-27
15.4.8.5	Radiological Consequences .....	15.4-28
15.4.8.6	Results .....	15.4-28
15.4.9	RWCU/SDC System Line Failure Outside Containment .....	15.4-29
15.4.9.1	Identification of Causes .....	15.4-29
15.4.9.2	Sequence of Events and Systems Operation .....	15.4-29
15.4.9.3	Core and System Performance .....	15.4-30
15.4.9.4	Barrier Performance .....	15.4-30
15.4.9.5	Radiological Consequences .....	15.4-30
15.4.9.6	Results .....	15.4-31
15.4.9.7	Assumptions Requiring Confirmation .....	15.4-32
15.4.10	Spent Fuel Cask Drop Accident .....	15.4-32

15.4.10.1 Identification of Causes .....	15.4-32
15.4.10.2 Radiological Analysis .....	15.4-32
15.4.11 COL Information .....	15.4-32
15.4.12 References.....	15.4-32
15.5 Special Event Evaluations.....	15.5-1
15.5.1 Overpressure Protection.....	15.5-1
15.5.1.1 Method of Analysis.....	15.5-1
15.5.1.2 System Design .....	15.5-1
15.5.1.3 Evaluation of Results .....	15.5-3
15.5.1.4 System Reliability.....	15.5-3
15.5.2 Shutdown Without Control Rods (Standby Liquid Control System Capability) .....	15.5-4
15.5.3 Shutdown from Outside Main Control Room.....	15.5-4
15.5.4 Anticipated Transients Without Scram.....	15.5-4
15.5.4.1 Requirements .....	15.5-4
15.5.4.2 Plant Capabilities .....	15.5-4
15.5.4.3 Performance Evaluation.....	15.5-5
15.5.4.4 Conclusion .....	15.5-12
15.5.5 Station Blackout.....	15.5-12
15.5.5.1 Acceptance Criteria.....	15.5-12
15.5.5.2 Analysis Assumptions.....	15.5-13
15.5.5.3 Analysis Results.....	15.5-14
15.5.6 Safe Shutdown Fire.....	15.5-14
15.5.6.1 Acceptance Criteria.....	15.5-15
15.5.6.2 Analysis Assumptions.....	15.5-15
15.5.6.3 Analysis Results.....	15.5-16
15.5.7 Waste Gas System Leak or Failure.....	15.5-17
15.5.8 COL Information .....	15.5-17
15.5.9 References.....	15.5-17
15A. Event Frequency Determination .....	15A-1
15A.1 Scope.....	15A-1
15A.2 Methodology .....	15A-1
15A.3 Results.....	15A-1
15A.3.1 Pressure Regulator Failure – Opening of All Turbine Control and Bypass Valves.....	15A-1
15A.3.1.1 Introduction.....	15A-1
15A.3.1.2 Analysis.....	15A-2
15A.3.1.3 Result .....	15A-2
15A.3.2 Pressure Regulator Failure – Closure of All Turbine Control and Bypass Valves.....	15A-2
15A.3.2.1 Introduction.....	15A-2
15A.3.2.2 Analysis.....	15A-2
15A.3.2.3 Result .....	15A-3

15A.3.3 Turbine Trip with Total Bypass Failure..... 15A-3

    15A.3.3.1 Introduction..... 15A-3

    15A.3.3.2 Analysis..... 15A-3

    15A.3.3.3 Result ..... 15A-4

15A.3.4 Generator Load Rejection with Total Turbine Bypass Failure ..... 15A-4

    15A.3.4.1 Introduction..... 15A-4

    15A.3.4.2 Analysis..... 15A-5

    15A.3.4.3 Result ..... 15A-6

15A.3.5 Feedwater Controller Failure ..... 15A-6

    15A.3.5.1 Feedwater Controller Failure – Maximum Flow Demand..... 15A-6

    15A.3.5.2 Feedwater Controller Failure – Minimum Temperature Demand ..... 15A-7

15A.3.6 Loss of Feedwater Heating with Failure of SCRR and SRI ..... 15A-8

    15A.3.6.1 Introduction..... 15A-8

    15A.3.6.2 Analysis..... 15A-8

    15A.3.6.3 Result ..... 15A-12

15A.3.7 Inadvertent Shutdown Cooling Function Operation ..... 15A-12

    15A.3.7.1 Introduction..... 15A-12

    15A.3.7.2 Analysis..... 15A-12

    15A.3.7.3 Result ..... 15A-14

15A.3.8 Inadvertent Opening of a Safety Relief Valve ..... 15A-14

    15A.3.8.1 Introduction..... 15A-14

    15A.3.8.2 Analysis..... 15A-14

    15A.3.8.3 Result ..... 15A-16

15A.3.9 Inadvertent Opening of a Depressurization Valve ..... 15A-16

    15A.3.9.1 Introduction..... 15A-16

    15A.3.9.2 Analysis..... 15A-18

    15A.3.9.3 Results..... 15A-20

15A.3.10 Stuck Open Safety Relief Valve ..... 15A-21

    15A.3.10.1 Introduction..... 15A-21

    15A.3.10.2 Analysis..... 15A-21

    15A.3.10.3 Result ..... 15A-22

15A.3.11 Control Rod Withdrawal Error During Refueling ..... 15A-22

    15A.3.11.1 Introduction..... 15A-22

    15A.3.11.2 Analysis..... 15A-23

    15A.3.11.3 Results..... 15A-24

15A.3.12 Control Rod Withdrawal Error During Startup With  
    Failure of Control Rod Block..... 15A-24

    15A.3.12.1 Introduction..... 15A-24

    15A.3.12.2 Analysis..... 15A-25

    15A.3.12.3 Results..... 15A-26

15A.3.13 Control Rod Withdrawal Error During Power Operation ..... 15A-27

    15A.3.13.1 Introduction..... 15A-27

    15A.3.13.2 Analysis..... 15A-27

    15A.3.13.3 Results..... 15A-28

15A.3.14 Fuel Assembly Loading Error, Mislocated Bundle..... 15A-28

    15A.3.14.1 Introduction..... 15A-28

15A.3.14.2 Analysis.....	15A-29
15A.3.14.3 Results.....	15A-29
15A.3.15 Fuel Assembly Loading Error, Misoriented Bundle.....	15A-29
15A.3.15.1 Introduction.....	15A-29
15A.3.15.2 Analysis.....	15A-29
15A.3.15.3 Results.....	15A-30
15A.3.16 Liquid-Containing Tank Failure.....	15A-30
15A.3.16.1 Introduction.....	15A-30
15A.3.16.2 Analysis.....	15A-30
15A.3.16.3 Results.....	15A-30
15A.4 Summary.....	15A-30
15A.4.1 COL Information.....	15A-30
15A.5 References.....	15A-30
15B. LOCA Inventory.....	15B-1
15B.1. COL Information.....	15B-1
15B.2. References.....	15B-1
15C. Pool pH Methodology.....	15C-1
15C.1. Source Term Discussion.....	15C-1
15C.2. NUREG/CR-5950 Assumptions and Methodology.....	15C-1
15C.2.1 Carbon Dioxide.....	15C-1
15C.2.2 Cesium Hydroxide.....	15C-1
15C.2.3 Hydriodic Acid.....	15C-2
15C.2.4 Hydrochloric Acid.....	15C-2
15C.2.5 Nitric Acid.....	15C-3
15C.2.6 Sodium Pentaborate.....	15C-3
15C.3. Pool pH Determination.....	15C-3
15C.4. pH Evaluation Results.....	15C-6
15C.5. COL Information.....	15C-6
15C.6. References.....	15C-6
15D. Effect Of Feedwater Temperature Variation.....	15D-1
15D.1. Introduction.....	15D-1
15D.2. AOO Analyses.....	15D-2
15D.3. Infrequent Events Analyses.....	15D-2
15D.4. Special Events Analyses.....	15D-2
15D.5. Other Analyses.....	15D-3
15D.6. Analyses for Reloads.....	15D-3
15D.7. References.....	15D-3

## 16.0 Technical Specifications

## 1.0 USE AND APPLICATION

1.1	Definitions.....	5.0, 05/31/08
1.2	Logical Connectors.....	2.0, 12/22/06
1.3	Completion Times.....	2.0, 12/22/06
1.4	Frequency.....	2.0, 12/22/06

## 2.0 SAFETY LIMITS (SLs) ..... 5.0, 05/31/08

2.1	SLs	
2.2	SL Violations	

## 3.0 LIMITING CONDITION FOR OPERATION (LCO) APPLICABILITY ..... 2.0, 12/22/06

## 3.0 SURVEILLANCE REQUIREMENT (SR) APPLICABILITY ..... 2.0, 12/22/06

## 3.1 REACTIVITY CONTROL SYSTEMS

3.1.1	SHUTDOWN MARGIN (SDM).....	4.0, 09/28/07
3.1.2	Reactivity Anomalies.....	2.0, 12/22/06
3.1.3	Control Rod OPERABILITY .....	5.0, 05/31/08
3.1.4	Control Rod Scram Times .....	5.0, 05/31/08
3.1.5	Control Rod Scram Accumulators .....	5.0, 05/31/08
3.1.6	Rod Pattern Control .....	5.0, 05/31/08
3.1.7	Standby Liquid Control (SLC) System.....	5.0, 05/31/08

## 3.2 POWER DISTRIBUTION LIMITS

3.2.1	LINEAR HEAT GENERATION RATE (LHGR) .....	3.0, 02/22/07
3.2.2	MINIMUM CRITICAL POWER RATIO (MCPR).....	3.0, 02/22/07

## 3.3 INSTRUMENTATION

3.3.1.1	Reactor Protection System (RPS) Instrumentation.....	5.0, 05/31/08
3.3.1.2	Reactor Protection System (RPS) Actuation .....	5.0, 05/31/08
3.3.1.3	Reactor Protection System (RPS) Manual Actuation .....	5.0, 05/31/08
3.3.1.4	Neutron Monitoring System (NMS) Instrumentation.....	5.0, 05/31/08
3.3.1.5	Neutron Monitoring System (NMS) Automatic Actuation .....	5.0, 05/31/08
3.3.1.6	Startup Range Neutron Monitor (SRNM) Instrumentation .....	5.0, 05/31/08
3.3.2.1	Control Rod Block Instrumentation.....	5.0, 05/31/08
3.3.3.1	Remote Shutdown System .....	5.0, 05/31/08
[3.3.3.2	Post-Accident Monitoring (PAM) Instrumentation.....	5.0, 05/31/08]
3.3.4.1	Reactor Coolant System (RCS) Leakage Detection Instrumentation .....	5.0, 05/31/08
3.3.5.1	Emergency Core Cooling System (ECCS) Instrumentation.....	5.0, 05/31/08
3.3.5.2	Emergency Core Cooling System (ECCS) Actuation .....	5.0, 05/31/08
3.3.5.3	Isolation Condenser System (ICS) Instrumentation .....	5.0, 05/31/08
3.3.5.4	Isolation Condenser System (ICS) Actuation .....	5.0, 05/31/08
3.3.6.1	Main Steam Isolation Valve (MSIV) Instrumentation.....	5.0, 05/31/08
3.3.6.2	Main Steam Isolation Valve (MSIV) Actuation .....	5.0, 05/31/08
3.3.6.3	Isolation Instrumentation .....	5.0, 05/31/08
3.3.6.4	Isolation Actuation.....	5.0, 05/31/08

3.3	INSTRUMENTATION (continued)	
3.3.7.1	Control Room Habitability Area (CRHA) Heating, Ventilation, and Air Conditioning (HVAC) Subsystem (CRHAVS) Instrumentation .....	5.0, 05/31/08
3.3.7.2	Control Room Habitability Area (CRHA) Heating, Ventilation, and Air Conditioning (HVAC) Subsystem (CRHAVS) Actuation .....	5.0, 05/31/08
3.3.8.1	Diverse Protection System (DPS) .....	5.0, 05/31/08
3.4	REACTOR COOLANT SYSTEM (RCS)	
3.4.1	Safety Relief Valves (SRVs) .....	5.0, 05/31/08
3.4.2	RCS Operational LEAKAGE .....	2.0, 12/22/06
3.4.3	RCS Specific Activity .....	5.0, 05/31/08
3.4.4	RCS Pressure and Temperature (P/T) Limits .....	5.0, 05/31/08
3.4.5	Reactor Steam Dome Pressure .....	5.0, 05/31/08
3.5	EMERGENCY CORE COOLING SYSTEMS (ECCS)	
3.5.1	Automatic Depressurization System (ADS) - Operating .....	5.0, 05/31/08
3.5.2	Gravity-Driven Cooling System (GDCCS) - Operating .....	5.0, 05/31/08
3.5.3	Gravity-Driven Cooling System (GDCCS) - Shutdown .....	5.0, 05/31/08
3.5.4	Isolation Condenser System (ICS) - Operating .....	5.0, 05/31/08
3.5.5	Isolation Condenser System (ICS) - Shutdown .....	5.0, 05/31/08
3.6	CONTAINMENT SYSTEMS	
3.6.1.1	Containment .....	5.0, 05/31/08
3.6.1.2	Containment Air Lock .....	5.0, 05/31/08
3.6.1.3	Containment Isolation Valves (CIVs) .....	5.0, 05/31/08
3.6.1.4	Drywell Pressure .....	5.0, 05/31/08
3.6.1.5	Drywell Air Temperature .....	5.0, 05/31/08
3.6.1.6	Wetwell-to-Drywell Vacuum Breakers .....	5.0, 05/31/08
3.6.1.7	Passive Containment Cooling System (PCCS) .....	4.0, 09/28/07
3.6.1.8	Containment Oxygen Concentration .....	5.0, 05/31/08
3.6.2.1	Suppression Pool Average Temperature .....	5.0, 05/31/08
3.6.2.2	Suppression Pool Water Level .....	5.0, 05/31/08
3.6.3.1	Reactor Building (Contaminated Area Ventilation Subsystem (CONAVS) Area) .....	5.0, 05/31/08
3.7	PLANT SYSTEMS	
3.7.1	Isolation Condenser (IC)/Passive Containment Cooling (PCC) Pools .....	5.0, 05/31/08
3.7.2	Control Room Habitability Area (CRHA) Heating, Ventilation, and Air Conditioning (HVAC) Subsystem (CRHAVS) .....	5.0, 05/31/08
3.7.3	Main Condenser Offgas .....	5.0, 05/31/08
3.7.4	Main Turbine Bypass System .....	3.0, 02/22/07
3.7.5	Fuel Pool Water Level .....	2.0, 12/22/06
3.7.6	Selected Control Rod Run-In (SCRRI) and Select Rod Insert (SRI) Functions .....	5.0, 05/31/08
3.8	ELECTRICAL POWER SYSTEMS	
3.8.1	DC Sources - Operating .....	5.0, 05/31/08



3.8.2	DC Sources - Shutdown.....	5.0, 05/31/08
3.8.3	Battery Parameters .....	5.0, 05/31/08
3.8.4	Inverters - Operating .....	2.0, 12/22/06
3.8.5	Inverters - Shutdown.....	3.0, 02/22/07
3.8.6	Distribution Systems - Operating.....	2.0, 12/22/06
3.8.7	Distribution Systems - Shutdown .....	3.0, 02/22/07
3.9	REFUELING OPERATIONS	
3.9.1	Refueling Equipment Interlocks .....	4.0, 09/28/07
3.9.2	Refuel Position One-Rod/Rod-Pair-Out Interlock.....	1.0, 02/28/06
3.9.3	Control Rod Position.....	1.0, 02/28/06
3.9.4	Control Rod Position Indication .....	1.0, 02/28/06
3.9.5	Control Rod OPERABILITY - Refueling .....	5.0, 05/31/08
3.9.6	Reactor Pressure Vessel (RPV) Water Level.....	2.0, 12/22/06
3.9.7	Decay Time.....	1.0, 02/28/06
3.10	SPECIAL OPERATIONS	
3.10.1	Inservice Leak and Hydrostatic Testing Operation .....	5.0, 05/31/08
3.10.2	Reactor Mode Switch Interlock Testing .....	1.0, 02/28/06
3.10.3	Control Rod Withdrawal - Hot / Stable Shutdown .....	5.0, 05/31/08
3.10.4	Control Rod Withdrawal - Cold Shutdown .....	5.0, 05/31/08
3.10.5	Control Rod Drive (CRD) Removal - Refueling .....	5.0, 05/31/08
3.10.6	Multiple Control Rod Withdrawal - Refueling.....	1.0, 02/28/06
3.10.7	Control Rod Testing - Operating .....	5.0, 05/31/08
3.10.8	SHUTDOWN MARGIN (SDM) Test - Refueling.....	5.0, 05/31/08
3.10.9	Oxygen Concentration - Startup Test Program.....	5.0, 05/31/08
3.10.10	Oscillation Power Range Monitor (OPRM) - Initial Cycle .....	5.0, 05/31/08
4.0	DESIGN FEATURES.....	5.0, 05/31/08
4.1	Site Location	
4.2	Reactor Core	
4.3	Fuel Storage	
5.0	ADMINISTRATIVE CONTROLS	
5.1	Responsibility .....	3.0, 02/22/07
5.2	Organization.....	5.0, 05/31/08
5.3	Unit Staff Qualifications .....	5.0, 05/31/08
5.4	Procedures.....	5.0, 05/31/08
5.5	Programs and Manuals.....	5.0, 05/31/08
5.6	Reporting Requirements .....	5.0, 05/31/08
5.7	High Radiation Area .....	3.0, 02/22/07

## 16B Bases

B 2.0	SAFETY LIMITS (SLs)	
B 2.1.1	Reactor Core SLs .....	5.0, 05/31/08
B 2.1.2	Reactor Coolant System (RCS) Pressure SL .....	5.0, 05/31/08
B 3.0	LIMITING CONDITION FOR OPERATION (LCO)	
	APPLICABILITY .....	3.0, 02/22/07
B 3.0	SURVEILLANCE REQUIREMENT (SR) APPLICABILITY .....	3.0, 02/22/07
B 3.1	REACTIVITY CONTROL SYSTEMS	
B 3.1.1	SHUTDOWN MARGIN (SDM) .....	4.0, 09/28/07
B 3.1.2	Reactivity Anomalies .....	2.0, 12/22/06
B 3.1.3	Control Rod OPERABILITY .....	5.0, 05/31/08
B 3.1.4	Control Rod Scram Times .....	5.0, 05/31/08
B 3.1.5	Control Rod Scram Accumulators .....	5.0, 05/31/08
B 3.1.6	Rod Pattern Control .....	5.0, 05/31/08
B 3.1.7	Standby Liquid Control (SLC) System .....	5.0, 05/31/08
B 3.2	POWER DISTRIBUTION LIMITS	
B 3.2.1	LINEAR HEAT GENERATION RATE (LHGR) .....	3.0, 02/22/07
B 3.2.2	MINIMUM CRITICAL POWER RATIO (MCPR) .....	5.0, 05/31/08
B 3.3	INSTRUMENTATION	
B 3.3.1.1	Reactor Protection System (RPS) Instrumentation .....	5.0, 05/31/08
B 3.3.1.2	Reactor Protection System (RPS) Actuation .....	5.0, 05/31/08
B 3.3.1.3	Reactor Protection System (RPS) Manual Actuation .....	5.0, 05/31/08
B 3.3.1.4	Neutron Monitoring System (NMS) Instrumentation .....	5.0, 05/31/08
B 3.3.1.5	Neutron Monitoring System (NMS) Automatic Actuation .....	5.0, 05/31/08
B 3.3.1.6	Startup Range Neutron Monitor (SRNM) Instrumentation .....	5.0, 05/31/08
B 3.3.2.1	Control Rod Block Instrumentation .....	5.0, 05/31/08
B 3.3.3.1	Remote Shutdown System .....	5.0, 05/31/08
[B 3.3.3.2	Post-Accident Monitoring (PAM) Instrumentation .....	5.0, 05/31/08]
B 3.3.4.1	Reactor Coolant System (RCS) Leakage Detection	
	Instrumentation .....	5.0, 05/31/08
B 3.3.5.1	Emergency Core Cooling System (ECCS) Instrumentation .....	5.0, 05/31/08
B 3.3.5.2	Emergency Core Cooling System (ECCS) Actuation .....	5.0, 05/31/08
B 3.3.5.3	Isolation Condenser System (ICS) Instrumentation .....	5.0, 05/31/08
B 3.3.5.4	Isolation Condenser System (ICS) Actuation .....	5.0, 05/31/08
B 3.3.6.1	Main Steam Isolation Valve (MSIV) Instrumentation .....	5.0, 05/31/08
B 3.3.6.2	Main Steam Isolation Valve (MSIV) Actuation .....	5.0, 05/31/08
B 3.3.6.3	Isolation Instrumentation .....	5.0, 05/31/08
B 3.3.6.4	Isolation Actuation .....	5.0, 05/31/08
B 3.3.7.1	Control Room Habitability Area (CRHA) Heating, Ventilation, and	
	Air Conditioning (HVAC) Subsystem (CRHAVS)	
	Instrumentation .....	5.0, 05/31/08
B 3.3.7.2	Control Room Habitability Area (CRHA) Heating, Ventilation, and	
	Air Conditioning (HVAC) Subsystem (CRHAVS) Actuation .....	5.0, 05/31/08
B 3.3.8.1	Diverse Protection System (DPS) .....	5.0, 05/31/08

B 3.4	REACTOR COOLANT SYSTEM (RCS)	
B 3.4.1	Safety Relief Valves (SRVs) .....	5.0, 05/31/08
B 3.4.2	RCS Operational LEAKAGE .....	5.0, 05/31/08
B 3.4.3	RCS Specific Activity .....	5.0, 05/31/08
B 3.4.4	RCS Pressure and Temperature (P/T) Limits .....	5.0, 05/31/08
B 3.4.5	Reactor Steam Dome Pressure .....	5.0, 05/31/08
B 3.5	EMERGENCY CORE COOLING SYSTEMS (ECCS)	
B 3.5.1	Automatic Depressurization System (ADS) - Operating .....	5.0, 05/31/08
B 3.5.2	Gravity-Driven Cooling System (GDCCS) - Operating .....	5.0, 05/31/08
B 3.5.3	Gravity-Driven Cooling System (GDCCS) - Shutdown .....	5.0, 05/31/08
B 3.5.4	Isolation Condenser System (ICS) - Operating .....	5.0, 05/31/08
B 3.5.5	Isolation Condenser System (ICS) - Shutdown .....	5.0, 05/31/08
B 3.6	CONTAINMENT SYSTEMS	
B 3.6.1.1	Containment .....	5.0, 05/31/08
B 3.6.1.2	Containment Air Lock .....	5.0, 05/31/08
B 3.6.1.3	Containment Isolation Valves (CIVs) .....	5.0, 05/31/08
B 3.6.1.4	Drywell Pressure .....	5.0, 05/31/08
B 3.6.1.5	Drywell Air Temperature .....	5.0, 05/31/08
B 3.6.1.6	Wetwell-to-Drywell Vacuum Breakers .....	5.0, 05/31/08
B 3.6.1.7	Passive Containment Cooling System (PCCS) .....	5.0, 05/31/08
B 3.6.1.8	Containment Oxygen Concentration .....	5.0, 05/31/08
B 3.6.2.1	Suppression Pool Average Temperature .....	5.0, 05/31/08
B 3.6.2.2	Suppression Pool Water Level .....	5.0, 05/31/08
B 3.6.3.1	Reactor Building (Contaminated Area Ventilation Subsystem (CONAVS) Area) .....	5.0, 05/31/08
B 3.7	PLANT SYSTEMS	
B 3.7.1	Isolation Condenser (IC)/Passive Containment Cooling (PCC) Pools .....	5.0, 05/31/08
B 3.7.2	Control Room Habitability Area (CRHA) Heating, Ventilation, and Air Conditioning (HVAC) Subsystem (CRHAVS) .....	5.0, 05/31/08
B 3.7.3	Main Condenser Offgas .....	5.0, 05/31/08
B 3.7.4	Main Turbine Bypass System .....	5.0, 05/31/08
B 3.7.5	Fuel Pool Water Level .....	4.0, 09/28/07
B 3.7.6	Selected Control Rod Run-In (SCRRI) and Select Rod Insert (SRI) Functions .....	5.0, 05/31/08
B 3.8	ELECTRICAL POWER	
B 3.8.1	DC Sources - Operating .....	5.0, 05/31/08
B 3.8.2	DC Sources - Shutdown .....	5.0, 05/31/08
B 3.8.3	Battery Parameters .....	5.0, 05/31/08
B 3.8.4	Inverters - Operating .....	5.0, 05/31/08
B 3.8.5	Inverters - Shutdown .....	3.0, 02/22/07
B 3.8.6	Distribution Systems - Operating .....	5.0, 05/31/08
B 3.8.7	Distribution Systems - Shutdown .....	4.0, 09/28/07

B 3.9	REFUELING OPERATIONS	
B 3.9.1	Refueling Equipment Interlocks .....	5.0, 05/31/08
B 3.9.2	Refuel Position One-Rod/Rod-Pair-Out Interlock.....	5.0, 05/31/08
B 3.9.3	Control Rod Position.....	1.0, 02/28/06
B 3.9.4	Control Rod Position Indication .....	5.0, 05/31/08
B 3.9.5	Control Rod OPERABILITY - Refueling .....	5.0, 05/31/08
B 3.9.6	Reactor Pressure Vessel (RPV) Water Level.....	5.0, 05/31/08
B 3.9.7	Decay Time.....	5.0, 05/31/08
B 3.10	SPECIAL OPERATIONS	
B 3.10.1	Inservice Leak and Hydrostatic Testing Operation .....	5.0, 05/31/08
B 3.10.2	Reactor Mode Switch Interlock Testing .....	4.0, 09/28/07
B 3.10.3	Control Rod Withdrawal - Hot / Stable Shutdown.....	5.0, 05/31/08
B 3.10.4	Control Rod Withdrawal - Cold Shutdown .....	5.0, 05/31/08
B 3.10.5	Control Rod Drive (CRD) Removal Refueling .....	5.0, 05/31/08
B 3.10.6	Multiple Control Rod Withdrawal - Refueling.....	1.0, 02/28/06
B 3.10.7	Control Rod Testing - Operating .....	5.0, 05/31/08
B 3.10.8	SHUTDOWN MARGIN (SDM) Test - Refueling.....	5.0, 05/31/08
B 3.10.9	Oxygen Concentration - Startup Test Program.....	5.0, 05/31/08
B 3.10.10	Oscillation Power Range Monitor (OPRM) - Initial Cycle .....	5.0, 05/31/08

17. Quality Assurance..... 17.0-1

    17.0 Introduction..... 17.0-1

        17.0.1 COL Information ..... 17.0-2

        17.0.2 References..... 17.0-2

    17.1 Quality Assurance During Design ..... 17.1-1

        17.1.1 Organization..... 17.1-1

        17.1.2 Quality Assurance Program ..... 17.1-1

        17.1.3 Design Control and Verification ..... 17.1-1

        17.1.4 Procurement Document Control ..... 17.1-1

        17.1.5 Instructions, Procedures, and Drawings..... 17.1-1

        17.1.6 Document Control..... 17.1-1

        17.1.7 Control of Purchased Material, Equipment, and Services ..... 17.1-2

        17.1.8 Identification and Control of Materials, Parts, and Components..... 17.1-2

        17.1.9 Control of Special Processes..... 17.1-2

        17.1.10 Inspection..... 17.1-2

        17.1.11 Test Control ..... 17.1-2

        17.1.12 Control of Measuring and Test Equipment..... 17.1-2

        17.1.13 Handling, Storage and Shipping ..... 17.1-2

        17.1.14 Inspection, Test, and Operating Status..... 17.1-2

        17.1.15 Nonconforming Materials, Parts, or Components ..... 17.1-2

        17.1.16 Corrective Action..... 17.1-3

        17.1.17 Quality Assurance Records..... 17.1-3

        17.1.18 Audits..... 17.1-3

        17.1.19 Training and Qualification Criteria – Quality Assurance ..... 17.1-3

        17.1.20 Training and Qualification – Inspection and Test..... 17.1-3

        17.1.21 QA Program Commitments ..... 17.1-3

        17.1.22 Nonsafety-Related SSC Quality Controls..... 17.1-3

        17.1.23 Independent Review..... 17.1-3

        17.1.24 COL Information ..... 17.1-3

        17.1.25 References..... 17.1-4

    17.2 Quality Assurance During Construction and Operations..... 17.2-1

        17.2.1 COL Information ..... 17.2-1

        17.2.2 References..... 17.2-1

    17.3 Quality Assurance Program Description ..... 17.3-1

        17.3.1 COL Information ..... 17.3-1

        17.3.2 References..... 17.3-1

    17.4 Reliability Assurance Program During Design Phase ..... 17.4-1

        17.4.1 Introduction..... 17.4-1

        17.4.2 Scope..... 17.4-2

        17.4.3 Purpose..... 17.4-2

        17.4.4 Objective ..... 17.4-2

        17.4.5 GEH Organization for D-RAP ..... 17.4-3

        17.4.6 SSC Identification/Prioritization..... 17.4-4

        17.4.7 Design Considerations ..... 17.4-4

17.4.8 Defining Failure Modes ..... 17.4-5

17.4.9 Operational Reliability Assurance Activities..... 17.4-5

17.4.10 Owner/Operator's Reliability Assurance Program..... 17.4-6

17.4.11 D-RAP Implementation – Example Case ..... 17.4-7

    17.4.11.1 System Description ..... 17.4-7

    17.4.11.2 Identifying Risk Information ..... 17.4-8

    17.4.11.3 Failure Mode Identification ..... 17.4-8

    17.4.11.4 Identification of Maintenance Requirements..... 17.4-9

17.4.12 Glossary of Terms ..... 17.4-9

17.4.13 COL Information ..... 17.4-9

17.4.14 References..... 17.4-10

18. Human Factors Engineering .....	18.1-1
18.1 Overview .....	18.1-1
18.1.1 Design Goals and Design Bases .....	18.1-4
18.1.2 Planning, Development, and Design .....	18.1-5
18.1.2.1 Standard Design Features .....	18.1-5
18.1.2.2 Inventory of Controls and Instrumentation .....	18.1-6
18.1.2.3 Detailed Design Implementation Process .....	18.1-6
18.1.3 Control Room Standard Design Features .....	18.1-6
18.1.4 Remote Shutdown System .....	18.1-6
18.1.5 Systems Integration .....	18.1-6
18.1.5.1 Safety-Related Systems .....	18.1-6
18.1.5.2 Nonsafety-Related Systems .....	18.1-7
18.1.6 Detailed Design of the Operator Interface System .....	18.1-7
18.1.7 COL Information .....	18.1-8
18.1.8 References .....	18.1-8
18.2 MMIS and HFE Program Management .....	18.2-1
18.2.1 HFE Program and MMIS and HFE Implementation Plan .....	18.2-1
18.2.2 MMIS and HFE Implementation Plan .....	18.2-1
18.2.3 HFE Design Team Composition .....	18.2-4
18.2.4 COL Information .....	18.2-6
18.2.5 References .....	18.2-6
18.3 Operating Experience Review .....	18.3-1
18.3.1 Objectives and Scope of OER .....	18.3-1
18.3.2 Operating Experience Review Methodology .....	18.3-1
18.3.2.1 Predecessor Plants and Systems .....	18.3-2
18.3.2.2 Risk-Important Human Actions .....	18.3-2
18.3.2.3 HFE Technology .....	18.3-2
18.3.2.4 Recognized Industry Issues .....	18.3-2
18.3.2.5 Issues Identified by Plant Personnel .....	18.3-3
18.3.2.6 Issue Analysis, Tracking, and Review .....	18.3-3
18.3.3 Results of OER .....	18.3-3
18.3.4 COL Information .....	18.3-3
18.3.5 References .....	18.3-4
18.4 Functional Requirements Analysis and Allocation of Functions .....	18.4-1
18.4.1 Functional Requirements Analysis Implementation Plan .....	18.4-1
18.4.1.1 Scope of FRA .....	18.4-1
18.4.1.2 Methods of FRA .....	18.4-1
18.4.1.3 Results of FRA .....	18.4-2
18.4.2 Allocation of Functions Implementation Plan .....	18.4-2
18.4.2.1 Scope of AOF .....	18.4-2
18.4.2.2 Methods of AOF .....	18.4-2
18.4.2.3 Results of AOF .....	18.4-3
18.4.3 COL Information .....	18.4-3
18.4.4 References .....	18.4-3

- 18.5 Task Analysis..... 18.5-1
  - 18.5.1 Task Analysis Implementation Plan ..... 18.5-1
    - 18.5.1.1 Scope of TA ..... 18.5-1
    - 18.5.1.2 Methods of TA ..... 18.5-1
    - 18.5.1.3 Results of TA ..... 18.5-2
  - 18.5.2 COL Information ..... 18.5-2
  - 18.5.3 References..... 18.5-2
- 18.6 Staffing and Qualifications ..... 18.6-1
  - 18.6.1 Background ..... 18.6-1
  - 18.6.2 Objectives and Scope of Staffing and Qualifications Analyses..... 18.6-1
  - 18.6.3 ESBWR Baseline Staffing Assumptions ..... 18.6-1
  - 18.6.4 Staffing and Qualifications Plan ..... 18.6-1
    - 18.6.4.1 Operating Experience Review ..... 18.6-1
    - 18.6.4.2 Functional Requirements Analysis and Function Allocation ..... 18.6-2
    - 18.6.4.3 Task Analysis..... 18.6-2
    - 18.6.4.4 Human Reliability Analysis..... 18.6-2
    - 18.6.4.5 Human-System Interface Design ..... 18.6-3
    - 18.6.4.6 Procedure Development..... 18.6-3
    - 18.6.4.7 Training Program Development ..... 18.6-3
  - 18.6.5 Methodology of Staffing and Qualifications Analyses..... 18.6-3
  - 18.6.6 Results of Staffing and Qualifications Analyses ..... 18.6-3
  - 18.6.7 COL Information ..... 18.6-3
  - 18.6.8 References..... 18.6-4
- 18.7 Human Reliability Analysis..... 18.7-1
  - 18.7.1 Objectives and Scope of Human Reliability Analysis ..... 18.7-1
  - 18.7.2 Methodology of Human Reliability Analysis ..... 18.7-1
  - 18.7.3 Results of Human Reliability Analysis..... 18.7-2
  - 18.7.4 COL Information ..... 18.7-2
  - 18.7.5 References..... 18.7-2
- 18.8 Human-System Interface Design ..... 18.8-1
  - 18.8.1 HSI Design Implementation Plan ..... 18.8-1
  - 18.8.2 Results of HSI Design..... 18.8-2
  - 18.8.3 COL Information ..... 18.8-2
  - 18.8.4 References..... 18.8-2
- 18.9 Procedure Development..... 18.9-1
  - 18.9.1 Objectives and Scope of Procedure Development..... 18.9-1
  - 18.9.2 Methodology of Procedure Development..... 18.9-2
  - 18.9.3 Results of Procedure Development..... 18.9-2
  - 18.9.4 COL Information ..... 18.9-2
  - 18.9.5 References..... 18.9-3
- 18.10 Training Program Development ..... 18.10-1
  - 18.10.1 Purpose..... 18.10-1
  - 18.10.2 Scope of Training Program Development ..... 18.10-1
  - 18.10.3 Methodology of Training Program Development..... 18.10-1
  - 18.10.4 Elements for Training Program Development..... 18.10-2



18.10.4.1 General Approach ..... 18.10-2

18.10.4.2 Organization of Training ..... 18.10-3

18.10.4.3 Learning Objectives ..... 18.10-3

18.10.4.4 Content of Training Program ..... 18.10-4

18.10.4.5 Evaluation and Modification of Training ..... 18.10-4

18.10.4.6 Periodic Retraining ..... 18.10-5

18.10.5 Results of Training Program Development ..... 18.10-5

18.10.6 COL Information ..... 18.10-5

18.10.7 References ..... 18.10-5

18.11 Human Factors Verification and Validation ..... 18.11-1

18.11.1 Human Factors Verification and Validation Implementation ..... 18.11-1

18.11.2 Results of HFE V&V ..... 18.11-2

18.11.3 COL Information ..... 18.11-2

18.11.4 References ..... 18.11-2

18.12 Design Implementation ..... 18.12-1

18.12.1 Objectives and Scope of Design Implementation ..... 18.12-1

18.12.2 Methodology of Design Implementation ..... 18.12-1

18.12.2.1 HSI Verification (As-Built) ..... 18.12-1

18.12.2.2 Procedures and Training Confirmation (As-Built) ..... 18.12-2

18.12.2.3 Final HFE Design Verification Not Performed in the Simulated  
HFE V&V Activity ..... 18.12-2

18.12.2.4 Resolution of Remaining HEDs and Open Issues and Transfer of  
HFEITS ..... 18.12-2

18.12.3 Results of Design Implementation ..... 18.12-2

18.12.4 COL Information ..... 18.12-2

18.12.5 References ..... 18.12-2

18.13 Human Performance Monitoring ..... 18.13-1

18.13.1 Purpose ..... 18.13-1

18.13.2 Human Performance Monitoring Strategy Development ..... 18.13-1

18.13.3 Elements of Human Performance Monitoring Process ..... 18.13-2

18.13.4 Results of Human Performance Monitoring ..... 18.13-3

18.13.5 COL Information ..... 18.13-3

18.13.6 References ..... 18.13-3

19.1	INTRODUCTION	19.1-1
19.1.1	Regulatory Requirements for PRA and Severe Accidents	19.1-1
19.1.2	Objectives	19.1-2
19.1.3	Report Structure	19.1-3
19.1.4	COL Information	19.1-4
19.1.5	References	19.1-4
19.2	PRA RESULTS AND INSIGHTS	19.2-1
19.2.1	Introduction	19.2-1
19.2.2	Uses of PRA	19.2-2
19.2.2.1	Design Phase	19.2-2
19.2.2.2	COL Application Phase	19.2-4
19.2.2.3	Construction Phase	19.2-4
19.2.2.4	Operational Phase	19.2-5
19.2.3	Evaluation of Full Power Operations	19.2-5
19.2.3.1	Risk from Internal Events	19.2-5
19.2.3.2	Risk from External Events Evaluation of External Event Fire	19.2-12
19.2.4	Evaluation of Other Modes of Operation – Shutdown	19.2-16
19.2.4.1	Significant Core Damage Sequences During Shutdown Mode	19.2-16
19.2.4.2	Significant Large Release Sequences of Shutdown Mode	19.2-18
19.2.4.3	Significant Offsite Consequences of Shutdown Mode	19.2-18
19.2.4.4	Summary of Important Results and Insights of Shutdown Mode	19.2-18
19.2.5	Summary of Overall Plant Risk Results and Insights	19.2-19
19.2.6	COL Information	19.2-19
19.2.7	References	19.2-19
19.3	SEVERE ACCIDENT EVALUATIONS	19.3-1
19.3.1	Severe Accident Preventive Features	19.3-1
19.3.1.1	Anticipated Transients Without Scram (ATWS)	19.3-1
19.3.1.2	Mid-Loop Operation	19.3-1
19.3.1.3	Station Blackout	19.3-1
19.3.1.4	Fire Protection	19.3-2
19.3.1.5	Intersystem Loss-of-Coolant Accident	19.3-2
19.3.1.6	Fire Water Addition System	19.3-2
19.3.1.7	Vessel Depressurization	19.3-2
19.3.1.8	Isolation Condenser System	19.3-2
19.3.2	Severe Accident Mitigative Features	19.3-3
19.3.2.1	Hydrogen Generation and Control	19.3-3
19.3.2.2	Core Debris Coolability	19.3-5
19.3.2.3	High-Pressure Core Melt Ejection	19.3-5
19.3.2.4	Containment Performance	19.3-5
19.3.2.5	GDCS Deluge Subsystem	19.3-7
19.3.2.6	Basemat Internal Melt Arrest and Coolability Device (BiMAC)	19.3-7
19.3.2.7	Containment Isolation	19.3-8
19.3.3	Containment Vent Penetration	19.3-8
19.3.4	Equipment Survivability Analysis	19.3-9
19.3.4.1	Functional Requirements During Severe Accident	19.3-9

19.3.4.2	Equipment Required for Severe Accident Mitigation	19.3-10
19.3.4.3	Severe Accident Environment	19.3-12
19.3.4.4	Equipment Capability	19.3-13
19.3.4.5	Summary	19.3-13
19.3.5	Improvements in Reliability of Core and Containment Heat Removal Systems	19.3-14
19.3.5.1	Core Heat Removal System Reliability Improvements	19.3-14
19.3.5.2	Containment Heat Removal System Reliability Improvements	19.3-14
19.3.6	COL Information	19.3-14
19.3.7	References	19.3-14
19.4	PRA MAINTENANCE	19.4-1
19.4.1	PRA Design Controls	19.4-1
19.4.2	PRA Maintenance and Update Program	19.4-1
19.4.3	Description of Significant Plant, Operational, and Modeling Changes	19.4-3
19.4.3.1	Design Phase Changes	19.4-3
19.4.3.2	COL Application Phase Changes	19.4-3
19.4.3.3	Construction Phase Changes	19.4-3
19.4.3.4	Operational Update Phase Changes	19.4-3
19.4.4	COL Information	19.4-3
19.4.5	References	19.4-3
19.5	CONCLUSIONS	19.5-1
19.5.1	COL Information	19.5-1
19.5.2	References	19.5-1
APPENDIX A REGULATORY TREATMENT OF NON-SAFETY SYSTEMS		
19A.1	Introduction	19A-1
19A.2	Criterion A: Beyond Design Basis Events Assessment	19A-3
19A.2.1	ATWS Assessment	19A-3
19A.2.2	Station Blackout Assessment	19A-4
19A.3	Criterion B: Long-Term Safety Assessment	19A-4
19A.3.1	Actions Required Beyond 72 Hours	19A-4
19A.3.1.1	Core Cooling	19A-5
19A.3.1.2	Containment Integrity	19A-6
19A.3.1.3	Control Room Habitability	19A-7
19A.3.1.4	Post-Accident Monitoring	19A-8
19A.3.2	Seismic Assessment	19A-9
19A.3.3	Summary of RTNSS Findings for Criterion B	19A-9
19A.4	Criterion C: PRA Mitigating Systems Assessment	19A-9
19A.4.1	Focused PRA Sensitivity Study	19A-10
19A.4.2	Assessment of Uncertainties	19A-12
19A.4.3	PRA Initiating Events Assessment	19A-13
19A.4.3.1	At-Power Generic Transients	19A-13
19A.4.3.2	At-Power Inadvertent Opening of a Relief Valve	19A-13
19A.4.3.3	At-Power Transient with Loss of Feedwater	19A-13
19A.4.3.4	At-Power Loss of Preferred Power	19A-14
19A.4.3.5	At-Power LOCA	19A-14
19A.4.3.6	Shutdown Loss of Preferred Power	19A-15

19A.4.3.7	Loss of Shutdown Cooling	19A-15
19A.4.3.8	Shutdown LOCA	19A-15
19A.4.4	Summary of RTNSS Candidates from Criterion C	19A-16
19A.5	Criterion D: Containment Performance Assessment	19A-16
19A.6	Criterion E: Assessment Of Significant Adverse Interactions	19A-16
19A.6.1	Systematic Approach	19A-17
19A.6.1.1	Gravity Driven Cooling System	19A-17
19A.6.1.2	Automatic Depressurization System (ADS)	19A-19
19A.6.1.3	Isolation Condenser System (ICS)	19A-19
19A.6.1.4	Standby Liquid Control System (SLC)	19A-21
19A.6.1.5	Passive Containment Cooling System (PCCS)	19A-21
19A.6.2	Further Assessment of Potential Adverse System Interactions	19A-22
19A.6.2.1	Assessment of Potential Adverse Functional Interactions	19A-22
19A.6.2.2	Assessment of Potential Adverse Spatial Interactions	19A-22
19A.6.2.3	Assessment of Potential Adverse Operator Interface	19A-23
19A.6.2.4	Conclusion	19A-23
19A.7	Selection Of Important NonSafety-Related Systems	19A-24
19A.8	Proposed Regulatory Oversight	19A-25
19A.8.1	Regulatory Oversight – Availability Controls	19A-25
19A.8.2	Reliability Assurance	19A-25
19A.8.3	Augmented Design Standards	19A-25
19A.8.4	Regulatory Treatment	19A-28
19A.8.4.1	Nonsafety-Related ATWS Actuation Logic	19A-28
19A.8.4.2	FPS Pool Cooling Makeup	19A-28
19A.8.4.3	Diverse Protection System	19A-29
19A.8.4.4	Post-Accident Monitoring	19A-29
19A.8.4.5	Basemat Internal Melt Arrest and Coolability System and GDCS Deluge Lines	19A-30
19A.8.4.6	Nonsafety-Related Distributed Control and Information System	19A-30
19A.8.4.7	Fuel and Auxiliary Pools Cooling System	19A-31
19A.8.4.8	AC Power System	19A-31
19A.8.4.9	Component Cooling – HVAC, Cooling Water, Chilled Water, and Plant Service Water	19A-31
19A.8.4.10	Long-Term Containment Integrity	19A-32
19A.8.4.11	Reactor Building HVAC Purge Exhaust Filters	19A-32
19A.8.4.12	Lower Drywell Hatches	19A-32
19A.8.5	COL Information	19A-33
19A.8.6	References	19A-33
	ACM AVAILABILITY CONTROLS MANUAL	19ACM-i
	APPENDIX B DETERMINISTIC ANALYSIS FOR CONTAINMENT PRESSURE CAPABILITY	
19B.1	INTRODUCTION	19B-1
19B.2	RCCV AND LINERS	19B-2
19B.3	DRYWELL HEAD	19B-6
19B.4	HATCHES AND AIRLOCKS	19B-9
19B.5	PENETRATIONS	19B-10

19B.6	PCCS HEAT EXCHANGERS	19B-11
19B.7	SUMMARY	19B-12
19B.8	REFERENCES	19B-13
APPENDIX C PROBABILISTIC ANALYSIS FOR CONTAINMENT PRESSURE FRAGILITY		
19C.1	INTRODUCTION	19C-1
19C.2	RCCV LINERS	19C-7
19C.3	DRYWELL HEAD	19C-10
19C.4	EQUIPMENT HATCHES	19C-12
19C.5	PRESSURE FRAGILITY SUMMARY	19C-15
19C.6	REFERENCES	19C-16

### List of Tables

Table 1.3-1	Comparison of Reactor System Design Characteristics.....	1.3-2
Table 1.3-2	Comparison of Emergency Core Cooling Systems and Safety-Related Containment Cooling Systems .....	1.3-9
Table 1.3-3	Comparison of Containment Design Characteristics .....	1.3-11
Table 1.3-4	Comparison of Structural Design Characteristics .....	1.3-13
Table 1.4-1	Commercial Nuclear Reactors Completed and Under Construction By GE/GEH .....	1.4-2
Table 1.5-1	Evolution of the GE/GEH BWR .....	1.5-10
Table 1.5-2	ESBWR Features and Related Experience.....	1.5-11
Table 1.6-1	Referenced GE / GEH Reports.....	1.6-2
Table 1.6-2	Referenced non-GE / GEH Topical Reports .....	1.6-16
Table 1.7-1	Piping Designations and Specifications for DCD Drawings.....	1.7-3
Table 1.7-2	Summary of Electrical/I&C System Configuration Drawings.....	1.7-7
Table 1.7-3	Summary of Mechanical System Configuration Drawings.....	1.7-9
Table 1.8-1	Matrix of NSSS Interfaces.....	1.8-3
Table 1.8-2	Matrix of BOP Interfaces .....	1.8-5
Table 1.9-1	Summary of Differences from SRP Section 1.....	1.9-2
Table 1.9-2	Summary of Differences from SRP Section 2.....	1.9-3
Table 1.9-3	Summary of Differences from SRP Section 3.....	1.9-4
Table 1.9-4	Summary of Differences from SRP Section 4.....	1.9-6
Table 1.9-5	Summary of Differences from SRP Section 5.....	1.9-7
Table 1.9-6	Summary of Differences from SRP Section 6.....	1.9-8
Table 1.9-7	Summary of Differences from SRP Section 7.....	1.9-11
Table 1.9-8	Summary of Differences from SRP Section 8.....	1.9-14
Table 1.9-9	Summary of Differences from SRP Section 9.....	1.9-18
Table 1.9-10	Summary of Differences from SRP Section 10.....	1.9-26
Table 1.9-11	Summary of Differences from SRP Section 11.....	1.9-30
Table 1.9-12	Summary of Differences from SRP Section 12.....	1.9-31
Table 1.9-13	Summary of Differences from SRP Section 13.....	1.9-32
Table 1.9-14	Summary of Differences from SRP Section 14.....	1.9-33
Table 1.9-15	Summary of Differences from SRP Section 15.....	1.9-34
Table 1.9-16	Summary of Differences from SRP Section 16.....	1.9-37
Table 1.9-17	Summary of Differences from SRP Section 17.....	1.9-38
Table 1.9-18	Summary of Differences from SRP Section 18.....	1.9-39
Table 1.9-19	Summary of Differences from SRP Section 19.....	1.9-40

Table 1.9-20 NRC Standard Review Plans and Branch Technical Positions Applicability to ESBWR.....	1.9-41
Table 1.9-21 NRC Regulatory Guides Applicability to ESBWR.....	1.9-66
Table 1.9-21a EPRI Intent and Optimization Topics.....	1.9-92
Table 1.9-21b ESBWR Compliance with Quality Related Regulatory Guides.....	1.9-95
Table 1.9-22 Industrial Codes and Standards Applicable to ESBWR.....	1.9-97
Table 1.9-23 NUREGs Referenced in ESBWR DCD .....	1.9-127
Table 1.10-1 Summary of COL Items .....	1.10-2
Table 1.11-1 Resolutions To NUREG-0933 Table II Task Action Plan Items, New Generic Issues, Human Factors Issues and Chernobyl Issues .....	1.11-2

Table 1A-1 TMI Action Plan Items .....	1A-2
Table 1B-1 Radiation Source Comparison .....	1B-9
Table 1B-2 Post-Accident Emergency Core Cooling Systems and Auxiliaries .....	1B-10
Table 1B-3 Post-Accident Containment Systems and Auxiliaries .....	1B-11
Table 1B-4 Post-Accident Fission Product Removal and Control Systems and Auxiliaries.....	1B-12
Table 1B-5 Post-Accident Instrumentation and Controls, Power and Habitability Systems and Auxiliaries.....	1B-13
Table 1C-1 Operating Experience Review Results Summary – Generic Letters .....	1C-2
Table 1C-2 Operating Experience Review Results Summary – IE Bulletins.....	1C-14



Table 2.0-1 Envelope of ESBWR Standard Plant Site Parameters ..... 2.0-4

Table 2.0-2 Limits Imposed on Acceptance Criteria in Section II of SRP by  
ESBWR Design ..... 2.0-12

Table 2A-1 ARCON96 Assumed Inputs Used for the Determination of On-Site  
X/Q Values..... 2A-4

Table 2A-2 Onsite Receptor/Source Locations ..... 2A-5

Table 2A-3 ARCON96 Design Inputs Used for the Determination of On-Site  
X/Q Values..... 2A-6

Table 2A-4 ARCON96 Direction Design Inputs Used for the Determination of  
On-Site X/Q Values ..... 2A-10

Table 3.2-1	Classification Summary.....	3.2-9
Table 3.2-2	Minimum Safety Class Requirements.....	3.2-44
Table 3.2-3	Quality Group Designations – Codes and Industry Standards.....	3.2-45
Table 3.4-1	Structures, Penetrations and Access Openings Designed for Flood Protection.....	3.4-9
Table 3.5-1	Requirement for the Probability of Missile Generation for ESBWR Standard Plant.....	3.5-12
Table 3.6-1	Safety-Related Systems, Components, and Equipment for Postulated Pipe Failures Inside Containment.....	3.6-25
Table 3.6-2	Safety-Related Systems, Components, and Equipment for Postulated Pipe Failures Outside Containment.....	3.6-26
Table 3.6-3	High and Moderate Energy Piping Inside Containment.....	3.6-27
Table 3.6-4	High and Moderate Energy Piping Outside Containment.....	3.6-28
Table 3.7-1	Damping Values for SSE Dynamic Analysis.....	3.7-34
Table 3.7-2	5%-Damped Target Spectra of Single Envelope Design Ground Motion at Foundation Level.....	3.7-35
Table 3.7-3	Summary of Methods of Seismic Analysis for Primary Building Structures.....	3.7-36
Table 3.8-1	Key Dimensions of Concrete Containment.....	3.8-45
Table 3.8-2	Load Combinations, Load Factors and Acceptance Criteria for the Reinforced Concrete Containment*1,*2,*3,*7.....	3.8-46
Table 3.8-3	Major Allowable Stresses in Concrete and Reinforcing Steel.....	3.8-48
Table 3.8-4	Load Combination, Load Factors and Acceptance Criteria for Steel Containment Components of the RCCV (1), (2), (3).....	3.8-49
Table 3.8-5	Welding Activities and Weld Examination Requirements for Containment Vessel.....	3.8-50
Table 3.8-6	Codes, Standards, Specifications, and Regulations Used in the Design and Construction of Seismic Category I Internal Structures of the Containment.....	3.8-51
Table 3.8-7	Load Combination, Load Factors and Acceptance Criteria for Steel Structures Inside the Containment*1,*2.....	3.8-53
Table 3.8-8	Key Dimensions of RB, CB, FB, RW and FWSC.....	3.8-54
Table 3.8-9	Codes, Standards, Specifications, and Regulatory Guides Used in the Design and Construction of Seismic Category I Structures.....	3.8-55
Table 3.8-10	Temperatures During Operating Conditions (RB).....	3.8-58
Table 3.8-11	Temperatures During Operating Conditions (CB).....	3.8-58
Table 3.8-12	Temperatures During Operating Conditions (FB).....	3.8-59
Table 3.8-13	Key Dimensions of Foundations.....	3.8-59
Table 3.8-14	Load Combinations and Factor of Safety for Foundation Design.....	3.8-60
Table 3.8-15	Load Combinations, Load Factors and Acceptance Criteria for the Safety-Related Reinforced Concrete Structures*1,*2,*3.....	3.8-61

Table 3.8-16 Load Combinations, Load Factors and Acceptance Criteria for the  
Safety-Related Steel Structures\*1,\*2,\*3..... 3.8-62

Table 3.8-17 PCCS Passages Through RCCV Top Slab..... 3.8-63

Table 3.8-18 Temperatures During Operating Conditions (FWSC)..... 3.8-64

Table 3.9-1 Plant Events .....	3.9-60
Table 3.9-2 Load Combinations and Acceptance Criteria for Safety-Related, ASME Code Class 1, 2 and 3 Components, Component Supports, and Class CS Structures.....	3.9-62
Table 3.9-3 Pressure Differentials Across Reactor Vessel Internals .....	3.9-66
Table 3.9-4 Deformation Limit for Safety Class Reactor Internal Structures Only .....	3.9-67
Table 3.9-5 Primary Stress Limit for Safety Class Reactor Internal Structures Only .....	3.9-68
Table 3.9-6 Buckling Stability Limit for Safety Class Reactor Internal Structures Only .....	3.9-70
Table 3.9-7 Fatigue Limit for Safety Class Reactor Internal Structures Only.....	3.9-71
Table 3.9-8 Inservice Testing .....	3.9-72
Table 3.9-9 Load Combinations and Acceptance Criteria for Class 1 Piping Systems.....	3.9-108
Table 3.9-10 Snubber Loads.....	3.9-109
Table 3.9-11 Strut Loads.....	3.9-110
Table 3.9-12 Linear Type (Anchor and Guide) Main Steam Piping Support.....	3.9-111
Table 3.11-1 Electrical and Mechanical Equipment for Environmental Qualification .....	3.11-16

Table 3A.2-1 Standard ESBWR Building Dimensions .....	3A-3
Table 3A.3-1 Generic Site Properties for SSI Analysis.....	3A-5
Table 3A.3-2 North Anna Site-specific Properties for SSI Analysis.....	3A-5
Table 3A.3-3 Layered Site Cases.....	3A-6
Table 3A.5-1 Soil Spring and Damping Coefficient for RB/FB complex.....	3A-9
Table 3A.5-2 Soil Spring and Damping Coefficient for CB .....	3A-10
Table 3A.5-3 Soil Spring and Damping Coefficient for FWSC.....	3A-11
Table 3A.6-1 Seismic SSI Analysis Cases .....	3A-14
Table 3A.7-1 Eigenvalue Analysis Results for RB/FB model at Soft Site.....	3A-19
Table 3A.7-2 Eigenvalue Analysis Results for RB/FB model at Medium Site.....	3A-20
Table 3A.7-3 Eigenvalue Analysis Results for RB/FB model at Hard Site .....	3A-21
Table 3A.7-4 Eigenvalue Analysis Results for RB/FB model in Fixed-base Case.....	3A-22
Table 3A.7-5 Eigenvalue Analysis Results for RB/FB model at Best-estimate North Anna Site .....	3A-23
Table 3A.7-6 Eigenvalue Analysis Results for RB/FB model at Upper-bound North Anna Site .....	3A-24
Table 3A.7-7 Eigenvalue Analysis Results for RB/FB model at Lower-bound North Anna Site .....	3A-25
Table 3A.7-8 Eigenvalue Analysis Results for CB Model at Soft Site .....	3A-26
Table 3A.7-9 Eigenvalue Analysis Results for CB Model at Medium Site .....	3A-27
Table 3A.7-10 Eigenvalue Analysis Results for CB Model at Hard Site.....	3A-28
Table 3A.7-11 Eigenvalue Analysis Results for CB Model in Fixed-base Case.....	3A-29
Table 3A.7-12 Eigenvalue Analysis Results for CB Model at Best-estimate North Anna Site .....	3A-30
Table 3A.7-13 Eigenvalue Analysis Results for CB Model at Upper-bound North Anna Site .....	3A-31
Table 3A.7-14 Eigenvalue Analysis Results for CB Model at Lower-bound North Anna Site .....	3A-32
Table 3A.7-15 Eigenvalue Analysis Results for FWSC Model at Soft Site.....	3A-33
Table 3A.7-16 Eigenvalue Analysis Results for FWSC Model at Medium Site.....	3A-34
Table 3A.7-17 Eigenvalue Analysis Results for FWSC Model at Hard Site .....	3A-35
Table 3A.7-18 Eigenvalue Analysis Results for FWSC Model in Fixed-base Case.....	3A-36
Table 3A.8.1-1 Maximum Forces - X Direction (RU-1 and RU-2/CU-1 and CU-2).....	3A-57
Table 3A.8.1-2 Maximum Forces - Y Direction (RU-1 and RU-2/CU-1 and CU-2).....	3A-58
Table 3A.8.1-3 Maximum Forces – X Direction (FU-1).....	3A-59
Table 3A.8.1-4 Maximum Forces – Y Direction (FU-1).....	3A-59
Table 3A.8.2-1 Maximum Forces - X Direction (RU-3/ CU-3).....	3A-60
Table 3A.8.2-2 Maximum Forces - Y Direction (RU-3/ CU-3).....	3A-61

Table 3A.8.3-1 Maximum Forces - X Direction (RU-4)..... 3A-62

Table 3A.8.3-2 Maximum Forces - Y Direction (RU-4)..... 3A-63

Table 3A.8.4-1 Maximum Forces - X Direction (RU-5)..... 3A-64

Table 3A.8.4-2 Maximum Forces - Y Direction (RU-5)..... 3A-65

Table 3A.8.4-3 Maximum Forces – X Direction (RU-5a)..... 3A-66

Table 3A.8.4-4 Maximum Forces – Y Direction (RU-5a)..... 3A-67

Table 3A.8.5-1 Maximum Forces - X Direction (RU-6)..... 3A-68

Table 3A.8.5-2 Maximum Forces - Y Direction (RU-6)..... 3A-69

Table 3A.8.7-1 Comparisons of RB/FB Basemat Reaction Shear Force ..... 3A-70

Table 3A.8.8-1 Lateral Soil Pressure – RB/FB..... 3A-70

Table 3A.8.8-2 Lateral Soil Pressure - CB ..... 3A-71

Table 3A.8.10-1 Maximum Horizontal Acceleration RB/FB Wall Out-of-plane Oscillators  
(RU-7)..... 3A-72

Table 3A.8.10-2 Maximum Horizontal Acceleration RB/FB Cracked Wall Out-of-plane  
Oscillators (RL-6) ..... 3A-73

Table 3A.9-1a Enveloping Seismic Loads: RB/FB Stick ..... 3A-180

Table 3A.9-1b Enveloping Seismic Loads: RCCV Stick ..... 3A-182

Table 3A.9-1c Enveloping Seismic Loads: VW/Pedestal Stick ..... 3A-184

Table 3A.9-1d Enveloping Seismic Loads: RSW Stick ..... 3A-186

Table 3A.9-1e Enveloping Seismic Loads: RPV Stick ..... 3A-188

Table 3A.9-1f Enveloping Seismic Loads: CB Stick ..... 3A-189

Table 3A.9-1g Enveloping Seismic Loads: FWS Stick..... 3A-190

Table 3A.9-1h Enveloping Seismic Loads: FPE Stick ..... 3A-191

Table 3A.9-2a Enveloping Seismic Loads for LOCA Flooding: RB/FB Stick..... 3A-192

Table 3A.9-2b Enveloping Seismic Loads for LOCA Flooding: RCCV Stick ..... 3A-193

Table 3A.9-2c Enveloping Seismic Loads for LOCA Flooding: VW/Pedestal Stick ..... 3A-194

Table 3A.9-2d Enveloping Seismic Loads for LOCA Flooding: RSW Stick ..... 3A-195

Table 3A.9-2e Enveloping Seismic Loads for LOCA Flooding: RPV Stick ..... 3A-196

Table 3A.9-3a Enveloping Maximum Vertical Acceleration: RB/FB..... 3A-197

Table 3A.9-3b Enveloping Maximum Vertical Acceleration: RCCV..... 3A-198

Table 3A.9-3c Enveloping Maximum Vertical Acceleration: VW/Pedestal..... 3A-199

Table 3A.9-3d Enveloping Maximum Vertical Acceleration: RSW ..... 3A-199

Table 3A.9-3e Enveloping Maximum Vertical Acceleration: RB/FB Flexible Slab  
Oscillators ..... 3A-200

Table 3A.9-3f Enveloping Maximum Horizontal Acceleration: RB/FB Wall  
Out-of-plane Oscillators..... 3A-204

Table 3A.9-3g Enveloping Maximum Vertical Acceleration: CB ..... 3A-205

Table 3A.9-3h Enveloping Maximum Vertical Acceleration: FWS ..... 3A-206

Table 3A.9-3i Enveloping Maximum Vertical Acceleration: FPE..... 3A-206

Table 3A.9-4a Enveloping Maximum Vertical Acceleration for LOCA Flooding: RB/FB .....	3A-207
Table 3A.9-4b Enveloping Maximum Vertical Acceleration for LOCA Flooding: RCCV .....	3A-207
Table 3A.9-4c Enveloping Maximum Vertical Acceleration for LOCA Flooding: VW/Pedestal .....	3A-208
Table 3A.9-4d Enveloping Maximum Vertical Acceleration for LOCA Flooding: RSW ..	3A-208
Table 3A.9-4e Enveloping Maximum Vertical Acceleration for LOCA Flooding: RB/FB Flexible Slab Oscillators .....	3A-209
Table 3D.1-1 Computer Program User Details.....	3D-12
Table 3F-1 Maximum Accelerations for Annulus Pressurization Loadings (g).....	3F-6
Table 3F-2 Maximum Accelerations for Hydrodynamic Loads (g) .....	3F-6
Table 3F-3 Maximum Displacements for Annulus Pressurization Loadings (mm) .....	3F-7
Table 3F-4 Maximum Displacements for Hydrodynamic Loads (mm) .....	3F-7

Table 3G.1-1	Soil Spring Constants for the RB Analysis Model .....	3G-20
Table 3G.1-2	Site Design Parameters .....	3G-21
Table 3G.1-3	Equipment and Hydrostatic Loads inside RCCV .....	3G-22
Table 3G.1-4	Equipment and Hydrostatic Loads in RB Pools .....	3G-23
Table 3G.1-5	Miscellaneous Structures, Piping, and Commodity Loads on RB Floor .....	3G-24
Table 3G.1-6	Equivalent Linear Temperature Distributions at Various Sections .....	3G-25
Table 3G.1-7	Pressure Loads Inside RCCV .....	3G-26
Table 3G.1-8	Pressure Loads Inside IC/PCCS Pools .....	3G-26
Table 3G.1-9	Maximum Vertical Acceleration .....	3G-27
Table 3G.1-10	Selected Load Combinations for the RCCV .....	3G-28
Table 3G.1-11	Selected Load Combinations for the RB .....	3G-28
Table 3G.1-12	Material Constants for Design Calculations .....	3G-29
Table 3G.1-13	Results of NASTRAN Analysis, Dead Load .....	3G-30
Table 3G.1-14	Results of NASTRAN Analysis, Drywell Unit Pressure (1 MPa) .....	3G-32
Table 3G.1-15	Results of NASTRAN Analysis, Wetwell Unit Pressure (1 MPa) .....	3G-34
Table 3G.1-16	Results of NASTRAN Analysis, Thermal Load (Normal Operation: Winter) .....	3G-36
Table 3G.1-17	Results of NASTRAN Analysis, Thermal Load (LOCA After 6 minutes: Winter) .....	3G-38
Table 3G.1-18	Results of NASTRAN Analysis, Thermal Load (LOCA After 72 hours: Winter) .....	3G-40
Table 3G.1-19	Results of NASTRAN Analysis, Seismic Load (Horizontal: North to South Direction) .....	3G-42
Table 3G.1-20	Results of NASTRAN Analysis, Seismic Load (Horizontal: East to West Direction) .....	3G-44
Table 3G.1-21	Results of NASTRAN Analysis, Seismic Load (Vertical: Upward Direction) .....	3G-46
Table 3G.1-22	Combined Forces and Moments: RCCV, Selected Load Combination CV-1 .....	3G-48
Table 3G.1-23	Combined Forces and Moments: RCCV, Selected Load Combination CV-7a .....	3G-50
Table 3G.1-24	Combined Forces and Moments: RCCV, Selected Load Combination CV-7b .....	3G-53
Table 3G.1-25	Combined Forces and Moments: RCCV, Selected Load Combination CV-11a .....	3G-56
Table 3G.1-26	Combined Forces and Moments: RCCV, Selected Load Combination CV-11b .....	3G-61
Table 3G.1-27	Sectional Thicknesses and Rebar Ratios of RCCV Used in the Evaluation .....	3G-66



Table 3G.1-28 Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-1.....	3G-69
Table 3G.1-29 Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-7a.....	3G-70
Table 3G.1-30 Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-7b.....	3G-71
Table 3G.1-31 Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-11a.....	3G-72
Table 3G.1-32 Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-11b.....	3G-73
Table 3G.1-33 Transverse Shear of RCCV .....	3G-74
Table 3G.1-33 Transverse Shear of RCCV .....	3G-74
Table 3G.1-34 Tangential Shear of RCCV.....	3G-75
Table 3G.1-35 Containment Liner Plate Strains (Max).....	3G-77
Table 3G.1-36 Drywell Head Elements Stress Summary.....	3G-79
Table 3G.1-37 Diaphragm Floor (D/F) Slab Elements Stress Summary.....	3G-80
Table 3G.1-38 Diaphragm Floor (D/F) Slab Anchorage Structural Capacity .....	3G-81
Table 3G.1-39 Vent Wall Structural Elements Stress Summary.....	3G-82
Table 3G.1-40 Reactor Shield Wall (RSW) Structural Element Stress Summary .....	3G-83
Table 3G.1-41 RPV Support Bracket Structural Elements Stress Summary.....	3G-84
Table 3G.1-42 Vent Wall and RPV Support Bracket Anchorage Structural Capacity .....	3G-84
Table 3G.1-43 GDCS Pool Structural Elements Stress Summary .....	3G-85
Table 3G.1-44 GDCS Pool Anchorage Structural Capacity.....	3G-86
Table 3G.1-45 Combined Forces and Moments: RB, Selected Load Combination RB-4 ....	3G-87
Table 3G.1-46 Combined Forces and Moments: RB, Selected Load Combination RB-8a ..	3G-89
Table 3G.1-47 Combined Forces and Moments: RB, Selected Load Combination RB-8b ..	3G-92
Table 3G.1-48 Combined Forces and Moments: RB, Selected Load Combination RB-9a ..	3G-95
Table 3G.1-49 Combined Forces and Moments: RB, Selected Load Combination RB-9b	3G-100
Table 3G.1-50 Sectional Thicknesses and Rebar Ratios of RB Used in the Evaluation.....	3G-105
Table 3G.1-51 Rebar and Concrete Stresses of RB: Selected Load Combination RB-4 ....	3G-108
Table 3G.1-52 Rebar and Concrete Stresses of RB: Selected Load Combination RB-8a...	3G-109
Table 3G.1-53 Rebar and Concrete Stresses of RB: Selected Load Combination RB-8b ..	3G-110
Table 3G.1-54 Rebar and Concrete Stresses of RB: Selected Load Combination RB-9a...	3G-111
Table 3G.1-55 Rebar and Concrete Stresses of RB: Selected Load Combination RB-9b ..	3G-112
Table 3G.1-56 Transverse Shear of RB.....	3G-113
Table 3G.1-57 Factors of Safety for Foundation Stability .....	3G-114
Table 3G.1-58 Maximum Soil Bearing Stress Involving SSE .....	3G-114
Table 3G.1-59 Stress Calculation Results for Basemat Uplift Analysis .....	3G-115
Table 3G.1-60 PCCS Condenser and Supports Stress Summary .....	3G-116

Table 3G.2-1	Soil Spring Constants for the CB Analysis Model .....	3G-195
Table 3G.2-2	Equipment Load of CB.....	3G-195
Table 3G.2-3	Miscellaneous Structures, Piping, and Commodity Load of CB.....	3G-195
Table 3G.2-4	Equivalent Liner Temperature Distributions at Various Sections.....	3G-196
Table 3G.2-5	Maximum Vertical Acceleration .....	3G-197
Table 3G.2-6	Selected Load Combinations for the CB .....	3G-198
Table 3G.2-7	Results of NASTRAN Analysis: Dead Load .....	3G-199
Table 3G.2-8	Results of NASTRAN Analysis: Thermal Load (LOCA: Winter).....	3G-200
Table 3G.2-9	Results of NASTRAN Analysis: Seismic Load (Horizontal: North to South Direction) .....	3G-201
Table 3G.2-10	Results of NASTRAN Analysis: Seismic Load (Horizontal: East to West Direction) .....	3G-202
Table 3G.2-11	Results of NASTRAN Analysis: Seismic Load (Vertical: Upward Direction).....	3G-203
Table 3G.2-12	Combined Forces and Moments: Selected Load Combination CB-3.....	3G-204
Table 3G.2-13	Combined Forces and Moments: Selected Load Combination CB-4.....	3G-206
Table 3G.2-14	Combined Forces and Moments: Selected Load Combination CB-7.....	3G-208
Table 3G.2-15	Combined Forces and Moments: Selected Load Combination CB-9.....	3G-210
Table 3G.2-16	Sectional Thicknesses and Rebar Ratios Used in the Evaluation.....	3G-213
Table 3G.2-17	Rebar and Concrete Stresses (Basemat and Slabs): Selected Load Combination CB-3 .....	3G-215
Table 3G.2-19	Rebar and Concrete Stresses (Basemat and Slabs): Selected Load Combination CB-4.....	3G-217
Table 3G.2-20	Rebar and Concrete Stresses (Walls): Selected Load Combination CB-4.....	3G-218
Table 3G.2-21	Rebar and Concrete Stresses (Basemat and Slabs): Selected Load Combination CB-7 .....	3G-219
Table 3G.2-22	Rebar and Concrete Stresses (Walls): Selected Load Combination CB-7 .....	3G-220
Table 3G.2-23	Rebar and Concrete Stresses (Basemat and Slabs): Selected Load Combination CB-9 .....	3G-221
Table 3G.2-24	Rebar and Concrete Stresses (Walls): Selected Load Combination CB-9 .....	3G-222
Table 3G.2-25	Calculation Results for Transverse Shear.....	3G-223
Table 3G.2-26	Factors of Safety for Foundation Stability .....	3G-224
Table 3G.2-27	Maximum Soil Bearing Stress Involving SSE .....	3G-224
Table 3G.3-1	Miscellaneous Structures and Commodity in Spent Fuel Pool .....	3G-246
Table 3G.3-2	Miscellaneous Structures, Piping, and Commodity Load on FB Floor.....	3G-247
Table 3G.3-3	Equivalent Liner Temperature Distributions at Various Sections.....	3G-247
Table 3G.3-4	Selected Load Combinations for the FB.....	3G-248

Table 3G.3-5 Results of NASTRAN Analysis: Dead Load .....	3G-249
Table 3G.3-6 Results of NASTRAN Analysis: Thermal Load (Winter).....	3G-250
Table 3G.3-7 Results of NASTRAN Analysis: Seismic Load (Horizontal: North to South Direction) .....	3G-251
Table 3G.3-8 Results of NASTRAN Analysis: Seismic Load (Horizontal: East to West Direction) .....	3G-252
Table 3G.3-9 Results of NASTRAN Analysis: Seismic Load (Vertical: Upward Direction).....	3G-253
Table 3G.3-10 Combined Forces and Moments: Selected Load Combination FB-4 .....	3G-254
Table 3G.3-11 Combined Forces and Moments: Selected Load Combination FB-8 .....	3G-255
Table 3G.3-12 Combined Forces and Moments: Selected Load Combination FB-9 .....	3G-257
Table 3G.3-13 Sectional Thicknesses and Rebar Ratios Used in the Evaluation.....	3G-259
Table 3G.3-14 Rebar and Concrete Stresses: Selected Load Combination FB-4.....	3G-261
Table 3G.3-15 Rebar and Concrete Stresses: Selected Load Combination FB-8.....	3G-262
Table 3G.3-16 Rebar and Concrete Stresses: Selected Load Combination FB-9.....	3G-263
Table 3G.3-17 Transverse Shear of FB .....	3G-264
Table 3G.4-1 Soil Spring Constants for FWSC Analysis Model .....	3G-275
Table 3G.4-2 Equipment Load of FWSC .....	3G-275
Table 3G.4-3 Miscellaneous Structures, Piping, and Commodity Load of FWSC .....	3G-275
Table 3G.4-4 Equivalent Linear Temperature Distributions at Various Sections .....	3G-276
Table 3G.4-5 Maximum Vertical Acceleration .....	3G-277
Table 3G.4-6 Selected Load Combinations for FWSC .....	3G-277
Table 3G.4-7 Results of NASTRAN Analysis: Dead Load .....	3G-278
Table 3G.4-8 Results of NASTRAN Analysis: Thermal Load (Winter).....	3G-279
Table 3G.4-9 Results of NASTRAN Analysis: Seismic Load (Horizontal: North to South Direction) .....	3G-280
Table 3G.4-10 Results of NASTRAN Analysis: Seismic Load (Horizontal: East to West Direction) .....	3G-281
Table 3G.4-11 Results of NASTRAN Analysis: Seismic Load (Vertical: Upward Direction).....	3G-282
Table 3G.4-12 Combined Forces and Moments: Selected Load Combination FWSC-3 ....	3G-283
Table 3G.4-13 Combined Forces and Moments: Selected Load Combination FWSC-4 ....	3G-284
Table 3G.4-14 Combined Forces and Moments: Selected Load Combination FWSC-6 ....	3G-285
Table 3G.4-15 Combined Forces and Moments: Selected Load Combination FWSC -7 ...	3G-287
Table 3G.4-16 Sectional Thicknesses and Rebar Ratios Used in the Evaluation.....	3G-289
Table 3G.4-17 Rebar and Concrete Stresses: Selected Load Combination FWSC-3.....	3G-291
Table 3G.4-18 Rebar and Concrete Stresses: Selected Load Combination FWSC-4.....	3G-292
Table 3G.4-19 Rebar and Concrete Stresses: Selected Load Combination FWSC-6.....	3G-293
Table 3G.4-20 Rebar and Concrete Stresses: Selected Load Combination FWSC-7.....	3G-294

Table 3G.4-21	Calculation Results for Transverse Shear.....	3G-295
Table 3G.4-22	Factors of Safety for Foundation Stability .....	3G-296
Table 3G.4-23	Maximum Soil Bearing Stress Involving SSE .....	3G-296
Table 3H-1	Cross Reference of Plant Environmental Data and Location.....	3H-6
Table 3H-2	Thermodynamic Environment Conditions Inside Containment Vessel for Normal Operating Conditions.....	3H-7
Table 3H-3	Thermodynamic Environment Conditions Inside Reactor Building for Normal Operating Conditions.....	3H-8
Table 3H-4	Thermodynamic Environment Conditions Inside Control Building for Normal Operating Conditions.....	3H-10
Table 3H-5	Radiation Environment Conditions Inside Containment Vessel for Normal Operating Conditions.....	3H-11
Table 3H-6	Typical Radiation Environmental Qualification Conditions Inside Reactor Building.....	3H-12
Table 3H-7	Typical Radiation Environmental Qualification Conditions Inside Control Building.....	3H-14
Table 3H-8	Thermodynamic Environment Conditions Inside Containment Vessel for Accident Conditions.....	3H-15
Table 3H-9	Thermodynamic Environment Conditions Inside Reactor Building for Accident Conditions.....	3H-16
Table 3H-10	Thermodynamic Environment Conditions Inside Control Building for Accident Conditions.....	3H-18
Table 3H-11	Radiation Environment Conditions Inside Containment Vessel for Accident Conditions.....	3H-19
Table 3H-12	Room Heat Loads .....	3H-20
Table 3H-13	Typical Mild Environment Parameter Limits.....	3H-22
Table 3H-14	Input Parameters, Initial Conditions and Assumptions used in Reactor Building and Control Building Heat up Analyses .....	3H-23
Table 3H-15	Analytical Room Environmental Temperatures .....	3H-24
Table 3L-1	Comparison of Typical Major Steam Dryer Configuration Parameters .....	3L-28
Table 3L-2	Specific Steam Dryer Load Definition Legend.....	3L-29
Table 3L-3	Typical Vibration Sensors.....	3L-29
Table 3L-4	Sensor Locations and Types .....	3L-30
Table 3L-5	Applicable Data Reduction Method for Comparison to Criteria .....	3L-31
Table 3L-6	Parameters Used in Spectrum Generation .....	3L-32
Table 3L-7	Data Evaluation Methods to be Used for Each Component .....	3L-32

Table 4.3-1 Equilibrium Calculated Core Effective Multiplication and Control System Worth - No Voids, 293.1 K, (68°F, 20°C) .....	4.3-13
Table 4.4-1a Typical Thermal–Hydraulic Design Characteristics of the Reactor Core (SI Units).....	4.4-14
Table 4.4-1b Typical Thermal–Hydraulic Design Characteristics of the Reactor Core (English Units).....	4.4-15
Table 4.4-2a Void Distribution for Analyzed Core - TRACG Average Channel .....	4.4-16
Table 4.4-2b Void Distribution for Analyzed Core - TRACG Hot Channel.....	4.4-17
Table 4.4-3a Flow Quality Distribution for Analyzed Core - TRACG Average Channel ....	4.4-18
Table 4.4-3b Flow Quality Distribution for Analyzed Core - Hot Channel .....	4.4-19
Table 4.4-4a Axial Power Distribution Used to Generate Void and Quality for Analyzed Core - TRACG Average Channel.....	4.4-20
Table 4.4-4b Axial Power Distribution Used to Generate Void and Quality for Analyzed Core - TRACG Hot Channel .....	4.4-21
Table 4.4-5 Axial Distribution for Typical Core – Core Simulator Hot Channel .....	4.4-22
Table 4.4-6 ESBWR Reactor Coolant System Geometric Data.....	4.4-23
Table 4.5-1 Reactor Internals Material Specifications .....	4.5-7
Table 4.6-1 Hydraulic Requirements.....	4.6-28
Table 4.6-2 CRD System Scram Performance .....	4.6-29
Table 4A-1 Incremental Exposure Steps and Related Figure Numbers .....	4A-1
Table 4B-1 Fuel Rod Thermal-Mechanical Design Criteria.....	4B-7
Table 4D-1 Initial Conditions for Channel and Core Stability Analysis.....	4D-21
Table 4D-2 Baseline Stability Analysis Results .....	4D-22
Table 4D-3 Statistical Stability Analysis Results .....	4D-23
Table 4D-4 Limiting AOO Event Results .....	4D-24
Table 4D-5 Defense-In-Depth Algorithm Setpoints.....	4D-25

Table 5.2-1 Reactor Coolant Pressure Boundary Components (Applicable Code Cases) ....	5.2-45
Table 5.2-2 Safety Relief Valve and Depressurization Valve Settings and/or Capacities ....	5.2-48
Table 5.2-3 (Deleted).....	5.2-49
Table 5.2-4 Reactor Coolant Pressure Boundary Materials.....	5.2-50
Table 5.2-5 Expected ESBWR Water Chemistry .....	5.2-60
Table 5.2-6 LD&IS Control and Isolation Functions vs. Monitored Variables.....	5.2-61
Table 5.2-7 Leakage Sources vs. Monitored Variables .....	5.2-64
Table 5.3-1 Reactor Vessel Controls .....	5.3-21
Table 5.3-2 Predicted Irradiation Effects on Beltline Materials .....	5.3-23
Table 5.3-3 Reactor Pressure Vessel Dimensions .....	5.3-24
Table 5.3-4 RPV Fluence Analysis Results.....	5.3-25
Table 5.4-1 Component and Subsystem Design Controls .....	5.4-45
Table 5.4-2 (Deleted).....	5.4-52
Table 5.4-3 Reactor Water Cleanup/Shutdown Cooling System Data .....	5.4-53
Table 5.4-4 DPV Design and Performance Parameters.....	5.4-55

Table 6.1-1	Containment System Including PCCS, and ECCS Component Materials .....	6.1-5
Table 6.2-1	Containment Design Parameters .....	6.2-68
Table 6.2-2	Containment Conditions During Normal Operation .....	6.2-69
Table 6.2-3	Containment Major Configuration Data.....	6.2-70
Table 6.2-4	Major Design Parameters of Vent System .....	6.2-71
Table 6.2-5	Summary of Containment-LOCA Performance Analyses .....	6.2-72
Table 6.2-6	Plant Initial Conditions Considered in the Containment DBA Cases .....	6.2-73
Table 6.2-6a	Summary of ESBWR TRACG Nodalization Changes.....	6.2-74
Table 6.2-7	Operational Sequence of ECCS For A Feedwater Line Break with Failure of One DPV (Nominal Case).....	6.2-76
Table 6.2-7a	Operational Sequence of ECCS for a Main Steam Line Break with Failure of One DPV (Nominal Case).....	6.2-78
Table 6.2-7b	Operational Sequence of ECCS for a GDCS Line Break with Failure of One DPV (Nominal Case).....	6.2-80
Table 6.2-7c	Operational Sequence of ECCS for a Bottom Drain Line Break with Failure of One DPV (Nominal Case).....	6.2-82
Table 6.2-7d	Operational Sequence of ECCS for a Feedwater Line Break with Failure of One DPV (Bounding Case).....	6.2-84
Table 6.2-7e	Operational Sequence of ECCS for a Main Steam Line Break with Failure of one DPV (Bounding Case).....	6.2-86
Table 6.2-7f	Operational Sequence of ECCS for a Feedwater Line Break with Failure of one SRV (Bounding Case).....	6.2-88
Table 6.2-7g	Operational Sequence of ECCS for a Main Steam Line Break with Failure of One SRV(Bounding Case).....	6.2-90
Table 6.2-8	Model Parameters for Containment Bounding Calculation .....	6.2-92
Table 6.2-9	ESBWR Design Feature for Severe Accident Control.....	6.2-93
Table 6.2-10	Passive Containment Cooling Design Parameters .....	6.2-94
Table 6.2-11	RWCU/SDC Break Locations.....	6.2-95
Table 6.2-12	Subcompartment Vent Path Designation.....	6.2-96
Table 6.2-12a	Subcompartment Nodal Description.....	6.2-104
Table 6.2-12b	(Deleted).....	6.2-106
Table 6.2-12c	Heat Sink Descriptions .....	6.2-107
Table 6.2-12d	RPV Sensible Heat Data.....	6.2-119
Table 6.2-13	Reactor Coolant Pressure Boundary Influent Lines Penetrating Drywell.....	6.2-120
Table 6.2-14	Reactor Coolant Pressure Boundary Effluent Lines Penetrating Drywell .....	6.2-121
Table 6.2-15	Legend For Tables 6.2-16 through 6.2-45.....	6.2-122
Table 6.2-16	Containment Isolation Valve Information for the Nuclear Boiler System Main Steam Line A.....	6.2-125

Table 6.2-17	Containment Isolation Valve Information for the Nuclear Boiler System Main Steam Line B .....	6.2-126
Table 6.2-18	Containment Isolation Valve Information for the Nuclear Boiler System Main Steam Line C .....	6.2-127
Table 6.2-19	Containment Isolation Valve Information for the Nuclear Boiler System Main Steam Line D .....	6.2-128
Table 6.2-20	Containment Isolation Valve Information for the Nuclear Boiler System Main Steam Line Drains .....	6.2-129
Table 6.2-21	Containment Isolation Valve Information for the Nuclear Boiler System Feedwater Line A .....	6.2-130
Table 6.2-22	Containment Isolation Valve Information for the Nuclear Boiler System Feedwater Line B .....	6.2-132
Table 6.2-23	Containment Isolation Valve Information for the Isolation Condenser System Loop A .....	6.2-134
Table 6.2-24	Containment Isolation Valve Information for the Isolation Condenser System Loop A .....	6.2-136
Table 6.2-25	Containment Isolation Valve Information for the Isolation Condenser System Loop B .....	6.2-138
Table 6.2-26	Containment Isolation Valve Information for the Isolation Condenser System Loop B .....	6.2-140
Table 6.2-27	Containment Isolation Valve Information for the Isolation Condenser System Loop C .....	6.2-142
Table 6.2-28	Containment Isolation Valve Information for the Isolation Condenser System Loop C .....	6.2-143
Table 6.2-29	Containment Isolation Valve Information for the Isolation Condenser System Loop D .....	6.2-145
Table 6.2-30	Containment Isolation Valve Information for the Isolation Condenser System Loop D .....	6.2-146
Table 6.2-31	Containment Isolation Valve Information for the Reactor Water Cleanup/Shutdown Cooling System .....	6.2-148
Table 6.2-31a	Containment Isolation Valve Information for the Reactor Water Cleanup/Shutdown Cooling System .....	6.2-150
Table 6.2-32a	Containment Isolation Valve Information for the Standby Liquid Control System .....	6.2-151
Table 6.2-32b	Containment Isolation Valve Information for the Standby Liquid Control System .....	6.2-152
Table 6.2-33a	Containment Isolation Valve Information for the Fuel and Auxiliary Pools Cooling System .....	6.2-153
Table 6.2-33b	Containment Isolation Valve Information for the Fuel and Auxiliary Pools Cooling System .....	6.2-154
Table 6.2-34	Containment Isolation Valve Information for the Fuel and Auxiliary Pools Cooling System .....	6.2-155



Table 6.2-35 Containment Isolation Valve Information for the Fuel and Auxiliary Pools Cooling System.....	6.2-156
Table 6.2-36 Containment Isolation Valve Information for the Containment Inerting System.....	6.2-157
Table 6.2-37 Containment Isolation Valve Information for the Containment Inerting System.....	6.2-159
Table 6.2-38 Containment Isolation Valve Information for the Containment Inerting System.....	6.2-160
Table 6.2-39 Containment Isolation Valve Information for the Chilled Water System Train A .....	6.2-161
Table 6.2-39a Containment Isolation Valve Information for the Chilled Water System Train B .....	6.2-162
Table 6.2-40 Containment Isolation Valve Information for the High Pressure Nitrogen Gas Supply System .....	6.2-163
Table 6.2-41 Containment Isolation Valve Information for the Makeup Water System.....	6.2-164
Table 6.2-42 Containment Isolation Valve Information for the Process Radiation Monitoring System.....	6.2-165
Table 6.2-43 Containment Isolation Valve Information for the Equipment and Floor Drain System.....	6.2-166
Table 6.2-44 Containment Isolation Valve Information for the Service Air System .....	6.2-167
Table 6.2-45 Containment Isolation Valve Information for the Containment Monitoring System.....	6.2-168
Table 6.2-46 (Deleted).....	6.2-169
Table 6.2-47 Containment Penetrations Subject To Type A, B, and C Testing.....	6.2-170
Table 6.2-48 RWCU/SDC NRHX Parameters Assumed in Post-LOCA Containment Cooling and Recovery Analysis.....	6.2-182
Table 6.3-1 Significant Input Variables to the ECCS-LOCA Performance Analysis .....	6.3-24
Table 6.3-2 GDCS Design Basis Parameters.....	6.3-27
Table 6.3-3 Inservice Testing and Maintenance .....	6.3-28
Table 6.3-4 (Deleted).....	6.3-29
Table 6.3-5 Summary of ECCS-LOCA Performance Analyses.....	6.3-30
Table 6.3-5a Summary of ECCS Line Break Sizes and Elevations .....	6.3-31
Table 6.3-6 Single Failure Evaluation .....	6.3-32
Table 6.3-7 Operational Sequence of ECCS for a Feedwater Line Break with Failure of One GDCS Injection Valve (Nominal Calculation).....	6.3-33
Table 6.3-8 Operational Sequence of ECCS for a Inside Steam Line Break with Failure of One GDCS Injection Valve (Nominal Calculation).....	6.3-34
Table 6.3-9 Operational Sequence of ECCS for a GDCS Injection Line Break with Failure of One GDCS Injection Valve (Nominal Calculation).....	6.3-36
Table 6.3-10 Operational Sequence of ECCS for a Bottom Drain Line Break .....	6.3-38
with Failure of One GDCS Injection Valve (Nominal Calculation).....	6.3-38

Table 6.3-10a Operational Sequence of ECCS for a IC Drain Line Break with Failure of One GDCS Valve (Bounding Case)..... 6.3-39

Table 6.3-11 Plant Variables with Nominal and Bounding Calculation Values ..... 6.3-41

Table 6.4-1 Design Parameters for CRHAVS ..... 6.4-15

Table 6.4-2 Typical Onsite Chemicals and Typical Locations..... 6.4-16

Table 6A-1 Evaluation of TRACG Application Procedure ..... 6A-2

Table 6B-1 Summary of Peak DW Pressure for Error Correction Cases ..... 6B-8

Table 6D-1 Listing of Passive Heat Sinks ..... 6D-2

Table 6D-2 Modeling of Passive Heat Sinks..... 6D-2

Table 6D-3 Thermophysical Properties of Passive Heat Sink Materials..... 6D-2

Table 6D-4 Total Heat Transfer Area by Containment Level ..... 6D-2

Table 6F1-1 Summary of Peak DW Pressures for the MSL Break Area Study ..... 6F-3

Table 6F1-2 Summary of Peak DW Pressures for the FWL Break Area Study..... 6F-3

Table 6F2-1 Summary of Peak DW Pressures for the MSL Break Elevation Study ..... 6F-3

Table 6G-1 Phenomena Identification and Ranking Table (PIRT) ..... 6G-5

Table 6G-2 Major Design Changes from Pre-Application Review Design to DCD Design, Parameter ..... 6G-6

Table 6G-3 Major Design Changes from Pre-Application Review Design to DCD Design, Modeling..... 6G-10

Table 6H-1 Summary of Parametric Cases on the Main Steam Line Break ..... 6H-4

Table 6I-1 Summary of Containment-LOCA Performance Analyses..... 6I-2

Table 6I-2 Operational Sequence of ECCS for a MSLB with Failure of One DPV (Bounding Case) ..... 6I-3

Table 6I-3 Operational Sequence of ECCS for a MSLB with Failure of one SRV (Bounding Case) ..... 6I-5

Table 7.1-1	I&C Systems Regulatory Requirements Applicability Matrix.....	7.1-93
Table 7.1-2	Section Roadmap of I&C Systems Conformance to Evaluation of IEEE Std. 603 Specific Criteria Compliance.....	7.1-98
Table 7.2-1	Sensors Used in Functional Performance of RPS .....	7.2-63
Table 7.2-2	SRNM Trip Function Summary .....	7.2-64
Table 7.2-3	SRNM Trip Signals .....	7.2-65
Table 7.2-4	APRM Trip Function Summary .....	7.2-66
Table 7.2-5	Outputs from SPTMs to Other Systems .....	7.2-67
Table 7.2-6	OPRM Trip Function Summary .....	7.2-68
Table 7.3-1	Automatic Depressurization System Parameters.....	7.3-63
Table 7.3-2	Safety Relief Valve Initiation Parameters .....	7.3-63
Table 7.3-3	Automatic Depressurization Valve Parameters.....	7.3-64
Table 7.3-4	Gravity Driven Cooling System Parameters .....	7.3-64
Table 7.3-5	LD&IS Interfacing Sensor Parameters .....	7.3-65
Table 7.5-1	(Deleted).....	7.5-30
Table 7.5-2	(Deleted).....	7.5-30
Table 7.5-3	(Deleted).....	7.5-30
Table 7.5-4	CMS Testing and Inspection Requirements .....	7.5-30
Table 7.5-5	Instrument Ranges for Hydrogen/Oxygen Analyzers .....	7.5-30
Table 7.7-1	Major Plant Automation System Interfaces .....	7.7-57
Table 7B-1	(Deleted) .....	7B-2
Table 7B-2	(Deleted) .....	7B-2
Table 7B-3	(Deleted) .....	7B-2
Table 7B-4	(Deleted) .....	7B-2
Table 7B-5	(Deleted) .....	7B-2
Table 7B-6	(Deleted) .....	7B-2
Table 7B-7	(Deleted) .....	7B-2
Table 7B-8	(Deleted) .....	7B-2

Table 8.1-1 Onsite Power System SRP Criteria Applicability Matrix ..... 8.1-10  
Table 8.3-1 Diesel-Generator Alarms..... 8.3-33  
Table 8.3-2 Battery Cycle Times ..... 8.3-34  
Table 8.3-3 250VDC Safety-Related Battery Nominal Load Requirements..... 8.3-35  
Table 8.3-4 Safety-Related DC and UPS Nominal Component Data ..... 8.3-36

Table 9.1-1 Pools Served by FAPCS and IC/PCCS .....	9.1-39
Table 9.1-2 FAPCS Operating Modes .....	9.1-40
Table 9.1-3 Safety Classification, Quality Group and Seismic Category.....	9.1-41
Table 9.1-4 Classification of Equipment .....	9.1-43
Table 9.1-5 Reference Codes and Standards .....	9.1-45
Table 9.1-6 Heavy Load Equipment Used to Handle Light Loads and Related Refueling Handling Tasks .....	9.1-46
Table 9.1-7 Summary of Heavy Load Operations .....	9.1-47
Table 9.1-8 Design Parameters for FAPCS System Components .....	9.1-50
Table 9.2-1 PSWS Heat Loads .....	9.2-25
Table 9.2-2 PSWS Component Design Characteristics.....	9.2-26
Table 9.2-3 RCCWS Nominal Heat Loads.....	9.2-27
Table 9.2-4 RCCWS Component Design Characteristics .....	9.2-30
Table 9.2-5 RCCWS Configuration by Mode .....	9.2-31
Table 9.2-6 Makeup Water System Supplied Equipment.....	9.2-32
Table 9.2-7 Makeup Water System Demineralized Water Storage Tank Nominal Water Quality Requirements .....	9.2-33
Table 9.2-8 Makeup Water System Demineralizer Effluent Nominal Water Quality Requirements .....	9.2-34
Table 9.2-9 Major Makeup Water System Components .....	9.2-35
Table 9.2-10 Capacity Requirements for the Condensate Storage Tank.....	9.2-35
Table 9.2-11 Chilled Water System Component Design Characteristics.....	9.2-36
Table 9.2-12 Turbine Component Cooling Water System Heat Loads.....	9.2-37
Table 9.3-1 Process Sampling System Measurements .....	9.3-31
Table 9.3-2 Major Equipment for EFDS .....	9.3-33
Table 9.3-3 Safety-Related Portions of the SLC System.....	9.3-39
Table 9.3-4 Safety-Related Support Interfaces for the SLC System .....	9.3-40
Table 9.3-5 SLC ATWS Mitigation Function Parameters.....	9.3-41
Table 9.3-6 Instrument Air System Requirements .....	9.3-42
Table 9.3-7 Service Air System Requirements.....	9.3-43
Table 9.3-8 High Pressure Nitrogen Supply Requirements.....	9.3-44
Table 9.4-1 Design Parameters for the CBVS .....	9.4-46
Table 9.4-2 Major Equipment for CBVS.....	9.4-47
Table 9.4-3 Design Parameters for FBVS .....	9.4-50
Table 9.4-4 Major Equipment for FBGAVS .....	9.4-51
Table 9.4-5 Major Equipment for FBFPVS.....	9.4-53
Table 9.4-6 RWVS Design Conditions.....	9.4-54
Table 9.4-7 Major Equipment for the RWVS.....	9.4-55

Table 9.4-8 Design Parameters for RBVS ..... 9.4-56

Table 9.4-9 Major Equipment for CLAVS ..... 9.4-58

Table 9.4-10 Major Equipment for REPAVS ..... 9.4-59

Table 9.4-11 Major Equipment for CONAVS ..... 9.4-60

Table 9.4-12 Drywell Cooling System Design Parameters ..... 9.4-62

Table 9.4-13 Drywell Cooling System Fan Cooling Units ..... 9.4-63

Table 9.4-14 Drywell Cooling System Heat Loads ..... 9.4-64

Table 9.4-15 Design Parameters for TBVS ..... 9.4-65

Table 9.4-16 Design Parameters for EBVS ..... 9.4-68

Table 9.4-17 Industrial Codes and Standards<sup>1</sup> Applicable to ESBWR HVAC ..... 9.4-72

Table 9.5-1 Lists of Applicable Codes for Fire Protection ..... 9.5-59

Table 9.5-2 FPS Component Design Characteristics ..... 9.5-62

Table 9.5-3 Typical Luminance Ranges for Normal Lighting ..... 9.5-63

Table 9A.2-1 Fire Protection Codes and Standards.....	9A.2-9
Table 9A.2-2 Systems Required to Achieve Safe Shutdown in the Event of Fire .....	9A.2-13
Table 9A.5-1 Reactor Building.....	9A.5-4
Table 9A.5-2 Fuel Building .....	9A.5-45
Table 9A.5-3 Control Building.....	9A.5-52
Table 9A.5-4 Turbine Building.....	9A.5-67
Table 9A.5-5 Radwaste Building.....	9A.5-94
Table 9A.5-6 Electrical Building.....	9A.5-105
Table 9A.5-7 Yard .....	9A.5-140
Table 9A.6-1 Turbine and Electrical Building Safety-Related Monitoring Devices.....	9A.6-19

Table 9B-1 Estimated Fire Severity for Offices and Light Commercial Occupancies..... 11  
Table 9B-2 Fire Severity Expected by Occupancy\* ..... 12  
Table 9B-3 Cable Type and Configuration for UL Tests\* ..... 13  
Table 9B-4 Summary of Burning Rate Calculations ..... 14



Table 10.1-1 Summary of Important Design Features and Performance Characteristics of the Steam and Power Conversion System .....	10.1-4
Table 10.3-1 Turbine Main Steam System Design Data .....	10.3-7
Table 10.3-2 ASME Section III Class 2 Steam and Feedwater System Piping Materials.....	10.3-8
Table 10.4-1 Main Condenser Data .....	10.4-28
Table 10.4-2 Main Condenser Evacuation System.....	10.4-29
Table 10.4-3 Circulating Water System.....	10.4-30
Table 10.4-4 Condensate Purification System.....	10.4-31
Table 10.4-5 Condensate and Feedwater System Data.....	10.4-32
Table 10.4-6 Condensate and Feedwater System Component Failure Analysis .....	10.4-33

Table 11.1-1 Source Term Design Basis Parameters.....	11.1-7
Table 11.1-2a Design Basis Noble Radiogas Source Terms in Steam .....	11.1-8
Table 11.1-2b Normal Operational Noble Radiogas Source Terms in Steam.....	11.1-9
Table 11.1-3 Calculational Parameters For Source Term Adjustment .....	11.1-10
Table 11.1-4a Design Basis Iodine Radioisotopes in Reactor Water and Steam .....	11.1-11
Table 11.1-4b Normal Operational Iodine Radioisotopes in Reactor Water and Steam .....	11.1-12
Table 11.1-5a Design Basis Non-Volatile Fission Products In Reactor Water .....	11.1-13
Table 11.1-5b Normal Operational Non-Volatile Fission Products In Reactor Water .....	11.1-14
Table 11.1-6 Design Basis*** N16 Concentrations in Reactor Water and Steam.....	11.1-15
Table 11.1-7a Design Basis Non-Coolant Activation Products in Reactor Water .....	11.1-16
Table 11.1-7b Normal Operational Non-Coolant Activation Products in Reactor Water ...	11.1-17
Table 11.2-1 Equipment Codes (from Table 1, RG 1.143) .....	11.2-12
Table 11.2-2a LWMS Component Capacity (Tanks)* .....	11.2-13
Table 11.2-2b LWMS Component Capacity (Pumps).....	11.2-14
Table 11.2-2c LWMS Component Capacity .....	11.2-15
Table 11.2-3 Decontamination Factors*** .....	11.2-16
Table 11.2-4 Probable Inputs to LWMS from Operational Occurrences .....	11.2-17
Table 11.3-1 Offgas System Design Parameters* .....	11.3-16
Table 11.3-2 Offgas System Major Equipment Items .....	11.3-17
Table 11.3-3 Equipment Malfunction Analysis.....	11.3-19
Table 11.3-4 Offgas System Failure Accident Parameters.....	11.3-21
Table 11.3-5 Isotopic Source Rates for Design Basis*.....	11.3-22
Table 11.3-6 Releases to the Environment* .....	11.3-23
Table 11.3-7 Offgas System Failure Meteorology and Dose Results.....	11.3-24
Table 11.4-1 SWMS Component Capacities .....	11.4-12
Table 11.4-2 Annual Shipped Waste Volumes ♦ .....	11.4-13
Table 11.5-1 Process and Effluent Radiation Monitoring Systems.....	11.5-30
Table 11.5-2 Process Radiation Monitoring System (Gaseous and Airborne Monitors) ....	11.5-34
Table 11.5-3 Key to Radiation Monitors Shown on Figure 11.5-1 .....	11.5-40
Table 11.5-4 Process Radiation Monitoring System (Liquid Monitors) .....	11.5-41
Table 11.5-5 Provisions for Sampling Liquid Streams.....	11.5-42
Table 11.5-6 Provisions for Sampling Gaseous Streams.....	11.5-45
Table 11.5-7 Radiological Analysis Summary of Liquid Effluent Samples .....	11.5-47
Table 11.5-8 Radiological Analysis Summary of Gaseous Effluent Samples.....	11.5-48
Table 11.5-9 Process Radiation Monitoring System Estimated Dynamic Ranges.....	11.5-49

Table 12.2-1 Basic Reactor Data .....	12.2-13
Table 12.2-2 Neutron Fluxes at Core Boundary and RPV .....	12.2-22
Table 12.2-3 Gamma Ray Source Energy Spectra .....	12.2-24
Table 12.2-4 Neutron and Gamma Ray Fluxes Outside the Vessel Wall.....	12.2-26
Table 12.2-5 Radioactive Sources in the Control Rod Drive System.....	12.2-27
Table 12.2-6a RWCU/SDC Regenerative Heat Exchanger Tube Side Activity .....	12.2-28
Table 12.2-6b RWCU/SDC Non-Regenerative Heat Exchanger Tube Side Activity.....	12.2-29
Table 12.2-6c RWCU/SDC Regenerative Heat Exchanger Shell Side .....	12.2-30
Table 12.2-7 RWCU Demineralizer Activity .....	12.2-31
Table 12.2-8 FAPCS Filter Activity .....	12.2-32
Table 12.2-8a FAPCS Demineralizer Activity .....	12.2-33
Table 12.2-8b FAPCS Heat Exchanger Tube Side Activity.....	12.2-34
Table 12.2-9 FAPCS Backwash Receiving Tank Activity.....	12.2-35
Table 12.2-10a Offgas System Steam Jet Air Ejector Inventory.....	12.2-36
Table 12.2-10b Offgas System Isotopic Inventory for Preheater through Charcoal Tanks.....	12.2-39
Table 12.2-11 Turbine Condenser Inventory.....	12.2-43
Table 12.2-12 Isotopic Inventory in the Ion Exchanger Filters.....	12.2-44
Table 12.2-13a Liquid Waste Management System Equipment Drain Collection Tank Activity .....	12.2-45
Table 12.2-13b Liquid Waste Management System Equipment Drain Sample Tank Activity .....	12.2-46
Table 12.2-13c Liquid Waste Management System Floor Drain Collection Tank Activity .....	12.2-47
Table 12.2-13d Liquid Waste Management System Floor Drain Sample Tank Activity....	12.2-48
Table 12.2-13e Liquid Waste Management System Chemical Collection Tank Activity...	12.2-49
Table 12.2-13f Liquid Waste Management System Detergent Collection Tank Activity...	12.2-50
Table 12.2-13g Liquid Waste Management System Detergent Sample Tank Activity.....	12.2-51
Table 12.2-14a Solid Waste Management System High Activity Resin Holdup Tank Activity .....	12.2-52
Table 12.2-14b Solid Waste Management System Low Activity Resin Holdup Tank Activity .....	12.2-53
Table 12.2-14c Solid Waste Management System Phase Separator Tank Activity .....	12.2-54
Table 12.2-14d Solid Waste Management System Condensate Resin Holdup Tank Activity .....	12.2-55
Table 12.2-14e Solid Waste Management System Concentrate Waste Tank Activity.....	12.2-56
Table 12.2-15 Airborne Sources Calculation.....	12.2-57
Table 12.2-16 Annual Airborne Releases for Offsite Dose Evaluations (MBq)** .....	12.2-58

Table 12.2-17 Comparison of Airborne Concentrations with 10 CFR 20 Concentrations .....	12.2-62
Table 12.2-18a Airborne Offsite Dose Calculation Bases.....	12.2-65
Table 12.2-18b ESBWR Annual Average Doses from Airborne Releases.....	12.2-66
Table 12.2-19a Average Annual Liquid Release Calculation Parameters.....	12.2-68
Table 12.2-19b Average Annual Liquid Releases .....	12.2-70
Table 12.2-20a Liquid Pathway Offsite Dose Calculation Bases.....	12.2-72
Table 12.2-20b Liquid Pathway Dose Results in mSv/year .....	12.2-73
Table 12.2-21 N-16 Skyshine Annual Dose .....	12.2-74
Table 12.2-22 Radiation Sources Parameters .....	12.2-75
Table 12.2-23a Parameters and Assumptions used for Calculating Inside the Building Airborne Radioactivity Concentrations .....	12.2-77
Table 12.2-23b Reactor Building Outside Containment Airborne Radioactivity Concentrations During Normal Operation.....	12.2-78
Table 12.2-23c Spent Fuel Pool and Equipment Areas Airborne Radioactivity Concentrations .....	12.2-80
Table 12.2-23d Turbine Building Airborne Radioactivity Concentrations .....	12.2-82
Table 12.2-23e Radwaste Building Airborne Radioactivity Concentrations.....	12.2-85
Table 12.3-1 Computer Programs Used in Shielding Design Calculations.....	12.3-26
Table 12.3-2 Area Radiation Monitors for Reactor Building.....	12.3-27
Table 12.3-3 Area Radiation Monitors for Fuel Building .....	12.3-28
Table 12.3-4 Area Radiation Monitors for Radwaste Building.....	12.3-29
Table 12.3-5 Area Radiation Monitors for Turbine Building.....	12.3-30
Table 12.3-6 Area Radiation Monitors for Control Building .....	12.3-32
Table 12.3-7 Area Radiation Channel Monitoring Range .....	12.3-33
Table 12.3-8 Shielding Geometry in Centimeters .....	12.3-34
Table 12.3-9 Activity Accumulated in the HVAC Filters in Accident Conditions.....	12.3-37
Table 12.3-10a Dose Rates in the Control Building EFU and Adjacent Rooms in Accident Conditions.....	12.3-39
Table 12.3-10b Dose Rates in the Reactor Building HVAC Filter Adjacent Rooms in Accident Conditions.....	12.3-40
Table 12.3-11 Beyond 72 Hour And Long Term Post Accident Recovery Actions Access Requirements .....	12.3-41
Table 12.3-12 Radiation Dose Rates At The Post-Accident Access Rooms .....	12.3-42
Table 12.3-13 Radiation Dose Rates At The Access Ways To Post-Accident Access Areas .....	12.3-43
Table 12.3-14 Reactor Building Post Accident Access Area .....	12.3-44
Table 12.3-15 Control Building Post Accident Access Area .....	12.3-48
Table 12.3-16 Electrical And Service Building Post Accident Access Area .....	12.3-49
Table 12.3-17 Outside Area - Post-Accident Radiation Mission Dose At 72 H .....	12.3-51

Table 12.4-1 Projected ESBWR Total Occupational Radiation Exposure Estimates Based on 24 Month Refueling Cycle .....	12.4-12
Table 12.4-2 Occupational Dose Estimates During Operation and Surveillances .....	12.4-14
Table 12.4-3 Occupational Dose Estimates During Routine Maintenance .....	12.4-15
Table 12.4-4 Occupational Dose Estimates During Waste Processing .....	12.4-16
Table 12.4-5 Occupational Dose Estimates During Refueling Operations .....	12.4-17
Table 12.4-6 Occupational Dose Estimates During Inservice Inspection .....	12.4-18
Table 12.4-7 Occupational Dose Estimates During Special Maintenance .....	12.4-19

Table 14.2-1 Power Ascension Test Matrix ..... 14.2-98  
Table 14.3-1 Types of Systems and Summary of Their Graded Treatment ..... 14.3-22  
Table 14.3-2 Test, Inspection or Analysis Approach & Application Process ..... 14.3-23

Table 15.0-1 Chapter 15 Abnormal Event Classification Determination Matrix.....	15.0-16
Table 15.0-2 ESBWR Abnormal Event Classifications .....	15.0-17
Table 15.0-3 Safety Analysis Acceptance Criteria for AOOs .....	15.0-20
Table 15.0-4 Safety Analysis Acceptance Criteria for AOOs In Combination With An Additional Single Active Component Failure or Single Operator Error .....	15.0-21
Table 15.0-5 Safety Analysis Acceptance Criteria for Infrequent Events.....	15.0-22
Table 15.0-6 Safety Analysis Acceptance Criteria for Accidents .....	15.0-23
Table 15.0-7 ESBWR Event Classifications and Radiological Acceptance Criteria .....	15.0-24
Table 15.0-8 ESBWR Safety Analysis Codes .....	15.0-27
Table 15.1-1 Operational Criteria .....	15.1-4
Table 15.1-2 ESBWR Operating Modes .....	15.1-5
Table 15.1-3 ESBWR Events Associated With Operating Modes .....	15.1-6
Table 15.1-4 Event Analysis Rules.....	15.1-9
Table 15.1-5 NSOA System Event Matrix .....	15.1-12
Table 15.1-6 NSOA Automatic Instrument Trip/Event Matrix.....	15.1-19
Table 15.1-7 ESBWR NSOA Events.....	15.1-27
Table 15.2-1 Input Parameters, Initial Conditions and Assumptions Used in AOO and Infrequent Event Analyses .....	15.2-25
Table 15.2-2 CRD Scram Times for Vessel Bottom Pressures Below 7.481 MPa gauge (1085 psig) .....	15.2-30
Table 15.2-3 CRD Scram Times for Bottom Vessel Pressures Between 7.481 MPa gauge (1085 psig) and 8.618 MPa gauge (1250 psig).....	15.2-30
Table 15.2-4a Results Summary of Anticipated Operational Occurrence Events.....	15.2-31
Table 15.2-4b Results Summary of Anticipated Operational Occurrence Events.....	15.2-33
Table 15.2-5 Sequence of Events for Loss of Feedwater Heating.....	15.2-34
Table 15.2-6 Sequence of Events for Fast Closure of One Turbine Control Valve .....	15.2-35
Table 15.2-7 Sequence of Events for Slow Closure of One Turbine Control Valve.....	15.2-35
Table 15.2-8 Sequence of Events for Generator Load Rejection with Turbine Bypass .....	15.2-36
Table 15.2-9 Sequence of Events for Generator Load Rejection with a Single Failure in the Turbine Bypass System .....	15.2-37
Table 15.2-10 Sequence of Events for Turbine Trip with Turbine Bypass.....	15.2-38
Table 15.2-11 Sequence of Events for Turbine Trip with a Single Failure in the Turbine Bypass System .....	15.2-39
Table 15.2-12 Sequence of Events for Closure of one MSIV .....	15.2-40
Table 15.2-13 Sequence of Events for Closure of all MSIV .....	15.2-40
Table 15.2-14 Typical Rates of Decay for Loss of Condenser Vacuum .....	15.2-41
Table 15.2-15 Sequence of Events for Loss of Condenser Vacuum .....	15.2-42
Table 15.2-16 Trip Signals Associated With Loss of Condenser Vacuum .....	15.2-43

Table 15.2-17	Sequence of Events for Inadvertent Isolation Condenser Initiation .....	15.2-43
Table 15.2-18	Single Failure Modes for Digital Controls .....	15.2-44
Table 15.2-19	Sequence of Events for Runout of One Feedwater Pump .....	15.2-45
Table 15.2-20	Sequence of Events for Opening of one Turbine Control or Bypass Valve .....	15.2-45
Table 15.2-21	Sequence of Events for Loss of Non-Emergency AC Power to Station Auxiliaries .....	15.2-46
Table 15.2-22	Sequence of Events for Loss of All Feedwater Flow .....	15.2-47
Table 15.2-23	Instrument Response Time Limits for RPS, ECCS, MSIV, ICS, CRHAVS and Isolation Functions .....	15.2-48
Table 15.3-1a	Results Summary of Infrequent Events (1) (2) .....	15.3-29
Table 15.3-1b	Results Summary of Infrequent Events .....	15.3-30
Table 15.3-2	Sequence of Events for Loss of Feedwater Heating With Failure of SCRRI and SRI .....	15.3-31
Table 15.3-3	Sequence of Events for Feedwater Controller Failure – Maximum Flow Demand .....	15.3-32
Table 15.3-4	Sequence of Events for Pressure Regulator Failure – Opening of All Turbine Control and Bypass Valves .....	15.3-33
Table 15.3-5	Sequence of Events for Pressure Regulator Failure – Closure of All Turbine Control and Bypass Valves .....	15.3-34
Table 15.3-6a	Sequence of Events for Generator Load Rejection With Total Turbine Bypass Failure .....	15.3-35
Table 15.3-6b	Causes of Control Rod Withdrawal Error (Deleted) .....	15.3-35
Table 15.3-6c	Sequence of Events for Continuous Control Rod Withdrawal Error During Reactor Startup (Deleted) .....	15.3-35
Table 15.3-7	Sequence of Events for Turbine Trip With Total Turbine Bypass Failure .....	15.3-36
Table 15.3-8	Sequence of Events for Continuous Control Rod Withdrawal Error During Reactor Startup With Failure of Control Rod Block .....	15.3-37
Table 15.3-9	Sequence of Events for the Mislocated Bundle .....	15.3-38
Table 15.3-10	Sequence of Events for the Misoriented Bundle .....	15.3-39
Table 15.3-11	Sequence of Events for Inadvertent SRV Opening .....	15.3-40
Table 15.3-12	Sequence of Events for Stuck Open Safety Relief Valve .....	15.3-41
Table 15.3-13	1000 Fuel Rod Failure Parameters .....	15.3-42
Table 15.3-14	1000 Fuel Rod Failure Fission Product Activity Released to Coolant .....	15.3-44
Table 15.3-15	1000 Fuel Rod Failure Fission Product Activity Cumulative Release to Environment .....	15.3-45
Table 15.3-16	1000 Fuel Rod Failure Dose Results .....	15.3-46
Table 15.3-17	Radwaste System Failure Accident Parameters .....	15.3-47
Table 15.3-18	Radwaste System Failure Accident Isotopic Airborne Release to Environment (megabecquerel) .....	15.3-49



Table 15.3-19 Radwaste System Failure Accident Dose Results .....	15.3-50
Table 15.4-1 Fuel Handling Accident Sequence of Events .....	15.4-34
Table 15.4-2 Fuel Handling Accident Parameters .....	15.4-35
Table 15.4-3 Fuel Handling Accident Activity Released from Fuel .....	15.4-38
Table 15.4-3a Fuel Handling Accident Isotopic Release to Environment.....	15.4-39
Table 15.4-4 Fuel Handling Accident Analysis Results .....	15.4-40
Table 15.4-5 Loss-of-Coolant Accident Dose Consequence Analysis Parameters .....	15.4-41
Table 15.4-5a LOCA Atmospheric Dispersion Factors (sec./m3).....	15.4-45
Table 15.4-6 LOCA Compartment Inventories (Ci).....	15.4-46
Table 15.4-6a LOCA Compartment Inventories (Mbc) .....	15.4-52
Table 15.4-7 LOCA Integrated Environmental Release (MBq).....	15.4-58
Table 15.4-7a LOCA Integrated Environmental Release (Ci).....	15.4-60
Table 15.4-8 LOCA Control Room Activity (MBq) .....	15.4-62
Table 15.4-8a LOCA Control Room Activity (Ci).....	15.4-64
Table 15.4-9 LOCA Inside Containment Analysis Total Effective Dose Equivalent (TEDE) Results.....	15.4-66
Table 15.4-10 Sequence of Events for Main Steamline Break Accident (MSLBA) Outside Containment.....	15.4-67
Table 15.4-11 MSLBA Parameters.....	15.4-68
Table 15.4-12 MSLBA Environment Releases .....	15.4-70
Table 15.4-13 MSLBA Analysis Results.....	15.4-72
Table 15.4-14 Feedwater Line Break Accident Parameters .....	15.4-73
Table 15.4-15 Feedwater Line Break Accident Isotopic Release to Environment.....	15.4-75
Table 15.4-16 Feedwater Line Break Analysis Results.....	15.4-77
Table 15.4-17 Small Line Carrying Coolant Outside Containment Break Accident Parameters.....	15.4-78
Table 15.4-18a Small Line Carrying Coolant Outside Containment Break Accident Integral Release to the Environment for the Pre-Accident Spike Case.....	15.4-80
Table 15.4-18b Small Line Carrying Coolant Outside Containment Break Accident Integral Release to the Environment for the Equilibrium Case.....	15.4-81
Table 15.4-19 Small Line Carrying Coolant Outside Containment Break Accident Results.....	15.4-82
Table 15.4-20 RWCU/SDC System Line Failure Outside Containment Sequence of Events .....	15.4-83
Table 15.4-21 RWCU/SDC Line Break Accident Parameters .....	15.4-84
Table 15.4-22 RWCU/SDC Line Break Accident Isotopic Release to Environment.....	15.4-86
Table 15.4-23 RWCU/SDC Line Break Accident Results .....	15.4-88
Table 15.5-1 ATWS Performance Requirements .....	15.5-18
Table 15.5-1a Systems That May Initiate or Trip During Overpressure Event.....	15.5-19
Table 15.5-1b Sequence of Events for Closure of all MSIV with Flux Trip.....	15.5-20

Table 15.5-2 ATWS Initial Operating Conditions.....	15.5-21
Table 15.5-3 ATWS Equipment Performance Characteristics .....	15.5-22
Table 15.5-4a ATWS MSIV Closure Summary - ARI Case.....	15.5-23
Table 15.5-4b ATWS MSIV Closure Summary - FMCRD Case.....	15.5-23
Table 15.5-4c ATWS MSIV Closure Summary – SLC System Bounding Case .....	15.5-24
Table 15.5-4d ATWS MSIV Closure Summary – SLC System Bounding Pool Temperature Case (Deleted).....	15.5-24
Table 15.5-4e ATWS MSIV Closure Sequence of Events .....	15.5-25
Table 15.5-5a ATWS Loss of Condenser Vacuum Summary – SLC System Bounding Case.....	15.5-26
Table 15.5-5b ATWS Loss of Condenser Vacuum Sequence of Events Bounding Case .....	15.5-26
Table 15.5-5c ATWS Loss of Condenser Vacuum Summary - SLC System Bounding Pool Temperature Case (Deleted).....	15.5-27
Table 15.5-5d ATWS Loss of Condenser Vacuum Sequence of Events Bounding Pool Temperature Case (Deleted) .....	15.5-27
Table 15.5-6a ATWS Loss of Feedwater Heating Summary - SLC System Case .....	15.5-28
Table 15.5-6b ATWS Loss of Feedwater Heating Sequence of Events .....	15.5-28
Table 15.5-7a ATWS Loss of Non-Emergency AC Power to Station Auxiliaries Summary - SLC System Case.....	15.5-29
Table 15.5-7b ATWS Loss of Non-Emergency AC Power to Station Auxiliaries Sequence of Events.....	15.5-29
Table 15.5-8a ATWS Loss of Feedwater Flow Summary - SLC System Case .....	15.5-30
Table 15.5-8b ATWS Loss of Feedwater Flow Sequence of Events .....	15.5-30
Table 15.5-9a ATWS Load Rejection with a Single Failure in the Turbine Bypass System Summary - SLC System Case.....	15.5-31
Table 15.5-9b ATWS Load Rejection with a Single Failure in the Turbine Bypass System Sequence of Events .....	15.5-31
Table 15.5-10a Sequence of Events for Station Blackout .....	15.5-32
Table 15.5-10b Theoretical Vessel Conditions at 72 hours after SBO.....	15.5-33
Table 15A-1 Instrumentation &Control (I&C) Failures Leading to Inadvertent Opening of DPVs.....	15A-32
Table 15A-2 Failure Data .....	15A-35
Table 15A-3 Summary of Event Frequency Estimates.....	15A-37
Table 15B-1 ESBWR Core Concentrations.....	15B-2

Table 17.0-1 Compliance With Quality Assurance Program Commitments..... 17.0-3  
Table 17.4-1 D-RAP Example Case - ICS Importance Analysis ..... 17.4-11  
Table 17.4-2 D-RAP Example Case - ICS Failure Modes and Reliability Strategy ..... 17.4-11

Table 18.6-1 ESBWR Staffing Assumptions ..... 18.6-5

Table 18.10-1 Example Knowledge and Skill Dimensions for Learning Objectives  
Identification ..... 18.10-6

Table 19.1-1	Systems and Functions Modeled .....	19.1-5
Table 19.2-1	Comparison of ESBWR Features With Existing BWRs .....	19.2-21
Table 19.2-2	ESBWR Design Features That Reduce Risk .....	19.2-26
Table 19.2-3	Risk Insights and Assumptions.....	19.2-27
Table 19.2-4	ESBWR Systems and Structures in Seismic Margins Analysis with Plant Level HCLPF not less than $1.67 * SSE(1)$ .....	19.2-36
Table 19A-1	Initiating Events Assessment for RTNSS (Deleted).....	19A-34
Table 19A-2	RTNSS Functions .....	19A-35
Table 19A-3	Structures Housing RTNSS Functions.....	19A-38
Table 19A-4	Capability of RTNSS Related Structures.....	19A-40
Table 19B-1	Summary of ASME Factored Load Limits Used for Containment Integrity.....	19B-14
Table 19B-2	Summary of Steel Elastic Properties for Level C Analysis .....	19B-15
Table 19B-3	Summary of Steel Plastic Properties for Level C Analysis .....	19B-16
Table 19B-4	Summary of Concrete Properties for Level C Analysis.....	19B-17
Table 19B-5	Summary of Thermal Material Properties .....	19B-18
Table 19B-6	Summary of Maximum Stresses in Rebar and Concrete at 0.620 MPaG (90 psig) Pressure.....	19B-19
Table 19B-7	Summary of Maximum Stresses in Rebar and Concrete at 0.992 MPaG (144 psig) Pressure.....	19B-21
Table 19B-8	Summary of Torispherical Shell Parameters for Benchmark Analysis ..	19B-23
Table 19B-9	Level C Pressure Capability of Drywell Head at 260°C (500°F).....	19B-24
Table 19B-10	Level C Pressure Capability of Hatches and Airlocks at 260°C (500°F).....	19B-25
Table 19B-11	Summary of Level C/Factored Load Category Pressure Capacity at 260°C (500°F).....	19B-26
Table 19C-1	Summary of Thermal Material Properties .....	19C-18
Table 19C-2	Summary of Elastic Mechanical Properties for Steels.....	19C-19
Table 19C-3	Summary of Plastic Mechanical Properties for Steels.....	19C-20
Table 19C-4	Summary of Concrete Material Properties .....	19C-21
Table 19C-5	Summary of Material Limits and Failure Criteria .....	19C-22
Table 19C-6	Summary of Variance for Modeling Uncertainty .....	19C-23
Table 19C-7	Summary of Uncertainty Evaluations for RCCV Pressure Capacity.....	19C-24
Table 19C-8	Summary of Pressure Fragility for RCCV and Liner .....	19C-25
Table 19C-9	Summary of Uncertainty Evaluations for Drywell Head Pressure Capacity .....	19C-26
Table 19C-10	Summary of Pressure Fragility for Drywell Head .....	19C-27
Table 19C-11	Summary of Uncertainty Evaluations for Equipment Hatch Pressure Capacity .....	19C-28

Table 19C-12	Summary of Pressure Fragility for Equipment Hatch.....	19C-29
Table 19C-13	Summary of ESBWR Fragility for Over-Pressurization .....	19C-30

### List of Illustrations

Figure 1.1-1. ESBWR Standard Plant General Site Plan.....	1.1-4
Figure 1.1-2. Safety System Configuration (not to scale) .....	1.1-5
Figure 1.1-3a. Reactor System Heat Balance at 100% Power (SI Units).....	1.1-6
Figure 1.1-3b. Reactor System Heat Balance at 100% Power (English Units).....	1.1-7
Figure 1.2-1. Nuclear Island Plan at Elevation –11500.....	1.2-75
Figure 1.2-2. Nuclear Island Plan at Elevation –6400.....	1.2-76
Figure 1.2-3. Nuclear Island Plan at Elevation –1000.....	1.2-77
Figure 1.2-4. Nuclear Island Plan at Elevation 4650.....	1.2-78
Figure 1.2-5. Nuclear Island Plan at Elevation 9060.....	1.2-79
Figure 1.2-6. Nuclear Island Plan at Elevation 13570.....	1.2-80
Figure 1.2-7. Nuclear Island Plan at Elevation 17500.....	1.2-81
Figure 1.2-8. Nuclear Island Plan at Elevation 27000.....	1.2-82
Figure 1.2-9. Nuclear Island Plan at Elevation 34000.....	1.2-83
Figure 1.2-10. Nuclear Island Elevation Section A-A.....	1.2-84
Figure 1.2-11. Nuclear Island Elevation Section B-B.....	1.2-85
Figure 1.2-12. Turbine Building Plan at Elevation –1400.....	1.2-86
Figure 1.2-13. Turbine Building Plan at Elevation 4650.....	1.2-87
Figure 1.2-14. Turbine Building Plan at Elevation 12000.....	1.2-88
Figure 1.2-15. Turbine Building Plan at Elevation 20000.....	1.2-89
Figure 1.2-16. Turbine Building Plan at Elevation 28000.....	1.2-90
Figure 1.2-17. Turbine Building Plan at Elevation 35000.....	1.2-91
Figure 1.2-18. Turbine Building Plan at Elevation Various.....	1.2-92
Figure 1.2-19. Turbine Building Elevation Section A-A.....	1.2-93
Figure 1.2-20. Turbine Building Elevation Section B-B.....	1.2-94
Figure 1.2-21. Radwaste Building Plan at Elevation -9350.....	1.2-95
Figure 1.2-22. Radwaste Building Plan at Elevation -2350.....	1.2-96
Figure 1.2-23. Radwaste Building Plan at Elevation 4650.....	1.2-97
Figure 1.2-24. Radwaste Building Plan at Elevation 10650.....	1.2-98
Figure 1.2-25. Radwaste Building Elevation Section A-A.....	1.2-99
Figure 1.2-26. Electrical Building Plan at Elevation 4650.....	1.2-100
Figure 1.2-27. Electrical Building Plan at Elevation 9800.....	1.2-101
Figure 1.2-28. (Deleted).....	1.2-102
Figure 1.2-29. Electrical Building Plan at Elevation 18000.....	1.2-103
Figure 1.2-30. (Deleted).....	1.2-104
Figure 1.2-31. Electrical Building Plan at Elevation 27000.....	1.2-105
Figure 1.2-32. Electrical Building Plan at Elevation Various.....	1.2-106

Figure 1.2-33. Electrical Building Elevation Section A-A .....	1.2-107
Figure 1.5-1. Evolution of the GE/GEH BWR.....	1.5-13
Figure 1.5-2. Evolution of the BWR Reactor Design.....	1.5-14
Figure 1.5-3. Comparison of BWR Containments.....	1.5-15
Figure 1.7-1. P&ID Symbols for Valves and Valve Actuators.....	1.7-11
Figure 1.7-2. P&ID Symbols for Instruments.....	1.7-12
Figure 1.7-3. Miscellaneous P&ID Symbols.....	1.7-13
Figure 1.7-4. P&ID Symbols for Piping, Instrument and Electrical Lines and Line Continuations 1.7-14	



Figure 2.0-1. ESBWR Horizontal SSE Design Ground Spectra  
at Foundation Level ..... 2.0-18

Figure 2.0-2. ESBWR Vertical SSE Design Ground Response Spectra  
at Foundation Level ..... 2.0-19

Figure 2A-1. Potential Radiological Sources and Receptors for  
the ESBWR Control Room..... 2A-14

Figure 3.2-1. Quality Group and Seismic Category Classification Applicable to Power Conversion System .....	3.2-47
Figure 3.2-2. Quality Group and Seismic Category Classification Applicable to Feedwater System.....	3.2-49
Figure 3.5-1. Missile Velocity and Displacement Characteristics Resulting from Saturated Steam and Water Blowdowns (7.2 MPa (1044 psia) Stagnation Pressure).....	3.5-13
Figure 3.5-2. ESBWR Standard Plant Low-Trajectory Turbine Missile Strike Zone.....	3.5-14
Figure 3.6-1. Jet Characteristics.....	3.6-29
Figure 3.6-2. Typical Pipe Whip Restraint Configuration.....	3.6-30
Figure 3.7-1. Horizontal SSE Design Spectra, Generic Site.....	3.7-37
Figure 3.7-2. Vertical SSE Design Spectra, Generic Site.....	3.7-38
Figure 3.7-3. Horizontal, H1 Component Time History, Generic Site.....	3.7-39
Figure 3.7-4. Horizontal, H2 Component Time History, Generic Site.....	3.7-40
Figure 3.7-5. Vertical, Component Time History, Generic Site.....	3.7-41
Figure 3.7-6. 2% Damped Response Spectra, H1 Component, Generic Site .....	3.7-42
Figure 3.7-7. 3% Damped Response Spectra, H1 Component, Generic Site .....	3.7-43
Figure 3.7-8. 4% Damped Response Spectra, H1 Component, Generic Site .....	3.7-44
Figure 3.7-9. 5% Damped Response Spectra, H1 Component, Generic Site .....	3.7-45
Figure 3.7-10. 7% Damped Response Spectra, H1 Component, Generic Site .....	3.7-46
Figure 3.7-11. 2% Damped Response Spectra, H2 Component, Generic Site .....	3.7-47
Figure 3.7-12. 3% Damped Response Spectra, H2 Component, Generic Site .....	3.7-48
Figure 3.7-13. 4% Damped Response Spectra, H2 Component, Generic Site .....	3.7-49
Figure 3.7-14. 5% Damped Response Spectra, H2 Component, Generic Site .....	3.7-50
Figure 3.7-15. 7% Damped Response Spectra, H2 Component, Generic Site .....	3.7-51
Figure 3.7-16. 2% Damped Response Spectra, Vertical Component, Generic Site .....	3.7-52
Figure 3.7-17. 3% Damped Response Spectra, Vertical Component, Generic Site .....	3.7-53
Figure 3.7-18. 4% Damped Response Spectra, Vertical Component, Generic Site .....	3.7-54
Figure 3.7-19. 5% Damped Response Spectra, Vertical Component, Generic Site .....	3.7-55
Figure 3.7-20. 7% Damped Response Spectra, Vertical Component, Generic Site .....	3.7-56
Figure 3.7-21. Power Spectral Density Function, H1 Component, Generic Site .....	3.7-57
Figure 3.7-22. Power Spectral Density Function, H2 Component, Generic Site .....	3.7-58
Figure 3.7-23. Power Spectral Density Function, Vertical Component, Generic Site .....	3.7-60
Figure 3.7-24. North Anna ESP Horizontal H1 Target Spectrum at ESBWR CB Base .....	3.7-61
Figure 3.7-25. North Anna ESP Horizontal H1 Time Histories at ESBWR CB Base .....	3.7-62
Figure 3.7-26. North Anna ESP Horizontal H2 Target Spectrum at ESBWR CB Base .....	3.7-63
Figure 3.7-27. North Anna ESP Horizontal H2 Time Histories at ESBWR CB Base .....	3.7-64
Figure 3.7-28. North Anna ESP Vertical Target Spectrum at ESBWR CB Base .....	3.7-65
Figure 3.7-29. North Anna ESP Vertical Time Histories at ESBWR CB Base .....	3.7-66
Figure 3.7-30. North Anna ESP Horizontal H1 Target Spectrum at ESBWR RB/FB Base .....	3.7-67
Figure 3.7-31. North Anna ESP Horizontal H1 Time Histories at ESBWR RB/FB Base .....	3.7-68
Figure 3.7-32. North Anna ESP Horizontal H2 Target Spectrum at ESBWR RB/FB Base .....	3.7-69
Figure 3.7-33. North Anna ESP Horizontal H2 Time Histories at ESBWR RB/FB Base .....	3.7-70
Figure 3.7-34. North Anna ESP Vertical Target Spectrum at ESBWR RB/FB Base .....	3.7-71
Figure 3.7-35. North Anna ESP Vertical Time Histories at ESBWR RB/FB Base .....	3.7-72
Figure 3.7-36. Not used. ....	3.7-73

Figure 3.7-37. Alternative Damping Values for Response Spectra Analysis of ASME Section III, Division 1 Class 1, 2, and 3, and ASME B31.1 Piping Systems ..... 3.7-74

Figure 3.7-38. Single Envelope Spectrum Match – H1 Component ..... 3.7-75

Figure 3.7-39. Single Envelope Spectrum Match – H2 Component ..... 3.7-76

Figure 3.7-40. Single Envelope Spectrum Match – Vertical Component ..... 3.7-77

Figure 3.7-41. Single Envelope Time Histories – H1 Component ..... 3.7-78

Figure 3.7-42. Single Envelope Time Histories – H2 Component ..... 3.7-79

Figure 3.7-43. Single Envelope Time Histories – Vertical Component ..... 3.7-80

Figure 3.8-1. Configuration of Concrete Containment ..... 3.8-66

Figure 3.8-2. Schematic of Reinforcements in RCCV Wall Around Equipment Hatch/Personnel Airlock Opening ..... 3.8-67

Figure 3.8-3. Typical Internal Containment Plate Support with Embedment Integral with Containment Liner ..... 3.8-68

Figure 3.8-4. Typical External Containment Plate Support with Embedment ..... 3.8-69

Figure 3.8-5. Quencher Anchorage ..... 3.8-70

Figure 3.8-6. RCCV Wall High-Energy Penetration ..... 3.8-71

Figure 3.8-7. RCCV Top Slab Penetration and PCCS Passages ..... 3.8-73

Figure 3.8-8. RCCV Low-Energy Penetration ..... 3.8-74

Figure 3.8-9. RCCV Multiple Penetration ..... 3.8-75

Figure 3.8-10. RCCV Electrical Penetration ..... 3.8-76

Figure 3.8-11. RCCV Spare Penetration ..... 3.8-77

Figure 3.8-12. RB Floor Composite Slab ..... 3.8-78

Figure 3.9-1. Stress-Strain Curve for Blowout Restraints .....	3.9-112
Figure 3.9-2. Minimum Floodable Volume .....	3.9-113
Figure 3.9-3. Recirculation Flow Path .....	3.9-114
Figure 3.9-4. Fuel Support Pieces .....	3.9-115
Figure 3.9-5. Pressure Nodes for Depressurization Analysis .....	3.9-116
Figure 3.9-6. Flow Chart for Determining Test Data Frequency and Amplitude .....	3.9-117
Figure 3.9-7. ESBWR Reactor Assembly Showing Reactor Internal Components .....	3.9-118
Figure 3.9-8. Typical Shroud, Chimney, and Top Guide Assembly .....	3.9-119
Figure 3.9-9. Typical Core Plate to Shroud Connection .....	3.9-120
Figure 3.9-10. Typical In-core Guide Tube Lateral Support Connection to Support Ring ..	3.9-121
Figure 3.9-11. Typical Inter-Connection Between In-core Guide Tube Lateral Supports ..	3.9-122
Figure 3.9-12. Typical Connection Between In-Core Guide Tube and Core Plate .....	3.9-123

Figure 3A.5-1. Method for Frequency-Independent Soil Properties .....	3A-12
Figure 3A.7-1. RB/FB Stick Model .....	3A-37
Figure 3A.7-2. RCCV Stick Model .....	3A-38
Figure 3A.7-3. Pedestal Stick Model .....	3A-39
Figure 3A.7-4. RB/FB Complex Seismic Model .....	3A-40
Figure 3A.7-5. Control Building Stick Model .....	3A-41
Figure 3A.7-6. Control Building Seismic Model .....	3A-42
Figure 3A.7-7. FWSC Seismic Model .....	3A-43
Figure 3A.7-8. SASSI2000 Plate Elements for RB/FB Basemat .....	3A-44
Figure 3A.7-9. SASSI2000 Plate Elements for RB/FB Exterior Walls .....	3A-45
Figure 3A.7-10. Overview of RB/FB SASSI2000 Model .....	3A-46
Figure 3A.7-11. SASSI2000 Plate Elements for CB Basemat .....	3A-47
Figure 3A.7-12. SASSI2000 Plate Elements for CB Exterior Walls .....	3A-48
Figure 3A.7-13. Overview of CB SASSI2000 Model .....	3A-49
Figure 3A.7-14. SASSI2000 Plate Elements for FWSC Basemat .....	3A-50
Figure 3A.7-15. Overview of FWSC SASSI2000 Model .....	3A-50
Figure 3A.8.1-1a. FRS (Effect of Soil Stiffness) – RB/FB Refueling Floor X .....	3A-74
Figure 3A.8.1-1b. FRS (Effect of Soil Stiffness) – RCCV Top Slab X .....	3A-74
Figure 3A.8.1-1c. FRS (Effect of Soil Stiffness) – Vent Wall Top X .....	3A-75
Figure 3A.8.1-1d. FRS (Effect of Soil Stiffness) – RSW Top X .....	3A-75
Figure 3A.8.1-1e. FRS (Effect of Soil Stiffness) – RPV Top X .....	3A-76
Figure 3A.8.1-1f. FRS (Effect of Soil Stiffness) – RB/FB Basemat X .....	3A-76
Figure 3A.8.1-1g. FRS (Effect of Soil Stiffness) – CB Top X .....	3A-77
Figure 3A.8.1-1h. FRS (Effect of Soil Stiffness) – CB Basemat X .....	3A-77
Figure 3A.8.1-2a. FRS (Effect of Soil Stiffness) – RB/FB Refueling Floor Y .....	3A-78
Figure 3A.8.1-2b. FRS (Effect of Soil Stiffness) – RCCV Top Slab Y .....	3A-78
Figure 3A.8.1-2c. FRS (Effect of Soil Stiffness) – Vent Wall Top Y .....	3A-79
Figure 3A.8.1-2d. FRS (Effect of Soil Stiffness) – RSW Top Y .....	3A-79
Figure 3A.8.1-2e. FRS (Effect of Soil Stiffness) – RPV Top Y .....	3A-80
Figure 3A.8.1-2f. FRS (Effect of Soil Stiffness) – RB/FB Basemat Y .....	3A-80
Figure 3A.8.1-2g. FRS (Effect of Soil Stiffness) – CB Top Y .....	3A-81
Figure 3A.8.1-2h. FRS (Effect of Soil Stiffness) – CB Basemat Y .....	3A-81
Figure 3A.8.1-3a. FRS (Effect of Soil Stiffness) – RB/FB Refueling Floor Z .....	3A-82
Figure 3A.8.1-3b. FRS (Effect of Soil Stiffness) – RCCV Top Slab Z .....	3A-82
Figure 3A.8.1-3c. FRS (Effect of Soil Stiffness) – Vent Wall Top Z .....	3A-83
Figure 3A.8.1-3d. FRS (Effect of Soil Stiffness) – RSW Top Z .....	3A-83
Figure 3A.8.1-3e. FRS (Effect of Soil Stiffness) – RPV Top Z .....	3A-84
Figure 3A.8.1-3f. FRS (Effect of Soil Stiffness) – RB/FB Basemat Z .....	3A-84
Figure 3A.8.1-3g. FRS (Effect of Soil Stiffness) – CB Top Z .....	3A-85
Figure 3A.8.1-3h. FRS (Effect of Soil Stiffness) – CB Basemat Z .....	3A-85
Figure 3A.8.1-4a. FRS (Effect of Soil Stiffness) – FWS Wall Top X .....	3A-86
Figure 3A.8.1-4b. FRS (Effect of Soil Stiffness) – FWS Basemat X .....	3A-86
Figure 3A.8.1-4c. FRS (Effect of Soil Stiffness) – FPE Top X .....	3A-87
Figure 3A.8.1-4d. FRS (Effect of Soil Stiffness) – FPE Basemat X .....	3A-87
Figure 3A.8.1-5a. FRS (Effect of Soil Stiffness) – FWS Wall Top Y .....	3A-88

Figure 3A.8.1-5b. FRS (Effect of Soil Stiffness) – FWS Basemat Y ..... 3A-88

Figure 3A.8.1-5c. FRS (Effect of Soil Stiffness) – FPE Top Y ..... 3A-89

Figure 3A.8.1-5d. FRS (Effect of Soil Stiffness) – FPE Basemat Y ..... 3A-89

Figure 3A.8.1-6a. FRS (Effect of Soil Stiffness) – FWS Wall Top Z ..... 3A-90

Figure 3A.8.1-6b. FRS (Effect of Soil Stiffness) – FWS Basemat Z ..... 3A-90

Figure 3A.8.1-6c. FRS (Effect of Soil Stiffness) – FPE Top Z ..... 3A-91

Figure 3A.8.1-6d. FRS (Effect of Soil Stiffness) – FPE Basemat Z ..... 3A-91

Figure 3A.8.2-1a. FRS (Effect of Single Envelope Ground Motion) –  
RB/FB Refueling Floor X ..... 3A-92

Figure 3A.8.2-1b. FRS (Effect of Single Envelope Ground Motion) – RCCV Top Slab X .. 3A-92

Figure 3A.8.2-1c. FRS (Effect of Single Envelope Ground Motion) – Vent Wall Top X .... 3A-93

Figure 3A.8.2-1d. FRS (Effect of Single Envelope Ground Motion) – RSW Top X ..... 3A-93

Figure 3A.8.2-1e. FRS (Effect of Single Envelope Ground Motion) – RPV Top X ..... 3A-94

Figure 3A.8.2-1f. FRS (Effect of Single Envelope Ground Motion) – RB/FB Basemat X .. 3A-94

Figure 3A.8.2-1g. FRS (Effect of Single Envelope Ground Motion) – CB Top X ..... 3A-95

Figure 3A.8.2-1h. FRS (Effect of Single Envelope Ground Motion) – CB Basemat X ..... 3A-95

Figure 3A.8.2-2a. FRS (Effect of Single Envelope Ground Motion) –  
RB/FB Refueling Floor Y ..... 3A-96

Figure 3A.8.2-2b. FRS (Effect of Single Envelope Ground Motion) – RCCV Top Slab Y .. 3A-96

Figure 3A.8.2-2c. FRS (Effect of Single Envelope Ground Motion) – Vent Wall Top Y .... 3A-97

Figure 3A.8.2-2d. FRS (Effect of Single Envelope Ground Motion) – RSW Top Y ..... 3A-97

Figure 3A.8.2-2e. FRS (Effect of Single Envelope Ground Motion) – RPV Top Y ..... 3A-98

Figure 3A.8.2-2f. FRS (Effect of Single Envelope Ground Motion) – RB/FB Basemat Y .. 3A-98

Figure 3A.8.2-2g. FRS (Effect of Single Envelope Ground Motion) – CB Top Y ..... 3A-99

Figure 3A.8.2-2h. FRS (Effect of Single Envelope Ground Motion) – CB Basemat Y ..... 3A-99

Figure 3A.8.2-3a. FRS (Effect of Single Envelope Ground Motion) –  
RB/FB Refueling Floor Z ..... 3A-100

Figure 3A.8.2-3b. FRS (Effect of Single Envelope Ground Motion) – RCCV Top Slab Z 3A-100

Figure 3A.8.2-3c. FRS (Effect of Single Envelope Ground Motion) – Vent Wall Top Z .. 3A-101

Figure 3A.8.2-3d. FRS (Effect of Single Envelope Ground Motion) – RSW Top Z ..... 3A-101

Figure 3A.8.2-3e. FRS (Effect of Single Envelope Ground Motion) – RPV Top Z ..... 3A-102

Figure 3A.8.2-3f. FRS (Effect of Single Envelope Ground Motion) – RB/FB Basemat Z. 3A-102

Figure 3A.8.2-3g. FRS (Effect of Single Envelope Ground Motion) – CB Top Z ..... 3A-103

Figure 3A.8.2-3h. FRS (Effect of Single Envelope Ground Motion) – CB Basemat Z ..... 3A-103

Figure 3A.8.3-1a. FRS (Effect of Updated Design of RSW and VW) – RB/FB Refueling  
Floor X ..... 3A-104

Figure 3A.8.3-1b. FRS (Effect of Updated Design of RSW and VW) – RCCV Top  
Slab X ..... 3A-104

Figure 3A.8.3-1c. FRS (Effect of Updated Design of RSW and VW) –  
Vent Wall Top X ..... 3A-105

Figure 3A.8.3-1d. FRS (Effect of Updated Design of RSW and VW) – RSW Top X ..... 3A-105

Figure 3A.8.3-1e. FRS (Effect of Updated Design of RSW and VW) – RPV Top X ..... 3A-106

Figure 3A.8.3-1f. FRS (Effect of Updated Design of RSW and VW) – RB/FB  
Basemat X ..... 3A-106

Figure 3A.8.3-2a. FRS (Effect of Updated Design of RSW and VW) –  
RB/FB Refueling Floor Y ..... 3A-107

Figure 3A.8.3-2b. FRS (Effect of Updated Design of RSW and VW) – RCCV Top Slab Y ..... 3A-107

Figure 3A.8.3-2c. FRS (Effect of Updated Design of RSW and VW) – Vent Wall Top Y ..... 3A-108

Figure 3A.8.3-2d. FRS (Effect of Updated Design of RSW and VW) – RSW Top Y ..... 3A-108

Figure 3A.8.3-2e. FRS (Effect of Updated Design of RSW and VW) – RPV Top Y ..... 3A-109

Figure 3A.8.3-2f. FRS (Effect of Updated Design of RSW and VW) – RB/FB Basemat Y ..... 3A-109

Figure 3A.8.3-3a. FRS (Effect of Updated Design of RSW and VW) – RB/FB Refueling Floor Z ..... 3A-110

Figure 3A.8.3-3b. FRS (Effect of Updated Design of RSW and VW) – RCCV Top Slab Z ..... 3A-110

Figure 3A.8.3-3c. FRS (Effect of Updated Design of RSW and VW) – Vent Wall Top Z ..... 3A-111

Figure 3A.8.3-3d. FRS (Effect of Updated Design of RSW and VW) – RSW Top Z ..... 3A-111

Figure 3A.8.3-3e. FRS (Effect of Updated Design of RSW and VW) – RPV Top Z ..... 3A-112

Figure 3A.8.3-3f. FRS (Effect of Updated Design of RSW and VW) – RB/FB Basemat Z ..... 3A-112

Figure 3A.8.4-1a. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RB/FB Refueling Floor X ..... 3A-113

Figure 3A.8.4-1b. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RCCV Top Slab X ..... 3A-113

Figure 3A.8.4-1c. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – Vent Wall Top X ..... 3A-114

Figure 3A.8.4-1d. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RSW Top X ..... 3A-114

Figure 3A.8.4-1e. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RPV Top X ..... 3A-115

Figure 3A.8.4-1f. FRS (Effect of Infill 50% Concrete Stiffness of VW and D/F) – RB/FB Basemat X ..... 3A-115

Figure 3A.8.4-2a. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RB/FB Refueling Floor Y ..... 3A-116

Figure 3A.8.4-2b. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RCCV Top Slab Y ..... 3A-116

Figure 3A.8.4-2c. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – Vent Wall Top Y ..... 3A-117

Figure 3A.8.4-2d. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RSW Top Y ..... 3A-117

Figure 3A.8.4-2e. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RPV Top Y ..... 3A-118

Figure 3A.8.4-2f. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RB/FB Basemat Y ..... 3A-118

Figure 3A.8.4-3a. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RB/FB Refueling Floor Z ..... 3A-119

Figure 3A.8.4-3b. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RCCV Top Slab Z ..... 3A-119

Figure 3A.8.4-3c. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – Vent Wall Top Z .....	3A-120
Figure 3A.8.4-3d. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RSW Top Z .....	3A-120
Figure 3A.8.4-3e. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RPV Top Z .....	3A-121
Figure 3A.8.4-3f. FRS (Effect of 50% Infill Concrete Stiffness of VW and D/F) – RB/FB Basemat Z .....	3A-121
Figure 3A.8.4-4a. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RB/FB Refueling Floor X .....	3A-122
Figure 3A.8.4-4b. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RCCV Top Slab X .....	3A-122
Figure 3A.8.4-4c. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – Vent Wall Top X .....	3A-123
Figure 3A.8.4-4d. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RSW Top X .....	3A-123
Figure 3A.8.4-4e. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RPV Top X .....	3A-124
Figure 3A.8.4-4f. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RB/FB Basemat X .....	3A-124
Figure 3A.8.4-5a. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RB/FB Refueling Floor Y .....	3A-125
Figure 3A.8.4-5b. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RCCV Top Slab Y .....	3A-125
Figure 3A.8.4-5c. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – Vent Wall Top Y .....	3A-126
Figure 3A.8.4-5d. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RSW Top Y .....	3A-127
Figure 3A.8.4-5e. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RPV Top Y .....	3A-128
Figure 3A.8.4-5f. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RB/FB Basemat Y .....	3A-128
Figure 3A.8.4-6a. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RB/FB Refueling Floor Z .....	3A-129
Figure 3A.8.4-6b. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RCCV Top Slab Z .....	3A-129
Figure 3A.8.4-6c. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – Vent Wall Top Z .....	3A-130
Figure 3A.8.4-6d. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RSW Top Z .....	3A-131
Figure 3A.8.4-6e. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RPV Top Z .....	3A-132
Figure 3A.8.4-6f. FRS (Effect of 100% Infill Concrete Stiffness of VW and D/F) – RB/FB Basemat Z .....	3A-132
Figure 3A.8.5-1a. FRS (Effect of LOCA Flooding) – RB/FB Refueling Floor X .....	3A-133
Figure 3A.8.5-1b. FRS (Effect of LOCA Flooding) – RCCV Top Slab X .....	3A-133



Figure 3A.8.5-1c. FRS (Effect of LOCA Flooding) – Vent Wall Top X.....	3A-134
Figure 3A.8.5-1d. FRS (Effect of LOCA Flooding) – RSW Top X.....	3A-134
Figure 3A.8.5-1e. FRS (Effect of LOCA Flooding) – RPV Top X.....	3A-135
Figure 3A.8.5-1f. FRS (Effect of LOCA Flooding) – RB/FB Basemat X.....	3A-135
Figure 3A.8.5-2a. FRS (Effect of LOCA Flooding) – RB/FB Refueling Floor Y.....	3A-136
Figure 3A.8.5-2b. FRS (Effect of LOCA Flooding) – RCCV Top Slab Y.....	3A-136
Figure 3A.8.5-2c. FRS (Effect of LOCA Flooding) – Vent Wall Top Y.....	3A-137
Figure 3A.8.5-2d. FRS (Effect of LOCA Flooding) – RSW Top Y.....	3A-137
Figure 3A.8.5-2e. FRS (Effect of LOCA Flooding) – RPV Top Y.....	3A-138
Figure 3A.8.5-2f. FRS (Effect of LOCA Flooding) – RB/FB Basemat Y.....	3A-138
Figure 3A.8.5-3a. FRS (Effect of LOCA Flooding) – RB/FB Refueling Floor Z.....	3A-139
Figure 3A.8.5-3b. FRS (Effect of LOCA Flooding) – RCCV Top Slab Z.....	3A-139
Figure 3A.8.5-3c. FRS (Effect of LOCA Flooding) – Vent Wall Top Z.....	3A-140
Figure 3A.8.5-3d. FRS (Effect of LOCA Flooding) – RSW Top Z.....	3A-140
Figure 3A.8.5-3e. FRS (Effect of LOCA Flooding) – RPV Top Z.....	3A-141
Figure 3A.8.5-3f. FRS (Effect of LOCA Flooding) – RB/FB Basemat Z.....	3A-141
Figure 3A.8.6-1a. FRS (Effect of Layered Sites) – RB/FB Refueling Floor X.....	3A-142
Figure 3A.8.6-1b. FRS (Effect of Layered Sites) – RCCV Top Slab X.....	3A-142
Figure 3A.8.6-1c. FRS (Effect of Layered Sites) – Vent Wall Top X.....	3A-143
Figure 3A.8.6-1d. FRS (Effect of Layered Sites) – RSW Top X.....	3A-143
Figure 3A.8.6-1e. FRS (Effect of Layered Sites) – RPV Top X.....	3A-144
Figure 3A.8.6-1f. FRS (Effect of Layered Sites) – RB/FB Basemat X.....	3A-144
Figure 3A.8.6-1g. FRS (Effect of Layered Sites) – CB Top X.....	3A-145
Figure 3A.8.6-1h. FRS (Effect of Layered Sites) – CB Basemat X.....	3A-145
Figure 3A.8.6-1i. FRS (Effect of Layered Sites) – FWS Wall Top X.....	3A-146
Figure 3A.8.6-1j. FRS (Effect of Layered Sites) – FWS Basemat X.....	3A-146
Figure 3A.8.6-1k. FRS (Effect of Layered Sites) – FPE Top X.....	3A-147
Figure 3A.8.6-1l. FRS (Effect of Layered Sites) – FPE Basemat X.....	3A-147
Figure 3A.8.6-2a. FRS (Effect of Layered Sites) – RB/FB Refueling Floor Y.....	3A-148
Figure 3A.8.6-2b. FRS (Effect of Layered Sites) – RCCV Top Slab Y.....	3A-148
Figure 3A.8.6-2c. FRS (Effect of Layered Sites) – Vent Wall Top Y.....	3A-149
Figure 3A.8.6-2d. FRS (Effect of Layered Sites) – RSW Top Y.....	3A-149
Figure 3A.8.6-2e. FRS (Effect of Layered Sites) – RPV Top Y.....	3A-150
Figure 3A.8.6-2f. FRS (Effect of Layered Sites) – RB/FB Basemat Y.....	3A-150
Figure 3A.8.6-2g. FRS (Effect of Layered Sites) – CB Top Y.....	3A-151
Figure 3A.8.6-2h. FRS (Effect of Layered Sites) – CB Basemat Y.....	3A-151
Figure 3A.8.6-2i. FRS (Effect of Layered Sites) – FWS Wall Top Y.....	3A-152
Figure 3A.8.6-2j. FRS (Effect of Layered Sites) – FWS Basemat Y.....	3A-152
Figure 3A.8.6-2k. FRS (Effect of Layered Sites) – FPE Top Y.....	3A-153
Figure 3A.8.6-2l. FRS (Effect of Layered Sites) – FPE Basemat Y.....	3A-153
Figure 3A.8.6-3a. FRS (Effect of Layered Sites) – RB/FB Refueling Floor Z.....	3A-154
Figure 3A.8.6-3b. FRS (Effect of Layered Sites) – RCCV Top Slab Z.....	3A-154
Figure 3A.8.6-3c. FRS (Effect of Layered Sites) – Vent Wall Top Z.....	3A-155
Figure 3A.8.6-3d. FRS (Effect of Layered Sites) – RSW Top Z.....	3A-155
Figure 3A.8.6-3e. FRS (Effect of Layered Sites) – RPV Top Z.....	3A-156
Figure 3A.8.6-3f. FRS (Effect of Layered Sites) – RB/FB Basemat Z.....	3A-156

Figure 3A.8.6-3g. FRS (Effect of Layered Sites) – CB Top Z.....	3A-157
Figure 3A.8.6-3h. FRS (Effect of Layered Sites) – CB Basemat Z.....	3A-157
Figure 3A.8.6-3i. FRS (Effect of Layered Sites) – FWS Wall Top Z.....	3A-158
Figure 3A.8.6-3j. FRS (Effect of Layered Sites) – FWS Basemat Z.....	3A-158
Figure 3A.8.6-3k. FRS (Effect of Layered Sites) – FPE Top Z.....	3A-159
Figure 3A.8.6-3l. FRS (Effect of Layered Sites) – FPE Basemat Z.....	3A-159
Figure 3A.8.8-1. Lateral Soil Pressure – RB/FB R1 and F3 Wall.....	3A-160
Figure 3A.8.8-2. Lateral Soil Pressure – RB/FB RA and RG Wall.....	3A-161
Figure 3A.8.8-3. Lateral Soil Pressure - CB C1 and C5 Wall.....	3A-162
Figure 3A.8.8-4. Lateral Soil Pressure - CB CA and CD Wall.....	3A-163
Figure 3A.8.9-1a. FRS (Effect of Concrete Cracking) – RB/FB Refueling Floor X.....	3A-164
Figure 3A.8.9-1b. FRS (Effect of Concrete Cracking) – RCCV Top Slab X.....	3A-164
Figure 3A.8.9-1c. FRS (Effect of Concrete Cracking) – Vent Wall Top X.....	3A-165
Figure 3A.8.9-1d. FRS (Effect of Concrete Cracking) – RSW Top X.....	3A-165
Figure 3A.8.9-1e. FRS (Effect of Concrete Cracking) – RPV Top X.....	3A-166
Figure 3A.8.9-1f. FRS (Effect of Concrete Cracking) – RB/FB Basemat X.....	3A-166
Figure 3A.8.9-1g. FRS (Effect of Concrete Cracking) – CB Top X.....	3A-167
Figure 3A.8.9-1h. FRS (Effect of Concrete Cracking) – CB Basemat X.....	3A-167
Figure 3A.8.9-1i. FRS (Effect of Concrete Cracking) – FWS Wall Top X.....	3A-168
Figure 3A.8.9-1j. FRS (Effect of Concrete Cracking) – FWS Basemat X.....	3A-168
Figure 3A.8.9-1k. FRS (Effect of Concrete Cracking) – FPE Top X.....	3A-169
Figure 3A.8.9-1l. FRS (Effect of Concrete Cracking) – FPE Basemat X.....	3A-169
Figure 3A.8.9-2a. FRS (Effect of Concrete Cracking) – RB/FB Refueling Floor Y.....	3A-170
Figure 3A.8.9-2b. FRS (Effect of Concrete Cracking) – RCCV Top Slab Y.....	3A-170
Figure 3A.8.9-2c. FRS (Effect of Concrete Cracking) – Vent Wall Top Y.....	3A-171
Figure 3A.8.9-2d. FRS (Effect of Concrete Cracking) – RSW Top Y.....	3A-171
Figure 3A.8.9-2e. FRS (Effect of Concrete Cracking) – RPV Top Y.....	3A-172
Figure 3A.8.9-2f. FRS (Effect of Concrete Cracking) – RB/FB Basemat Y.....	3A-172
Figure 3A.8.9-2g. FRS (Effect of Concrete Cracking) – CB Top Y.....	3A-173
Figure 3A.8.9-2h. FRS (Effect of Concrete Cracking) – CB Basemat Y.....	3A-173
Figure 3A.8.9-2i. FRS (Effect of Concrete Cracking) – FWS Wall Top Y.....	3A-174
Figure 3A.8.9-2j. FRS (Effect of Concrete Cracking) – FWS Basemat Y.....	3A-174
Figure 3A.8.9-2k. FRS (Effect of Concrete Cracking) – FPE Top Y.....	3A-175
Figure 3A.8.9-2l. FRS (Effect of Concrete Cracking) – FPE Basemat Y.....	3A-175
Figure 3A.8.11-1. FRS (Effect of Structure-Structure Interaction) – CB Top X.....	3A-176
Figure 3A.8.11-2. FRS (Effect of Structure-Structure Interaction) – CB Basemat X.....	3A-176
Figure 3A.8.11-3. FRS (Effect of Structure-Structure Interaction) – CB Top Y.....	3A-177
Figure 3A.8.11-4. FRS (Effect of Structure-Structure Interaction) – CB Basemat Y.....	3A-177
Figure 3A.8.11-5. FRS (Effect of Structure-Structure Interaction) – CB Top Z.....	3A-178
Figure 3A.8.11-6. FRS (Effect of Structure-Structure Interaction) – CB Basemat Z.....	3A-178
Figure 3A.9-1a. Enveloping Floor Response Spectra – RB/FB Refueling Floor X.....	3A-211
Figure 3A.9-1b. Enveloping Floor Response Spectra – RCCV Top Slab X.....	3A-212
Figure 3A.9-1c. Enveloping Floor Response Spectra – Vent Wall Top X.....	3A-213
Figure 3A.9-1d. Enveloping Floor Response Spectra – RSW Top X.....	3A-214
Figure 3A.9-1e. Enveloping Floor Response Spectra – RPV Top X.....	3A-215
Figure 3A.9-1f. Enveloping Floor Response Spectra – RB/FB Basemat X.....	3A-216

Figure 3A.9-1g. Enveloping Floor Response Spectra – CB Top X.....	3A-217
Figure 3A.9-1h. Enveloping Floor Response Spectra – CB Basemat X .....	3A-217
Figure 3A.9-1i. Enveloping Floor Response Spectra – FWS Wall Top X.....	3A-218
Figure 3A.9-1j. Enveloping Floor Response Spectra – FWS Basemat X .....	3A-218
Figure 3A.9-1k. Enveloping Floor Response Spectra – FPE Top X.....	3A-219
Figure 3A.9-1l. Enveloping Floor Response Spectra – FPE Basemat X.....	3A-219
Figure 3A.9-2a. Enveloping Floor Response Spectra – RB/FB Refueling Floor Y .....	3A-220
Figure 3A.9-2b. Enveloping Floor Response Spectra – RCCV Top Slab Y .....	3A-221
Figure 3A.9-2c. Enveloping Floor Response Spectra – Vent Wall Top Y .....	3A-222
Figure 3A.9-2d. Enveloping Floor Response Spectra – RSW Top Y .....	3A-223
Figure 3A.9-2e. Enveloping Floor Response Spectra – RPV Top Y.....	3A-224
Figure 3A.9-2f. Enveloping Floor Response Spectra – RB/FB Basemat Y .....	3A-225
Figure 3A.9-2g. Enveloping Floor Response Spectra – CB Top Y.....	3A-226
Figure 3A.9-2h. Enveloping Floor Response Spectra – CB Basemat Y .....	3A-226
Figure 3A.9-2i. Enveloping Floor Response Spectra – FWS Wall Top Y .....	3A-227
Figure 3A.9-2j. Enveloping Floor Response Spectra – FWS Basemat Y .....	3A-227
Figure 3A.9-2k. Enveloping Floor Response Spectra – FPE Top Y .....	3A-228
Figure 3A.9-2l. Enveloping Floor Response Spectra – FPE Basemat Y.....	3A-228
Figure 3A.9-3a. Enveloping Floor Response Spectra – RB/FB Refueling Floor Z .....	3A-229
Figure 3A.9-3b. Enveloping Floor Response Spectra – RCCV Top Slab Z.....	3A-230
Figure 3A.9-3c. Enveloping Floor Response Spectra – Vent Wall Top Z .....	3A-231
Figure 3A.9-3d. Enveloping Floor Response Spectra – RSW Top Z.....	3A-232
Figure 3A.9-3e. Enveloping Floor Response Spectra – RPV Top Z.....	3A-233
Figure 3A.9-3f. Enveloping Floor Response Spectra – RB/FB Basemat Z.....	3A-234
Figure 3A.9-3g. Enveloping Floor Response Spectra – CB Top Z .....	3A-235
Figure 3A.9-3h. Enveloping Floor Response Spectra – CB Basemat Z.....	3A-235
Figure 3A.9-3i. Enveloping Floor Response Spectra – FWS Wall Top Z .....	3A-236
Figure 3A.9-3j. Enveloping Floor Response Spectra – FWS Basemat Z.....	3A-236
Figure 3A.9-3k. Enveloping Floor Response Spectra – FPE Top Z.....	3A-237
Figure 3A.9-3l. Enveloping Floor Response Spectra – FPE Basemat Z .....	3A-237
Figure 3F-1. Beam Model for Annulus Pressurization Load.....	3F-8
Figure 3F-2. RB/FB 3D Shell Model.....	3F-9
Figure 3F-3. RB/FB 3D Shell Model (0°-180° Direction) .....	3F-11
Figure 3F-4. RB/FB 3D Shell Model (90°-270° Direction) .....	3F-13
Figure 3F-5. Floor Response Spectrum—Annulus Pressurization Envelope, Node Family: 701, Vertical.....	3F-15
Figure 3F-6. Floor Response Spectrum-Annulus Pressurization Envelope, Node Family: 706, Vertical.....	3F-17
Figure 3F-7. Floor Response Spectrum-Annulus Pressurization Envelope, Node Family: 208, Vertical.....	3F-19
Figure 3F-8. Floor Response Spectrum—Annulus Pressurization Envelope, Node Family: 701, Horizontal.....	3F-21
Figure 3F-9. Floor Response Spectrum—Annulus Pressurization Envelope, Node Family: 706, Horizontal.....	3F-23
Figure 3F-10. Floor Response Spectrum—Annulus Pressurization Envelope, Node Family: 208, Horizontal.....	3F-25

Figure 3F-11. Floor Response Spectrum—SRV Discharge Envelope, Node Family: 1104,  
Z-direction (Vertical) ..... 3F-27

Figure 3F-12. Floor Response Spectrum—SRV Discharge Envelope, Node Family: 1254,  
Z-direction (Vertical) ..... 3F-29

Figure 3F-13. Floor Response Spectrum—SRV Discharge Envelope, Node Family: 1119,  
Z-direction (Vertical) ..... 3F-31

Figure 3F-14. Floor Response Spectrum—SRV Discharge Envelope, Node Family: 18P1,  
Z-direction (Vertical) ..... 3F-33

Figure 3F-15. Floor Response Spectrum—SRV Discharge Envelope, Node Family: 1104,  
X-direction (0°-180°) ..... 3F-35

Figure 3F-16. Floor Response Spectrum—SRV Discharge Envelope, Node Family: 1254,  
X-direction (0°-180°) ..... 3F-37

Figure 3F-17. Floor Response Spectrum—SRV Discharge Envelope, Node Family: 1119,  
X-direction (0°-180°) ..... 3F-39

Figure 3F-18. Floor Response Spectrum—SRV Discharge Envelope, Node Family: 18P1,  
X-direction (0°-180°) ..... 3F-41

Figure 3F-19. Floor Response Spectrum—SRV Discharge Envelope, Node Family: 1104,  
Y-direction (90°-270°) ..... 3F-42

Figure 3F-20. Floor Response Spectrum—SRV Discharge Envelope, Node Family: 1254,  
Y-direction (90°-270°) ..... 3F-43

Figure 3F-21. Floor Response Spectrum—SRV Discharge Envelope, Node Family: 1119,  
Y-direction (90°-270°) ..... 3F-44

Figure 3F-22. Floor Response Spectrum—SRV Discharge Envelope, Node Family: 18P1,  
Y-direction (90°-270°) ..... 3F-45

Figure 3F-23. Floor Response Spectrum—Chugging & CO Envelope, Node Family: 1104,  
Z-direction (Vertical) ..... 3F-47

Figure 3F-24. Floor Response Spectrum—Chugging & CO Envelope, Node Family: 1254,  
Z-direction (Vertical) ..... 3F-49

Figure 3F-25. Floor Response Spectrum—Chugging & CO Envelope, Node Family: 1119,  
Z-direction (Vertical) ..... 3F-51

Figure 3F-26. Floor Response Spectrum—Chugging & CO Envelope, Node Family: 18P1,  
Z-direction (Vertical) ..... 3F-53

Figure 3F-27. Floor Response Spectrum—Chugging & CO Envelope, Node Family: 1104,  
X-direction (0°-180°) ..... 3F-55

Figure 3F-28. Floor Response Spectrum—Chugging & CO Envelope, Node Family: 1254,  
X-direction (0°-180°) ..... 3F-57

Figure 3F-29. Floor Response Spectrum—Chugging & CO Envelope, Node Family: 1119,  
X-direction (0°-180°) ..... 3F-59

Figure 3F-30. Floor Response Spectrum—Chugging & CO Envelope, Node Family: 18P1,  
X-direction (0°-180°) ..... 3F-61

Figure 3F-31. Floor Response Spectrum—Chugging & CO Envelope, Node Family: 1104,  
Y-direction (90°-270°) ..... 3F-62

Figure 3F-32. Floor Response Spectrum—Chugging & CO Envelope, Node Family: 1254,  
Y-direction (90°-270°) ..... 3F-63

Figure 3F-33. Floor Response Spectrum—Chugging & CO Envelope, Node Family: 1119,  
Y-direction (90°-270°) ..... 3F-64

Figure 3F-34. Floor Response Spectrum—Chugging & CO Envelope, Node Family: 18P1,  
Y-direction (90°-270°) .....3F-65

Figure 3G.1-1. RB and FB Concrete Outline Plan at EL -11500 .....	3G-117
Figure 3G.1-2. RB and FB Concrete Outline Plan at EL 4650.....	3G-118
Figure 3G.1-3. RB and FB Concrete Outline Plan at EL 17500.....	3G-119
Figure 3G.1-4. RB and FB Concrete Outline Plan at EL 27000.....	3G-120
Figure 3G.1-5. RB Concrete Outline Plan at EL 34000 .....	3G-121
Figure 3G.1-6. RB and FB Concrete Outline N-S Section.....	3G-122
Figure 3G.1-7. RB and FB Concrete Outline E-W Section.....	3G-123
Figure 3G.1-8. Finite Element Model of RB/FB (Isometric View).....	3G-124
Figure 3G.1-9. Finite Element Model of RB/FB (Foundation Mat).....	3G-125
Figure 3G.1-10. Finite Element Model of RB/FB (RCCV Wall).....	3G-126
Figure 3G.1-11. Finite Element Model of RB/FB (RPV Pedestal) .....	3G-127
Figure 3G.1-12. Finite Element Model of RB/FB (Top Slab).....	3G-128
Figure 3G.1-13. Finite Element Model of RB/FB (Suppression Pool Slab) .....	3G-129
Figure 3G.1-14. Finite Element Model of RB/FB (External Wall: North Side).....	3G-130
Figure 3G.1-15. Finite Element Model of RB/FB (External Wall: East Side)).....	3G-131
Figure 3G.1-16. Finite Element Model of RB/FB (Internal Wall on R7/F1 Column Line).....	3G-132
Figure 3G.1-17. Finite Element Model of RB/FB (RCCV Internals).....	3G-133
Figure 3G.1-18. Finite Element Model of RB/FB (RCCV Liner).....	3G-134
Figure 3G.1-19. Soil Pressure at Rest.....	3G-135
Figure 3G.1-20. Sections Where Thermal Loads Are Defined .....	3G-136
Figure 3G.1-21. Condensation Oscillation (CO) Pressure Loads.....	3G-137
Figure 3G.1-22. Chugging (CHUG) Pressure Loads.....	3G-138
Figure 3G.1-23. SRV Pressure Loads.....	3G-139
Figure 3G.1-24. Design Seismic Shears and Moments for RB and FB Walls .....	3G-140
Figure 3G.1-25. Design Seismic Shears and Moments for RCCV.....	3G-141
Figure 3G.1-26. Design Seismic Shears and Moments for RPV Pedestal and Vent Wall ..	3G-142
Figure 3G.1-27. Seismic Lateral Soil Pressure.....	3G-143
Figure 3G.1-28. Section Considered for Analysis.....	3G-144
Figure 3G.1-29. Force and Moment in Shell Element.....	3G-145
Figure 3G.1-30. Section Deformation for Dead Load .....	3G-146
Figure 3G.1-31. Section Deformation for Drywell Unit Pressure (1 MPa).....	3G-147
Figure 3G.1-32. Section Deformation for Wetwell Unit Pressure (1 MPa) .....	3G-148
Figure 3G.1-33. Section Deformation for Thermal Load (Normal Operation: Winter).....	3G-149
Figure 3G.1-34. Section Deformation for Thermal Load (LOCA After 6 min.: Winter)....	3G-150
Figure 3G.1-35. Section Deformation for Thermal Load (LOCA After 72 hr.: Winter) ....	3G-151
Figure 3G.1-36. Section Deformation for Seismic Load (Horizontal: North to South) .....	3G-152
Figure 3G.1-37. Section Deformation for Seismic Load (Horizontal: East to West).....	3G-153
Figure 3G.1-38. Section Deformation for Seismic Load (Vertical: Upward) .....	3G-154
Figure 3G.1-39. Flow Chart for Structural Analysis and Design .....	3G-155
Figure 3G.1-40. Reinforcing Steel of Foundation Mat: Plan.....	3G-156
Figure 3G.1-41. Reinforcing Steel of Foundation Mat: Section A-A.....	3G-157
Figure 3G.1-42. Reinforcing Steel of RCCV Wall.....	3G-158
Figure 3G.1-43. Reinforcing Steel of Suppression Pool Slab .....	3G-159
Figure 3G.1-44. Reinforcing Steel of Top Slab.....	3G-160

Figure 3G.1-45. Reinforcing Steel of RPV Pedestal .....	3G-161
Figure 3G.1-46. Reinforcing Steel of IC/PCCS Pool Girder.....	3G-162
Figure 3G.1-47. List of RB Wall and Slab Reinforcement.....	3G-163
Figure 3G.1-48. Liner Anchor .....	3G-164
Figure 3G.1-49. Liner Plate Plans.....	3G-165
Figure 3G.1-50. Liner Plate Development Elevation .....	3G-166
Figure 3G.1-51. Drywell Head .....	3G-167
Figure 3G.1-52. Equipment Hatch.....	3G-168
Figure 3G.1-53. Wetwell Hatch.....	3G-169
Figure 3G.1-54. Personnel Airlock.....	3G-170
Figure 3G.1-55. Diaphragm Floor .....	3G-171
Figure 3G.1-56. Diaphragm Floor Slab Anchor .....	3G-172
Figure 3G.1-57. RPV Support Bracket & Vent Wall .....	3G-173
Figure 3G.1-58. Reactor Shield Wall .....	3G-174
Figure 3G.1-59. GDCS Pool.....	3G-175
Figure 3G.1-60. Comparison of Basemat Deformation without Tension Springs (NS Direction SSE) .....	3G-176
Figure 3G.1-61. Comparison of Basemat Deformation without Tension Springs (EW Direction SSE) .....	3G-177
Figure 3G.1-62. Comparison of Basemat Sectional Moments (S to N SSE) .....	3G-178
Figure 3G.1-63. Comparison of Basemat Sectional Moments (W to E SSE) .....	3G-179
Figure 3G.1-64. Comparison of Basemat Sectional Moments (E to W SSE) .....	3G-180
Figure 3G.1-65. Concrete Backfill in Sliding Evaluation.....	3G-181
Figure 3G.1-66. Detail Local Finite Element Model of RCCV Wall Around Upper Drywell Personnel Airlock Opening.....	3G-182
Figure 3G.1-67. Additional Reinforcements in RCCV Wall Around Upper Drywell Personnel Airlock Opening (Inside Face).....	3G-183
Figure 3G.1-68. Additional Reinforcements in RCCV Wall Around Upper Drywell Personnel Airlock Opening (Outside Face).....	3G-184
Figure 3G.1-69. Reinforcements in RCCV Wall Around Upper Drywell Personnel Airlock Opening (Section) .....	3G-185
Figure 3G.1-70. Reinforcements in RCCV Wall Around Upper Drywell Personnel Airlock Opening (Plan).....	3G-186
Figure 3G.1-71a. PCCS Condenser and Supports .....	3G-187
Figure 3G.1-71b. PCCS Condenser and Supports Details.....	3G-188
Figure 3G.1-72. Finite Element Model of PCCS Condenser and Supports.....	3G-189
Figure 3G.2-1. CB Concrete Outline Plan at EL -7400 and Foundation Reinforcement ....	3G-225
Figure 3G.2-2. CB Concrete Outline Plan at EL -2000/4650 and Section Details.....	3G-226
Figure 3G.2-3. CB Concrete Outline Plan at EL 9060/13800, Section and Section Detail.	3G-227
Figure 3G.2-4. Finite Element Model of CB (Isometric View).....	3G-228
Figure 3G.2-5. Finite Element Model of CB (Foundation Mat).....	3G-229
Figure 3G.2-6. Finite Element Model of CB (External Wall: South Side).....	3G-230
Figure 3G.2-7. Finite Element Model of CB (External Wall: East Side).....	3G-231
Figure 3G.2-8. Finite Element Model of CB (Floor Slab: EL -2000) .....	3G-232
Figure 3G.2-9. Finite Element Model of CB (Floor Slab: EL 4650).....	3G-233
Figure 3G.2-10. Finite Element Model of CB (Floor Slab: EL 9060).....	3G-234

Figure 3G.2-11. Finite Element Model of CB (Roof: EL 13800) .....	3G-235
Figure 3G.2-12. Soil Pressure at Rest.....	3G-236
Figure 3G.2-13. Sections Where Thermal Loads Are Defined .....	3G-237
Figure 3G.2-14. Design Seismic Shears and Moments for CB .....	3G-238
Figure 3G.2-15. Seismic Lateral Soil Pressure.....	3G-239
Figure 3G.2-16. Force and Moment in Shell Element.....	3G-240
Figure 3G.2-17. Concrete Backfill in Sliding Evaluation.....	3G-241
Figure 3G.3-1. Sections Where Thermal Loads Are Defined .....	3G-265
Figure 3G.3-2. Section Considered for Analysis .....	3G-266
Figure 3G.3-3. Force and Moment in Shell Element.....	3G-267
Figure 3G.3-4. Reinforcing Steel of Spent Fuel Pool.....	3G-268
Figure 3G.3-5. List of FB Wall and Slab Reinforcement.....	3G-269
Figure 3G.4-1. FWSC Concrete Outline and Typical Rebar Arrangement.....	3G-297
Figure 3G.4-2. Finite Element Model of FWSC (Isometric View).....	3G-298
Figure 3G.4-3a. Finite Element Model of FWSC (Foundation Mat) .....	3G-299
Figure 3G.4-4. Finite Element Model of FWSC (South FWS Wall).....	3G-301
Figure 3G.4-5. Finite Element Model of FWSC (FPE Wall: East and South) .....	3G-302
Figure 3G.4-6. Finite Element Model of FWSC (FPE Roof Slab, South FWS Roof Slab) .....	3G-303
Figure 3G.4-7. Sections Where Thermal Loads Are Defined .....	3G-304
Figure 3G.4-8. Design Seismic Shears and Moments for FWSC (FWS).....	3G-305
Figure 3G.4-9. Design Seismic Shears and Moments for FWSC (FPE) .....	3G-306
Figure 3G.4-10. Force and Moment in Shell Element.....	3G-307
Figure 3G.4-11. Shear Keys and Concrete Backfill in Sliding Evaluation .....	3G-308
Figure 3H-1. Control Room Habitability Area .....	3H-27
Figure 3H-2. Control Room Habitability Area Heat up – 0% Exceedance Maximum Temperature Case .....	3H-28
Figure 3J-1. Simplified Piping Models.....	3J-7
Figure 3J-2. Representation of Pipe With Both Ends Supported With a Longitudinal Break..	3J-8
Figure 3L-1. Typical Chimney Assembly .....	3L-33
Figure 3L-2. Typical Steam Dryer Assembly.....	3L-34



Figure 4.1-1. Core Configuration with Location of Instrumentation.....	4.1-6
Figure 4.2-1. Axial Power Distributions (Full Length Fuel Rod).....	4.2-14
Figure 4.2-2. Fuel Assembly.....	4.2-15
Figure 4.2-3. Typical Control Rod Assembly.....	4.2-16
Figure 4.2-4. Typical ESBWR Control Rod Configuration .....	4.2-17
Figure 4.3-1. Core Loading Map – Reference Equilibrium Loading Pattern Exposures (GWD/MT) .....	4.3-14
Figure 4.3-2. Moderator Void Coefficient for Reference Equilibrium Core Design.....	4.3-15
Figure 4.3-3. Moderator Temperature Coefficient for Reference Equilibrium Core Design.....	4.3-15
Figure 4.3-4. SLCS Shutdown Margin for Reference Equilibrium Core Design.....	4.3-16
Figure 4.3-5. Hydraulic Control Unit Assignments.....	4.3-16
Figure 4.4-1. Typical ESBWR Power – Feedwater Temperature Operating Domain.....	4.4-24
Figure 4.6-1. Fine Motion Control Rod Drive Schematic .....	4.6-30
Figure 4.6-2. Fine Motion Control Rod Drive Unit (Cutaway).....	4.6-31
Figure 4.6-3. Continuous Full-in Indicating Device.....	4.6-32
Figure 4.6-4. Control Rod Separation Detection .....	4.6-33
Figure 4.6-5. Control Rod to Control Rod Drive Coupling.....	4.6-34
Figure 4.6-6. FMCRD Electro-Mechanical Brake.....	4.6-35
Figure 4.6-7. Internal CRD Blowout Support Schematic.....	4.6-36
Figure 4.6-8. Control Rod Drive System Simplified Process and Instrumentation Diagram.....	4.6-37
Figure 4.6-9. Control Rod Drive System Process Flow Diagram.....	4.6-38
Figure 4.6-10. FMCRD Anti-Rotation Devices.....	4.6-40
Figure 4A-1a. Control Rod Pattern Summary at 0.0 GWd/MT Exposure.....	4A-2
Figure 4A-1b. Relative Axial Power at 0.0 GWd/MT.....	4A-3
Figure 4A-1c. Axial Exposure at 0.0 GWd/MT Exposure .....	4A-4
Figure 4A-1d. Relative Integrated Power Per Bundle at 0.0 GWd/MT Exposure .....	4A-5
Figure 4A-1e. Average Bundle Exposure at 0.0 GWd/MT Exposure .....	4A-6
Figure 4A-2a. Control Rod Pattern Summary at 1.1 GWd/MT Exposure.....	4A-7
Figure 4A-2b. Relative Axial Power at 1.1 GWd/MT Exposure.....	4A-8
Figure 4A-2c. Axial Exposure at 1.1 GWd/MT Exposure .....	4A-9
Figure 4A-2d. Relative Integrated Power Per Bundle at 1.1 GWd/MT Exposure .....	4A-10
Figure 4A-2e. Average Bundle Exposure at 1.1 GWd/MT Exposure .....	4A-11
Figure 4A-3a. Control Rod Pattern Summary at 2.2 GWd/MT Exposure.....	4A-12
Figure 4A-3b. Relative Axial Power at 2.2 GWd/MT Exposure.....	4A-13
Figure 4A-3c. Axial Exposure at 2.2 GWd/MT Exposure .....	4A-14
Figure 4A-3d. Relative Integrated Power Per Bundle at 2.2 GWd/MT Exposure .....	4A-15
Figure 4A-3e. Average Bundle Exposure at 2.2 GWd/MT Exposure .....	4A-16
Figure 4A-4a. Control Rod Pattern Summary at 3.3 GWd/MT Exposure.....	4A-17
Figure 4A-4b. Relative Axial Power at 3.3 GWd/MT Exposure.....	4A-18
Figure 4A-4c. Axial Exposure at 3.3 GWd/MT Exposure .....	4A-19
Figure 4A-4d. Relative Integrated Power Per Bundle at 3.3 GWd/MT Exposure .....	4A-20
Figure 4A-4e. Average Bundle Exposure at 3.3 GWd/MT Exposure .....	4A-21
Figure 4A-5a. Control Rod Pattern Summary at 4.4 GWd/MT Exposure.....	4A-22
Figure 4A-5b. Relative Axial Power at 4.4 GWd/MT Exposure.....	4A-23
Figure 4A-5c. Axial Exposure at 4.4 GWd/MT Exposure .....	4A-24

Figure 4A-5d. Relative Integrated Power Per Bundle at 4.4 GWd/MT Exposure .....	4A-25
Figure 4A-5e. Average Bundle Exposure at 4.4 GWd/MT Exposure .....	4A-26
Figure 4A-6a. Control Rod Pattern Summary at 5.5 GWd/MT Exposure.....	4A-27
Figure 4A-6b. Relative Axial Power at 5.5 GWd/MT Exposure.....	4A-28
Figure 4A-6c. Axial Exposure at 5.5 GWd/MT Exposure .....	4A-29
Figure 4A-6d. Relative Integrated Power Per Bundle at 5.5 GWd/MT Exposure .....	4A-30
Figure 4A-6e. Average Bundle Exposure at 5.5 GWd/MT Exposure .....	4A-31
Figure 4A-7a. Control Rod Pattern Summary at 6.6 GWd/MT Exposure.....	4A-32
Figure 4A-7b. Relative Axial Power at 6.6 GWd/MT Exposure.....	4A-33
Figure 4A-7c. Axial Exposure at 6.6 GWd/MT Exposure .....	4A-34
Figure 4A-7d. Relative Integrated Power Per Bundle at 6.6 GWd/MT Exposure .....	4A-35
Figure 4A-7e. Average Bundle Exposure at 6.6 GWd/MT Exposure .....	4A-36
Figure 4A-8a. Control Rod Pattern Summary at 7.7 GWd/MT Exposure.....	4A-37
Figure 4A-8b. Relative Axial Power at 7.7 GWd/MT Exposure.....	4A-38
Figure 4A-8c. Axial Exposure at 7.7 GWd/MT Exposure .....	4A-39
Figure 4A-8d. Relative Integrated Power Per Bundle at 7.7 GWd/MT Exposure .....	4A-40
Figure 4A-8e. Average Bundle Exposure at 7.7 GWd/MT Exposure .....	4A-41
Figure 4A-9a. Control Rod Pattern Summary at 8.8 GWd/MT Exposure.....	4A-42
Figure 4A-9b. Relative Axial Power at 8.8 GWd/MT Exposure.....	4A-43
Figure 4A-9c. Axial Exposure at 8.8 GWd/MT Exposure .....	4A-44
Figure 4A-9d. Relative Integrated Power Per Bundle at 8.8 GWd/MT Exposure .....	4A-45
Figure 4A-9e. Average Bundle Exposure at 8.8 GWd/MT Exposure .....	4A-46
Figure 4A-10a. Control Rod Pattern Summary at 9.9 GWd/MT Exposure.....	4A-47
Figure 4A-10b. Relative Axial Power at 9.9 GWd/MT Exposure.....	4A-48
Figure 4A-10c. Axial Exposure at 9.9 GWd/MT Exposure .....	4A-49
Figure 4A-10d. Relative Integrated Power Per Bundle at 9.9 GWd/MT Exposure .....	4A-50
Figure 4A-10e. Average Bundle Exposure at 9.9 GWd/MT Exposure .....	4A-51
Figure 4A-11a. Control Rod Pattern Summary at 11.0 GWd/MT Exposure.....	4A-52
Figure 4A-11b. Relative Axial Power at 11.0 GWd/MT Exposure.....	4A-53
Figure 4A-11c. Axial Exposure at 11.0 GWd/MT Exposure .....	4A-54
Figure 4A-11d. Relative Integrated Power Per Bundle at 11.0 GWd/MT Exposure .....	4A-55
Figure 4A-11e. Average Bundle Exposure at 11.0 GWd/MT Exposure .....	4A-56
Figure 4A-12a. Control Rod Pattern Summary at 12.1 GWd/MT Exposure.....	4A-57
Figure 4A-12b. Relative Axial Power at 12.1 GWd/MT Exposure.....	4A-58
Figure 4A-12c. Axial Exposure at 12.1 GWd/MT Exposure .....	4A-59
Figure 4A-12d. Relative Integrated Power Per Bundle at 12.1 GWd/MT Exposure .....	4A-60
Figure 4A-12e. Average Bundle Exposure at 12.1 GWd/MT Exposure .....	4A-61
Figure 4A-13a. Control Rod Pattern Summary at 13.2 GWd/MT Exposure.....	4A-62
Figure 4A-13b. Relative Axial Power at 13.2 GWd/MT Exposure.....	4A-63
Figure 4A-13c. Axial Exposure at 13.2 GWd/MT Exposure .....	4A-64
Figure 4A-13d. Relative Integrated Power Per Bundle at 13.2 GWd/MT Exposure .....	4A-65
Figure 4A-13e. Average Bundle Exposure at 13.2 GWd/MT Exposure .....	4A-66
Figure 4A-14a. Control Rod Pattern Summary at 14.3 GWd/MT Exposure.....	4A-67
Figure 4A-14b. Relative Axial Power at 14.3 GWd/MT Exposure.....	4A-68
Figure 4A-14c. Axial Exposure at 14.3 GWd/MT Exposure .....	4A-69
Figure 4A-14d. Relative Integrated Power Per Bundle at 14.3 GWd/MT Exposure .....	4A-70

Figure 4A-14e. Average Bundle Exposure at 14.3 GWd/MT Exposure .....	4A-71
Figure 4A-15a. Control Rod Pattern Summary at 15.4 GWd/MT Exposure.....	4A-72
Figure 4A-15b. Relative Axial Power at 15.4 GWd/MT Exposure.....	4A-73
Figure 4A-15c. Axial Exposure at 15.4 GWd/MT Exposure .....	4A-74
Figure 4A-15d. Relative Integrated Power Per Bundle at 15.4 GWd/MT Exposure .....	4A-75
Figure 4A-15e. Average Bundle Exposure at 15.4 GWd/MT Exposure .....	4A-76
Figure 4A-16a. Control Rod Pattern Summary at 16.5 GWd/MT Exposure.....	4A-77
Figure 4A-16b. Relative Axial Power at 16.5 GWd/MT Exposure.....	4A-78
Figure 4A-16c. Axial Exposure at 16.5 GWd/MT Exposure .....	4A-79
Figure 4A-16d. Relative Integrated Power Per Bundle at 16.5 GWd/MT Exposure .....	4A-80
Figure 4A-16e. Average Bundle Exposure at 16.5 GWd/MT Exposure .....	4A-81
Figure 4A-17a. Control Rod Pattern Summary at 17.9 GWd/MT Exposure.....	4A-82
Figure 4A-17b. Relative Axial Power at 17.9 GWd/MT Exposure.....	4A-83
Figure 4A-17c. Axial Exposure at 17.9 GWd/MT Exposure .....	4A-84
Figure 4A-17d. Relative Integrated Power Per Bundle at 17.9 GWd/MT Exposure .....	4A-85
Figure 4A-17e. Average Bundle Exposure at 17.9 GWd/MT Exposure .....	4A-86
Figure 4A-18a. Control Rod Pattern Summary at 18.5 GWd/MT Exposure.....	4A-87
Figure 4A-18b. Relative Axial Power at 18.5 GWd/MT Exposure.....	4A-88
Figure 4A-18c. Axial Exposure at 18.5 GWd/MT Exposure .....	4A-89
Figure 4A-18d. Relative Integrated Power Per Bundle at 18.5 GWd/MT Exposure .....	4A-90
Figure 4A-18e. Average Bundle Exposure at 18.5 GWd/MT Exposure .....	4A-91
Figure 4A-19. Minimum Critical Power Ratio (MCPR) as a Function of Exposure .....	4A-92
Figure 4D-1. Qualitative Two-Dimensional Stability Map for ESBWR.....	4D-26
Figure 4D-2. Three-Dimensional Stability Map for ESBWR .....	4D-27
Figure 4D-3. Core Average Axial Power Shape at Different Exposures .....	4D-28
Figure 4D-4. Decay Ratio Results Compared to Design Criteria.....	4D-29
Figure 4D-5. Stability in Expanded Operating Map.....	4D-30
Figure 4D-6. Generalized Stability Map showing Type 1 and Type 2 Instability.....	4D-30
Figure 4D-7. Indications of Periodic Behavior During Dodewaard Startup .....	4D-31
Figure 4D-8. Thermal – Hydraulic Conditions during Startup.....	4D-31
Figure 4D-9. Enthalpy Profiles for Different Heatup Rates .....	4D-32
Figure 4D-10. ESBWR Startup Trajectory.....	4D-32
Figure 4D-11. TRACG Startup Simulation: Reactor Power Trajectories .....	4D-33
Figure 4D-12. TRACG Startup Simulation: Pressure Response .....	4D-33
Figure 4D-13. TRACG Startup Simulation – Core Inlet Subcooling.....	4D-34
Figure 4D-14. TRACG Startup Simulation – Core Inlet Flow .....	4D-34
Figure 4D-15. Separator Void Fraction (50 MWt heatup) .....	4D-35
Figure 4D-16. Separator Void Fraction (85 MWt heatup) .....	4D-35
Figure 4D-17. Separator Void Fraction (125 MWt heatup) .....	4D-36
Figure 4D-18. Hot Bundle Void Fraction (50 MWt heatup) .....	4D-36
Figure 4D-19. Hot Bundle Void Fraction (85 MWt heatup) .....	4D-37
Figure 4D-20. Hot Bundle Void Fraction (125 MWt heatup) .....	4D-37
Figure 4D-21. Hot Bundle Exit Flow .....	4D-38
Figure 4D-22. Peripheral Bundle Exit Flow .....	4D-38
Figure 4D-23. Hot Bundle CPR.....	4D-39
Figure 4D-24. Peripheral Bundle CPR .....	4D-39

Figure 4D-25. ESBWR Control Rod Groups for Startup Simulation.....	4D-40
Figure 4D-26. Withdrawal Fraction for all Control Rods.....	4D-41
Figure 4D-27. Reactor Power .....	4D-41
Figure 4D-28. Steam Dome Pressure.....	4D-42
Figure 4D-29. Core Inlet Subcooling.....	4D-42
Figure 4D-30. Core Inlet Flow.....	4D-43
Figure 4D-31. Hot Bundle Void Fraction .....	4D-43
Figure 4D-32. ESBWR Backup Stability Protection Boundary .....	4D-44

Figure 5.1-1. Coolant Volumes.....	5.1-5
Figure 5.1-2. Nuclear Boiler System Schematic.....	5.1-7
Figure 5.1-3. Isolation Condenser System Schematic.....	5.1-9
Figure 5.1-4. Reactor Water Cleanup/Shutdown Cooling System Schematic.....	5.1-11
Figure 5.2-1. Safety Relief Valve Schematic Elevation.....	5.2-68
Figure 5.2-2. Safety Relief Valves, Safety Valves, and Depressurization Valves on Steamlines Diagram.....	5.2-69
Figure 5.2-3. Safety Relief Valve Discharge Line Quencher Arrangement.....	5.2-70
Figure 5.2-4a. (Deleted).....	5.2-71
Figure 5.2-4b. (Deleted).....	5.2-72
Figure 5.2-4c. (Deleted).....	5.2-73
Figure 5.2-4d. (Deleted).....	5.2-74
Figure 5.2-4e. (Deleted).....	5.2-75
Figure 5.2-4f. (Deleted).....	5.2-76
Figure 5.3-1. Minimum Temperatures Required Versus Reactor Pressure for Hydrotest-Core Not Critical (Representative Curve for the ESBWR).....	5.3-26
Figure 5.3-2. Minimum Temperatures Required Versus Reactor Pressure for Normal Startup and Shutdown (Representative Curve for the ESBWR).....	5.3-27
Figure 5.3-3. Reactor Pressure Vessel System Key Features.....	5.3-29
Figure 5.4-1. Main Steamline Nozzle and Flow Restrictor.....	5.4-56
Figure 5.4-2. (Deleted).....	5.4-57
Figure 5.4-3. Layout of Main Steam and Feedwater Lines.....	5.4-59
Figure 5.4-4a. Schematic of the Isolation Condenser.....	5.4-60
Figure 5.4-4b. Isolation Condenser System Simplified Process Diagram.....	5.4-62
Figure 5.4-5. NBS Depressurization Valve.....	5.4-63

Figure 6.2-1. Containment System .....	6.2-183
Figure 6.2-2. IC/PCC Pools Configuration.....	6.2-184
Figure 6.2-3. GDCS Pools Configuration.....	6.2-185
Figure 6.2-4. (Deleted).....	6.2-186
Figure 6.2-5. Horizontal Vent System Configuration.....	6.2-187
Figure 6.2-6. TRACG Nodalization of the ESBWR RPV.....	6.2-188
Figure 6.2-7. TRACG Nodalization of the ESBWR Containment.....	6.2-189
Figure 6.2-8. TRACG Nodalization of the ESBWR Main Steam Lines .....	6.2-190
Figure 6.2-8a. TRACG Nodalization of the ESBWR Isolation Condenser System.....	6.2-191
Figure 6.2-8b. TRACG Nodalization of the ESBWR Feedwater Line System.....	6.2-192
Figure 6.2-8c. ESBWR End-of-Cycle Core Average Decay Heat .....	6.2-193
Figure 6.2-9a1. Feedwater Line Break (Nominal Case) – Containment Pressures (72 hrs) .....	6.2-194
Figure 6.2-9a2. Feedwater Line Break (Nominal Case) – Containment Pressures (500 s).....	6.2-195
Figure 6.2-9a3. Feedwater Line Break (Nominal Case) – Containment Pressures (2000 s).....	6.2-196
Figure 6.2-9b1. Feedwater Line Break (Nominal Case) – Containment Temperatures (72 hrs) .....	6.2-197
Figure 6.2-9b2. Feedwater Line Break (Nominal Case) – Containment Temperatures (500 s).....	6.2-198
Figure 6.2-9b3. Feedwater Line Break (Nominal Case) – Containment Temperatures (2000 s).....	6.2-199
Figure 6.2-9c1. Feedwater Line Break (Nominal Case) – PCCS Heat Removal versus Decay Heat (72 hrs).....	6.2-200
Figure 6.2-9c2. Feedwater Line Break (Nominal Case) – PCCS Heat Removal versus Decay Heat (500 s).....	6.2-201
Figure 6.2-9c3. Feedwater Line Break (Nominal Case) – PCCS Heat Removal versus Decay Heat (2000 s).....	6.2-202
Figure 6.2-9d1. Feedwater Line Break (Nominal Case) - Drywell and GDCS Air Pressures (72 hrs).....	6.2-203
Figure 6.2-9d2. Feedwater Line Break (Nominal Case) - Drywell and GDCS Air Pressures (500 s) .....	6.2-204
Figure 6.2-9d3. Feedwater Line Break (Nominal Case) - Drywell and GDCS Air Pressures (2000 s) .....	6.2-205
Figure 6.2-9e1. Vessel Wall Heat Slab Temperature (FWL) (72 hrs).....	6.2-206
Figure 6.2-9e2. Vessel Wall Heat Slab Temperature (FWL) (2000 s).....	6.2-207
Figure 6.2-10a1. Main Steam Line Break (Nominal Case) – Containment Pressures (72 hrs) .....	6.2-208
Figure 6.2-10a2. Main Steam Line Break (Nominal Case) – Containment Pressures (500 s).....	6.2-209
Figure 6.2-10a3. Main Steam Line Break (Nominal Case) - Containment Pressures (2000 s).....	6.2-210
Figure 6.2-10b1. Main Steam Line Break (Nominal Case) – Containment Temperatures (72 hrs) .....	6.2-211

Figure 6.2-10b2. Main Steam Line Break (Nominal Case) – Containment Temperatures (500 s).....	6.2-212
Figure 6.2-10b3. Main Steam Line Break (Nominal Case) – Containment Temperatures (2000 s).....	6.2-213
Figure 6.2-10c1. Main Steam Line Break (Nominal Case) – PCCS Heat Removal versus Decay Heat (72 hrs).....	6.2-214
Figure 6.2-10c2. Main Steam Line Break (Nominal Case) – PCCS Heat Removal versus Decay Heat (500 s).....	6.2-215
Figure 6.2-10c3. Main Steam Line Break (Nominal Case) – PCCS Heat Removal versus Decay Heat (2000 s).....	6.2-216
Figure 6.2-10d1. Main Steam Line Break (Nominal Case) - Drywell and GDCS Noncondensable Gas Pressures (72 hrs).....	6.2-217
Figure 6.2-10d2. Main Steam Line Break (Nominal Case) - Drywell and GDCS Noncondensables Gas Pressures (500 s).....	6.2-218
Figure 6.2-10d3. Main Steam Line Break (Nominal Case) - Drywell and GDCS Noncondensable Gas Pressures (2000 s).....	6.2-219
Figure 6.2-10e1. Vessel Wall Heat Slab Temperature (MSL) (72 hrs).....	6.2-220
Figure 6.2-10e2. Vessel Wall Heat Slab Temperature (MSL) (2000 s).....	6.2-221
Figure 6.2-11a1. GDCS Line Break (Nominal Case) – Containment Pressures (72 hrs).....	6.2-222
Figure 6.2-11a2. GDCS Line Break (Nominal Case) – Containment Pressures (500 s).....	6.2-223
Figure 6.2-11a3. GDCS Line Break (Nominal Case) – Containment Pressures (2000 s).....	6.2-224
Figure 6.2-11b1. GDCS Line Break (Nominal Case) – Containment Temperatures (72 hrs).....	6.2-225
Figure 6.2-11b2. GDCS Line Break (Nominal Case) – Containment Temperatures (500 s).....	6.2-226
Figure 6.2-11b3. GDCS Line Break (Nominal Case) – Containment Temperatures (2000 s).....	6.2-227
Figure 6.2-11c1. GDCS Line Break (Nominal Case) – PCCS Heat Removal versus Decay Heat (72 hrs).....	6.2-228
Figure 6.2-11c2. GDCS Line Break (Nominal Case) – PCCS Heat Removal versus Decay Heat (500 s).....	6.2-229
Figure 6.2-11c3. GDCS Line Break (Nominal Case) – PCCS Heat Removal versus Decay Heat (2000 s).....	6.2-230
Figure 6.2-11d1. GDCS Line Break (Nominal Case) – Drywell and GDCS Noncondensable Gas Pressures (72 hrs).....	6.2-231
Figure 6.2-11d2. GDCS Line Break (Nominal Case) – Drywell and GDCS Noncondensable Gas Pressures (500 s).....	6.2-232
Figure 6.2-11d3. GDCS Line Break (Nominal Case) – Drywell and GDCS Noncondensable Gas Pressures (2000 s).....	6.2-233
Figure 6.2-12a1. Bottom Drain Line Break (Nominal case) - Containment Pressures (72 hrs).....	6.2-234
Figure 6.2-12a2. Bottom Drain Line Break (Nominal Case) - Containment Pressures (500s).....	6.2-235

Figure 6.2-12a3. Bottom Drain Line Break (Nominal Case) -  
 Containment Pressures (2000 s)..... 6.2-236

Figure 6.2-12b1. Bottom Drain Line Break (Nominal Case) -  
 Containment Temperatures (72 hrs) ..... 6.2-237

Figure 6.2-12b2. Bottom Drain Line Break (Nominal Case) -  
 Containment Temperatures (500 s)..... 6.2-238

Figure 6.2-12b3. Bottom Drain Line Break (Nominal Case) -  
 Containment Temperatures (2000 s)..... 6.2-239

Figure 6.2-12c1. Bottom Drain Line Break (Nominal Case) - PCCS Heat Removal versus Decay  
 Heat (72 hrs)..... 6.2-240

Figure 6.2-12c2. Bottom Drain Line Break (Nominal Case) - PCCS Heat Removal versus Decay  
 Heat (500 s)..... 6.2-241

Figure 6.2-12c3. Bottom Drain Line Break (Nominal Case) - PCCS Heat Removal versus Decay  
 Heat (2000 s)..... 6.2-242

Figure 6.2-12d1. Bottom Drain Line Break (Nominal Case) - Drywell and GDCS  
 Noncondensable Pressures (72 hrs) ..... 6.2-243

Figure 6.2-12d2. Bottom Drain Line Break (Nominal Case) - Drywell and GDCS  
 Noncondensable Pressures (500 s)..... 6.2-244

Figure 6.2-12d3. Bottom Drain Line Break (Nominal Case) - Drywell and GDCS  
 Noncondensable Pressures (2000 s)..... 6.2-245

Figure 6.2-13a1. Feedwater Line Break, 1 DPV Failure (Bounding Case) – Containment  
 Pressures (72 hrs)..... 6.2-246

Figure 6.2-13a2. Feedwater Line Break, 1 DPV Failure (Bounding Case) – Containment  
 Pressures (500 s) ..... 6.2-247

Figure 6.2-13a3. Feedwater Line Break, 1 DPV Failure (Bounding Case) – Containment  
 Pressures (2000 s) ..... 6.2-248

Figure 6.2-13b1. Feedwater Line Break, 1 DPV Failure (Bounding Case) – Containment  
 Temperatures (72 hrs) ..... 6.2-249

Figure 6.2-13b2. Feedwater Line Break, 1 DPV Failure (Bounding Case) – Containment  
 Temperatures (500 s) ..... 6.2-250

Figure 6.2-13b3. Feedwater Line Break, 1 DPV Failure (Bounding Case) – Containment  
 Temperatures (2000 s) ..... 6.2-251

Figure 6.2-13c1. Feedwater Line Break, 1 DPV Failure (Bounding Case) – PCCS Heat Removal  
 versus Decay Heat (72 hrs) ..... 6.2-252

Figure 6.2-13c2. Feedwater Line Break, 1 DPV Failure (Bounding Case) – PCCS Heat Removal  
 versus Decay Heat (500 s)..... 6.2-253

Figure 6.2-13c3. Feedwater Line Break, 1 DPV Failure (Bounding Case) – PCCS Heat Removal  
 versus Decay Heat (2000 s)..... 6.2-254

Figure 6.2-13d1. Feedwater Line Break, 1 DPV Failure (Bounding Case) - Drywell and GDCS  
 Noncondensable Pressures (72 hrs) ..... 6.2-255

Figure 6.2-13d2. Feedwater Line Break, 1 DPV Failure (Bounding Case) - Drywell and GDCS  
 Noncondensable Pressures (500 s)..... 6.2-256

Figure 6.2-13d3. Feedwater Line Break, 1 DPV Failure (Bounding Case) - Drywell and GDCS  
 Noncondensable Pressures (2000 s)..... 6.2-257

Figure 6.2-13e1. Feed Water Line Break, 1 SRV Failure (Bounding Case) - Containment  
 Pressures (72 hrs)..... 6.2-258



Figure 6.2-13e2. Feed Water Line Break, 1 SRV Failure (Bounding Case) – Containment Pressures (500 s) .....	6.2-259
Figure 6.2-13e3. Feed Water Line Break, 1 SRV Failure (Bounding Case) – Containment Pressures (2000 s) .....	6.2-260
Figure 6.2-13f1. Feed Water Line Break, 1 SRV Failure (Bounding Case) – Containment Temperatures (72 hrs) .....	6.2-261
Figure 6.2-13f2. Feed Water Line Break, 1 SRV Failure (Bounding Case) – Containment Temperatures (500 s) .....	6.2-262
Figure 6.2-13f3. Feed Water Line Break, 1 SRV Failure (Bounding Case) – Containment Temperatures (2000 s) .....	6.2-263
Figure 6.2-13g1. Feed Water Line Break, 1 SRV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (72 hrs).....	6.2-264
Figure 6.2-13g2. Feed Water Line Break, 1 SRV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (500 s).....	6.2-265
Figure 6.2-13g3. Feed Water Line Break, 1 SRV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (2000 s).....	6.2-266
Figure 6.2-13h1. Feed Water Line Break, 1 SRV Failure (Bounding Case) – Drywell and GDCS Noncondensable Gas Pressures (72 hrs).....	6.2-267
Figure 6.2-13h2. Feed Water Line Break, 1 SRV Failure (Bounding Case) – Drywell and GDCS Noncondensable Gas Pressures (500 s).....	6.2-268
Figure 6.2-13h3. Feed Water Line Break, 1 SRV Failure (Bounding Case) – Drywell and GDCS Noncondensable Gas Pressures (2000 s).....	6.2-269
Figure 6.2-14a1. Main Steam Line Break, 1 DPV Failure (Bounding Case) - Containment Pressures (72 hrs).....	6.2-270
Figure 6.2-14a2. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Containment Pressures (500 s) .....	6.2-271
Figure 6.2-14a3. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Containment Pressures (2000 s) .....	6.2-272
Figure 6.2-14b1. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Containment Temperatures (72 hrs) .....	6.2-273
Figure 6.2-14b2. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Containment Temperatures (500 s) .....	6.2-274
Figure 6.2-14b3. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Containment Temperatures (2000 s) .....	6.2-275
Figure 6.2-14c1. Main Steam Line Break, 1 DPV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (72 hrs).....	6.2-276
Figure 6.2-14c2. Main Steam Line Break, 1 DPV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (500 s).....	6.2-277
Figure 6.2-14c3. Main Steam Line Break, 1 DPV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (2000 s).....	6.2-278
Figure 6.2-14d1. Main Steam Line Break, 1 DPV Failure (Bounding Case) - Drywell and GDCS Noncondensable Gas Pressures (72 hrs).....	6.2-279
Figure 6.2-14d2. Main Steam Line Break, 1 DPV Failure (Bounding Case) - Drywell and GDCS Noncondensable Gas Pressures (500 s).....	6.2-280
Figure 6.2-14d3. Main Steam Line Break, 1 DPV Failure (Bounding Case) - Drywell and GDCS Noncondensable Gas Pressures (2000 s).....	6.2-281

Figure 6.2-14e1. Drywell and Wetwell Pressures .....	6.2-282
Figure 6.2-14e2. Drywell and Wetwell Temperatures.....	6.2-282
Figure 6.2-14e3. Comparison of Drywell Pressures with and without Credit for PARS ....	6.2-283
Figure 6.2-14e4. Comparison of Drywell Pressures.....	6.2-283
Figure 6.2-14e5. Drywell, Wetwell and RPV Pressures.....	6.2-284
Figure 6.2-14e6. Drywell, Wetwell and Suppression Pool Temperatures.....	6.2-284
Figure 6.2-14e7. Total Power and Total PCCS Power .....	6.2-285
Figure 6.2-14e8. DW and GDCS Noncondensable Pressures .....	6.2-285
Figure 6.2-14e9. GDCS Pool Water Level .....	6.2-286
Figure 6.2-14e10. PCCS Pool Water Level.....	6.2-286
Figure 6.2-14e11. Containment Pressure Response – Post-LOCA Containment Cooling and Recovery .....	6.2-287
Figure 6.2-14e12. Containment Temperature Response – Post-LOCA Containment Cooling and Recovery .....	6.2-287
Figure 6.2-14f1. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Containment Pressures (72 hrs).....	6.2-288
Figure 6.2-14f2. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Containment Pressures (500 s) .....	6.2-289
Figure 6.2-14f3. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Containment Pressures (2000 s) .....	6.2-290
Figure 6.2-14g1. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Containment Temperatures (72 hrs).....	6.2-291
Figure 6.2-14g2. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Containment Temperatures (500 s) .....	6.2-292
Figure 6.2-14g3. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Containment Temperatures (2000 s) .....	6.2-293
Figure 6.2-14h1. Main Steam Line Break, 1 SRV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (72 hrs).....	6.2-294
Figure 6.2-14h2. Main Steam Line Break, 1 SRV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (500 s).....	6.2-295
Figure 6.2-14h3. Main Steam Line Break, 1 SRV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (2000 s).....	6.2-296
Figure 6.2-14i1. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Drywell and GDCS Noncondensable Gas Pressure (72 hrs).....	6.2-297
Figure 6.2-14i2. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Drywell and GDCS Noncondensable Gas Pressures (500 s).....	6.2-298
Figure 6.2-14i3. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Drywell and GDCS Noncondensable Gas Pressures (2000 s).....	6.2-299
Figure 6.2-15. Summary of Severe Accident Design Features.....	6.2-300
Figure 6.2-16. PCCS Schematic Diagram .....	6.2-301
Figure 6.2-17. Reactor Building Envelope .....	6.2-302
Figure 6.2-18. RWCU System Subcompartment Pressurization Analysis .....	6.2-303
Figure 6.2-18a. RWCU Pipe Break Mass Flow Rate .....	6.2-305
Figure 6.2-18b. RWCU Pipe Break Enthalpy.....	6.2-305
Figure 6.2-18c. RWCU Pipe Break Energy Release .....	6.2-306
Figure 6.2-19. Pressure Histories due to Break Case 1 in Cell 1 (Sub-Model 1) .....	6.2-307

Figure 6.2-20. Pressure Histories due to Break Case 1 in Cell 6 (Sub-Model 1) ..... 6.2-307

Figure 6.2-21. Pressure Histories due to Break Case 2 in Cell 2 (Sub-Model 1) ..... 6.2-308

Figure 6.2-22. Pressure Histories due to Break Case 2 in Cell 7 (Sub-Model 1) ..... 6.2-308

Figure 6.2-23. Pressure Histories due to Break Case 3 in Cell 1 (Sub-Model 1) ..... 6.2-309

Figure 6.2-24. Pressure Histories due to Break Case 3 in Cell 6 (Sub-Model 1) ..... 6.2-309

Figure 6.2-25. Pressure Histories due to Break Case 4 in Cell 8 (Sub-Model 1) ..... 6.2-310

Figure 6.2-26. Pressure Histories due to Break Case 4 in Cell 9 (Sub-Model 1) ..... 6.2-310

Figure 6.2-27. Pressure Histories due to Break Case 5 in Cell 11 (Sub-Model 2) ..... 6.2-311

Figure 6.2-28. Wetwell-to-Drywell Vacuum Breaker ..... 6.2-312

Figure 6.2-29. CIS Simplified System Diagram ..... 6.2-313

Figure 6.2-30. Drywell Fission Product Radiation Monitoring Subsystem ..... 6.2-314

Figure 6.3-1. GDSCS Configuration ..... 6.3-42

Figure 6.3-1a. GDSCS Typical Process Flows ..... 6.3-43

Figure 6.3-2. (Deleted) ..... 6.3-44

Figure 6.3-3. (Deleted) ..... 6.3-45

Figure 6.3-4. (Deleted) ..... 6.3-45

Figure 6.3-5. (Deleted) ..... 6.3-45

Figure 6.3-6. Minimum Transient Chimney Water Level vs. Break Area ..... 6.3-46

Figure 6.3-7a. MCPR, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s) ..... 6.3-47

Figure 6.3-7b. MCPR, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s) ..... 6.3-48

Figure 6.3-8a. Chimney Water Level, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s) ..... 6.3-49

Figure 6.3-8b. Chimney Water Level, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s) ..... 6.3-50

Figure 6.3-9a. Downcomer Water Level, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s) ..... 6.3-51

Figure 6.3-9b. Downcomer Water Level, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s) ..... 6.3-52

Figure 6.3-10a. System Pressures, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s) ..... 6.3-53

Figure 6.3-10b. System Pressures, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s) ..... 6.3-54

Figure 6.3-11a. Steam Line and Break Flows, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s) ..... 6.3-55

Figure 6.3-11b. Steam Line and Break Flows, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s) ..... 6.3-56

Figure 6.3-12a. ADS Flows, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s) ..... 6.3-57

Figure 6.3-12b. ADS Flows, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s) ..... 6.3-58

Figure 6.3-13a. Flows Into Vessel, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s) ..... 6.3-59

Figure 6.3-13b. Flows Into Vessel, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s) ..... 6.3-60

Figure 6.3-14a. PCT, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s).....	6.3-61
Figure 6.3-14b. PCT, Feedwater Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s).....	6.3-62
Figure 6.3-15a. MCPR, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s).....	6.3-63
Figure 6.3-15b. MCPR, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s).....	6.3-64
Figure 6.3-16a. Chimney Water Level, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s).....	6.3-65
Figure 6.3-16b. Chimney Water Level, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s).....	6.3-66
Figure 6.3-17a. Downcomer Water Level, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s).....	6.3-67
Figure 6.3-17b. Downcomer Water Level, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s).....	6.3-68
Figure 6.3-18a. System Pressures, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s).....	6.3-69
Figure 6.3-18b. System Pressures, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s).....	6.3-70
Figure 6.3-19a. Steam Line and Break Flow with Void Fraction, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s).....	6.3-71
Figure 6.3-19b. Steam Line and Break Flow with Void Fraction, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s).....	6.3-72
Figure 6.3-20a. ADS Flow, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s).....	6.3-73
Figure 6.3-20b. ADS Flows, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s).....	6.3-74
Figure 6.3-21a. Flows Into Vessel, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s).....	6.3-75
Figure 6.3-21b. Flows Into Vessel, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s).....	6.3-76
Figure 6.3-22a. PCT, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s).....	6.3-77
Figure 6.3-22b. PCT, Inside Steam Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s).....	6.3-78
Figure 6.3-23a. MCPR, Bottom Drain Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s).....	6.3-79
Figure 6.3-23b. MCPR, Bottom Drain Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s).....	6.3-80
Figure 6.3-24a. Chimney Water Level, Bottom Drain Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s).....	6.3-81
Figure 6.3-24b. Chimney Water Level, Bottom Drain Line Break (Nominal Case), 1 GDSCS Valve Failure (100 s).....	6.3-82
Figure 6.3-25a. Downcomer Water Level, Bottom Drain Line Break (Nominal Case), 1 GDSCS Valve Failure (2000 s).....	6.3-83

Figure 6.3-25b. Downcomer Water Level, Bottom Drain Line Break (Nominal Case), 1 GDCS Valve Failure (100 s).....	6.3-84
Figure 6.3-26a. System Pressures, Bottom Drain Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s) .....	6.3-85
Figure 6.3-26b. System Pressures, Bottom Drain Line Break (Nominal Case), 1 GDCS Valve Failure (100 s) .....	6.3-86
Figure 6.3-27a. Steam Line and Break Flow with Void Fraction, Bottom Drain Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s).....	6.3-87
Figure 6.3-27b. Steam Line and Break Flow with Void Fraction, Bottom Drain Line Break (Nominal Case), 1 GDCS Valve Failure (100 s).....	6.3-88
Figure 6.3-28a. ADS Flow, Bottom Drain Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s) .....	6.3-89
Figure 6.3-28b. ADS Flows, Bottom Drain Line Break (Nominal Case), 1 GDCS Valve Failure (100 s) .....	6.3-90
Figure 6.3-29a. Flows Into Vessel, Bottom Drain Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s) .....	6.3-91
Figure 6.3-29b. Flows Into Vessel, Bottom Drain Line Break (Nominal Case), 1 GDCS Valve Failure (100 s) .....	6.3-92
Figure 6.3-30a. PCT, Bottom Drain Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s).....	6.3-93
Figure 6.3-30b. PCT, Bottom Drain Line Break (Nominal Case), 1 GDCS Valve Failure (100 s).....	6.3-94
Figure 6.3-31a. MCPR, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s) .....	6.3-95
Figure 6.3-31b. MCPR, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (100 s) .....	6.3-96
Figure 6.3-32a. Chimney Water Level, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s).....	6.3-97
Figure 6.3-32b. Chimney Water Level, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (100 s).....	6.3-98
Figure 6.3-33a. Downcomer Water Level, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s).....	6.3-99
Figure 6.3-33b. Downcomer Water Level, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (100 s).....	6.3-100
Figure 6.3-34a. System Pressures, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s) .....	6.3-101
Figure 6.3-34b. System Pressures, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (100 s) .....	6.3-102
Figure 6.3-35a. Steam Line and Break Flow with Void Fraction, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s).....	6.3-103
Figure 6.3-35b. Steam Line and Break Flow with Void Fraction, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (100 s).....	6.3-104
Figure 6.3-36a. ADS Flow, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s) .....	6.3-105
Figure 6.3-36b. ADS Flows, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (100 s) .....	6.3-106

Figure 6.3-37a. Flows Into Vessel, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s) .....	6.3-107
Figure 6.3-37b. Flows Into Vessel, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (100 s) .....	6.3-108
Figure 6.3-38a. PCT, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (2000 s) .....	6.3-109
Figure 6.3-38b. PCT, GDCS Injection Line Break (Nominal Case), 1 GDCS Valve Failure (100 s) .....	6.3-110
Figure 6.3-38A-a. MCPR, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s) .....	6.3-110
Figure 6.3-38A-b. MCPR, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (100 s) .....	6.3-111
Figure 6.3-38B-a. Chimney Water Level, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s) .....	6.3-112
Figure 6.3-38B-b. Chimney Water Level, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (100 s) .....	6.3-112
Figure 6.3-38C-a. Downcomer Water Level, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s) .....	6.3-113
Figure 6.3-38C-b. Downcomer Water Level, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (100 s) .....	6.3-113
Figure 6.3-38D-a. System Pressures, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s) .....	6.3-114
Figure 6.3-38D-b. System Pressures, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (100 s) .....	6.3-114
Figure 6.3-38E-a. Break Flows and Void Fractions IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s) .....	6.3-115
Figure 6.3-38E-b. Break Flows and Void Fractions IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (100 s) .....	6.3-115
Figure 6.3-38F-a. ADS Flow, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s) .....	6.3-116
Figure 6.3-38F-b. ADS Flow, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (100 s) .....	6.3-116
Figure 6.3-38G-a. Flows Into Vessel, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s) .....	6.3-117
Figure 6.3-38G-b. Flows Into Vessel, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (100 s) .....	6.3-117
Figure 6.3-38H-a. PCT, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s) .....	6.3-118
Figure 6.3-38H-b. PCT, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (100 s) .....	6.3-118
Figure 6.3-38I. Vacuum Breaker Flows, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s) .....	6.3-119
Figure 6.3-38J. PCC Flows, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s) .....	6.3-119
Figure 6.3-38K. PCC Power, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s) .....	6.3-120

Figure 6.3-38L. Chimney Water Level, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s) .....	6.3-120
Figure 6.3-38M. Downcomer Water Level, IC Drain Line Break (Bounding Case), 1 GDCS Valve Failure (2000 s).....	6.3-121
Figure 6.3-39. Normalized Shutdown Power .....	6.3-121
Figure 6.4-1. CRHAVS Schematic Diagram.....	6.4-17
Figure 6A-1. TRACG Nodalization showing Containment Heat Slabs .....	6A-7
Figure 6A-2. RPV Nodalization showing Vessel Wall Heat Slab.....	6A-8
Figure 6B-1. TRACG Nodalization for ESBWR ECCS/LOCA Analysis .....	6B-9
Figure 6B-2. TRACG Nodalization for ESBWR Containment Analysis.....	6B-10
Figure 6B-3. TRACG Combined Nodalization .....	6B-11
Figure 6B-4. TRACG Combined Nodalization .....	6B-12
Figure 6B-5. MSLB-CB5 – GDCS and DC Water Levels .....	6B-13
Figure 6B-6. MSLB-NL2_V40 – GDCS and DC Water Levels .....	6B-13
Figure 6B-7. MSLB-CB5 vs. MSLB-NL2_V40 – Total PCC Condensation Powers.....	6B-14
Figure 6B-8. MSLB-CB5 vs. MSLB-NL2_V40 – Suppression Pool Surface Temperatures .....	6B-14
Figure 6B-9. MSLB-CB5 – Drywell Partial Noncondensable Gas Pressures.....	6B-15
Figure 6B-10. MSLB-NL2_V40 – Drywell Partial Noncondensable Gas Pressures .....	6B-15
Figure 6B-11. MSLB-CB5 vs MSLB-NL2_V40 – Drywell Pressures .....	6B-16
Figure 6B-12. MSLB-CB6 – Drywell Partial Noncondensable Gas Pressures.....	6B-16
Figure 6B-13. MSLB-CB6 – RPV, Drywell and Wetwell Pressures .....	6B-17
Figure 6B-14. Drywell Pressure Comparison – MSLB-CB6, MSLB-CB5 and MSLB-NL2_V40 .....	6B-17
Figure 6B-15. MSLB-CB6 – Suppression Pool Temperatures.....	6B-18
Figure 6B-16. MSLB-CB5 – Suppression Pool Temperatures.....	6B-18
Figure 6B-17. MSLB-CB6 – PCC Condensation Power.....	6B-19
Figure 6B-18. MSLB-CB5 – PCC Condensation Power.....	6B-19
Figure 6B-19. E0 (Base Case) – Drywell Pressure Response .....	6B-20
Figure 6B-20. E0 (Base Case) – Top Main Vent Flow.....	6B-20
Figure 6B-21. E0 (Base Case) – DPV and SRV Flows.....	6B-21
Figure 6B-22. E0a (Time Step) – Drywell Pressure Response.....	6B-21
Figure 6B-23. E0a (Time Step) – Top Main Vent Flow.....	6B-22
Figure 6B-24. E0a (Time Step) – DPV and SRV Flows .....	6B-22
Figure 6C-1. Effect of Wetwell Pressure on the GDCS Initiation Timing.....	6C-3
Figure 6C-2. Effect of Wetwell Pressure on the Minimum Chimney Collapsed Level .....	6C-3
Figure 6E-1. FWLB (Bounding) Drywell Annulus and Suppression Pool Levels (72 hrs) .....	6E-4
Figure 6E-2. FWLB (Bounding) GDCS Pool Levels (72 hrs).....	6E-4
Figure 6E-3. MSLB (Bounding) Drywell Annulus and Suppression Pool Levels (72 hrs) .....	6E-5
Figure 6E-4. MSLB (Bounding) GDCS Pool Levels (72 hrs).....	6E-5
Figure 6F1-1. MSLB - Effect of Break Areas on Transient DW Pressures .....	6F-4
Figure 6F1-2a. Feedwater Line Break - Parametric Study on the Break Areas (0-72 hrs).....	6F-4
Figure 6F1-2b. Feedwater Line Break - Parametric Study on the Break Areas (0-2000 sec) .....	6F-5
Figure 6F2-1. Main Steam Line Break - Parametric Study on the Break Elevation .....	6F-5
Figure 6G-1. Phases of the LOCA Transient.....	6G-11
Figure 6G-2. Inventory Distributions for Main Steam Line Break .....	6G-12
Figure 6G-3. RPV and Drywell Water Levels for MSLB (12 hours).....	6G-13

Figure 6G-4. RPV and Drywell Water Levels for FWLB (12 hours) .....	6G-13
Figure 6G-5. Inventory Distributions for Bottom Drain Line Break.....	6G-14
Figure 6G-6. RPV and Drywell Water Levels for BDL Break (12 hours).....	6G-15
Figure 6G-7. RPV and Drywell Water Levels for GDCS Line Break (12 hours).....	6G-15
Figure 6H-1. Air Mass Profiles in the GDCS Airspace.....	6H-5
Figure 6H-2. Air Mass Profile in the Drywell Head Airspace .....	6H-5
Figure 6H-3. Air Mass Profiles in the Wetwell Airspace.....	6H-6
Figure 6H-4. Comparison of DW Pressures .....	6H-6
Figure 6H-5. Comparison of DW Pressures .....	6H-7
Figure 6H-6. Comparison of DW Pressures .....	6H-7
Figure 6H-7. Comparison of DW Pressures .....	6H-8
Figure 6H-8. Comparison of DW Pressures .....	6H-8
Figure 6H-9. Comparison of DW Pressures .....	6H-9
Figure 6H-10. Comparison of DW Pressures .....	6H-9
Figure 6H-11. Comparison of DW Pressures .....	6H-10
Figure 6I-1a1. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Containment Pressures (72 hrs).....	6I-7
Figure 6I-1a2. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Containment Pressures (500 s) .....	6I-8
Figure 6I-1a3. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Containment Pressures (2000 s) .....	6I-9
Figure 6I-1b1. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Containment Temperatures (72 hrs) .....	6I-10
Figure 6I-1b2. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Containment Temperatures (500 s) .....	6I-11
Figure 6I-1b3. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Containment Temperatures (2000 s) .....	6I-12
Figure 6I-1c1. Main Steam Line Break, 1 DPV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (72 hrs).....	6I-13
Figure 6I-1c2. Main Steam Line Break, 1 DPV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (500 s).....	6I-14
Figure 6I-1c3. Main Steam Line Break, 1 DPV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (2000 s).....	6I-15
Figure 6I-1d1. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Drywell and GDCS Noncondensable Gas Pressures (72 hrs).....	6I-16
Figure 6I-1d2. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Drywell and GDCS Noncondensable Gas Pressures (500 s).....	6I-17
Figure 6I-1d3. Main Steam Line Break, 1 DPV Failure (Bounding Case) – Drywell and GDCS Noncondensable Gas Pressures (2000 s).....	6I-18
Figure 6I-2a1. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Containment Pressures (72 hrs).....	6I-19
Figure 6I-2a2. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Containment Pressures (500 s) .....	6I-20
Figure 6I-2a3. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Containment Pressures (2000 s) .....	6I-21



Figure 6I-2b1. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Containment Temperatures (72 hrs) .....	6I-22
Figure 6I-2b2. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Containment Temperatures (500 s) .....	6I-23
Figure 6I-2b3. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Containment Temperatures (2000 s) .....	6I-24
Figure 6I-2c1. Main Steam Line Break, 1 SRV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (72 hrs) .....	6I-25
Figure 6I-2c2. Main Steam Line Break, 1 SRV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (500 s).....	6I-26
Figure 6I-2c3. Main Steam Line Break, 1 SRV Failure (Bounding Case) – PCCS Heat Removal versus Decay Heat (2000 s).....	6I-27
Figure 6I-2d1. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Drywell and GDCS Noncondensable Gas Pressures (72 hrs) .....	6I-28
Figure 6I-2d2. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Drywell and GDCS Noncondensable Gas Pressures (500 s).....	6I-29
Figure 6I-2d3. Main Steam Line Break, 1 SRV Failure (Bounding Case) – Drywell and GDCS Noncondensable Gas Pressures (2000 s).....	6I-30

Figure 7.1-1. ESBWR Instrumentation and Control Simplified Block Diagram .....	7.1-112
Figure 7.1-2. ESBWR Distributed Control and Information System (DCIS) Functional Network Diagram.....	7.1-114
Figure 7.1-3. ESBWR Distributed Power-Sensor Diversity Diagram.....	7.1-116
Figure 7.1-4. ESBWR Hardware/Software (Architecture) Diversity Diagram .....	7.1-118
Figure 7.2-1. RPS Functional Block Diagram.....	7.2-69
Figure 7.2-2. RPS Interfaces and Boundaries Diagram.....	7.2-71
Figure 7.2-3. Neutron Flux Monitoring Ranges .....	7.2-73
Figure 7.2-4. Basic Configuration of a Typical SRNM Subsystem .....	7.2-74
Figure 7.2-5. Basic Configuration of a Typical PRNM Subsystem .....	7.2-75
Figure 7.2-6. SRNM Detector Locations.....	7.2-76
Figure 7.2-7. LPRM Locations in the Core .....	7.2-77
Figure 7.2-8. Axial Distribution of LPRM Detectors.....	7.2-79
Figure 7.2-9. LPRM Assignments to APRM Channels.....	7.2-80
Figure 7.2-10. LPRM Assignment to OPRM Channels .....	7.2-81
Figure 7.3-1a. SRV Initiation Logics.....	7.3-68
Figure 7.3-1b. GDCS and DPV Initiation Logics.....	7.3-70
Figure 7.3-1c. DPS Initiation Logic.....	7.3-72
Figure 7.3-2. GDCS Equalizing Valve Initiation Logics.....	7.3-74
Figure 7.3-3. LD&IS System Design Configuration .....	7.3-76
Figure 7.3-4. SSLC/ESF Functional Block Diagram.....	7.3-77
Figure 7.4-1. Remote Shutdown System Panel Schematic.....	7.4-30
Figure 7.4-2a. RWCU/SDC System Train A Differential Mass Flow Logic- Division 1 .....	7.4-31
Figure 7.4-2b. RWCU/SDC System Train A Differential Mass Flow Logic- Division 2.....	7.4-32
Figure 7.4-2c. RWCU/SDC System Train A Differential Mass Flow Logic- Division 3 .....	7.4-33
Figure 7.4-2d. RWCU/SDC System Train A Differential Mass Flow Logic- Division 4.....	7.4-34
Figure 7.4-2e. RWCU/SDC Line Break Outside Containment Train A Isolation Logic .....	7.4-35
Figure 7.4-3. Isolation Condenser System Initiation and Actuation.....	7.4-37
Figure 7.5-1. Containment Monitoring System Design.....	7.5-31
Figure 7.5-2. (Deleted).....	7.5-32
Figure 7.5-3. Area Radiation Monitoring System Functional Block Diagram.....	7.5-34
Figure 7.7-1. Water Level Range Definition .....	7.7-60
Figure 7.7-2. RC&IS Block Diagram .....	7.7-61
Figure 7.7-3. Feedwater Control System Functional Diagram.....	7.7-63
Figure 7.7-4. Plant Automation System Simplified Functional Diagram.....	7.7-64
Figure 7.7-5. SB&PC System Simplified Functional Block Diagram .....	7.7-65
Figure 7.7-6. SB&PC System FTDC Block Diagram .....	7.7-66
Figure 7.7-7. HP Feedwater Heater Temperature Control Diagram.....	7.7-65
Figure 7.8-1. Simplified DPS Block Diagram.....	7.8-22
Figure 7.8-2. Alternate Rod Insertion & FMCRD Run-in Logic .....	7.8-24
Figure 7.8-3. ATWS Mitigation Logic (SLC System Initiation, Feedwater Runback).....	7.8-25
Figure 7.8-4. Diverse ESF Triple Redundant Logic .....	7.8-27

Figure 8.1-1. Electrical Power Distribution System ..... 8.1-12  
Figure 8.1-2. Direct Current Power Supply (Nonsafety-Related) ..... 8.1-15  
Figure 8.1-3. Direct Current Power Supply (Safety-Related)..... 8.1-17  
Figure 8.1-4. Uninterruptible AC Power Supply (Safety-Related)..... 8.1-18  
Figure 8.1-5. Uninterruptible AC Power Supply (Nonsafety-Related) ..... 8.1-19  
Figure 8.1-6. Deleted ..... 8.1-21  
Figure 8.3-1. Safety-Related 480 Volt Power Centers ..... 8.3-37  
Figure 8.3-2. Nonsafety-Related 480 Volt Power Centers ..... 8.3-38  
Figure 8.3-3. Ancillary Power Functional Figure ..... 8.3-41

Figure 9.1-1. FAPCS Schematic Diagram.....	9.1-52
Figure 9.1-2. Inclined Fuel Transfer System .....	9.1-53
Figure 9.1-3. Refueling Sequence.....	9.1-54
Figure 9.2-1. Plant Service Water System Simplified Diagram .....	9.2-39
Figure 9.2-2a. Reactor Component Cooling Water System .....	9.2-40
Figure 9.2-2.b Reactor Component Cooling Water System .....	9.2-41
Figure 9.2-3. Chilled Water System Simplified Diagram.....	9.2-42
Figure 9.2-4. Turbine Component Cooling Water System Configuration.....	9.2-43
Figure 9.3-1. Standby Liquid Control System Simplified Diagram .....	9.3-46
Figure 9.3-1a. Standby Liquid Control System Simplified Process Flow Diagram.....	9.3-47
Figure 9.3-2. Instrument Air System Simplified Diagram (See Figure 9.3-3) .....	9.3-48
Figure 9.3-3. Service Air and Instrument Air System Simplified Diagram .....	9.3-49
Figure 9.3-4. HPNSS Simplified Diagram .....	9.3-50
Figure 9.3-5. Hydrogen Water Chemistry System Simplified Diagram.....	9.3-51
Figure 9.4-1. CRHAVS Simplified System Diagram.....	9.4-78
Figure 9.4-2. CRHAVS Air Flow Diagram.....	9.4-79
Figure 9.4-3. CBGAVS SET A Simplified System Diagram.....	9.4-80
Figure 9.4-4. CBGAVS SET B Simplified System Flow Diagram.....	9.4-81
Figure 9.4-5. FBGAVS Simplified System Diagram .....	9.4-83
Figure 9.4-6. FBFVVS Simplified System Diagram.....	9.4-84
Figure 9.4-7a. RWCRVS Simplified Subsystem Diagram.....	9.4-86
Figure 9.4-7b. RWGAVS Simplified Subsystem Diagram .....	9.4-87
Figure 9.4-8. TBVS Simplified System Diagram.....	9.4-88
Figure 9.4-9. CLAVS Simplified System Diagram.....	9.4-89
Figure 9.4-10. CONAVS Simplified System Diagram.....	9.4-90
Figure 9.4-11. REPAVS Simplified System Diagram.....	9.4-91
Figure 9.4-12. Electrical Building HVAC System .....	9.4-93
Figure 9.4-13. DCS Simplified System Diagram .....	9.4-94
Figure 9.4-14. CIS Simplified System Diagram [Moved to Chapter 6].....	9.4-95
Figure 9.5-1. Fire Protection System Simplified Diagram .....	9.5-64
Figure 9.5-2. (Deleted).....	9.5-65
Figure 9.5-3. (Deleted).....	9.5-66
Figure 9.5-4. (Deleted).....	9.5-67
Figure 9.5-5. (Deleted).....	9.5-68
Figure 9.5-6. (Deleted).....	9.5-69
Figure 9.5-7. (Deleted).....	9.5-70
Figure 9.5-8. (Deleted).....	9.5-71
Figure 9.5-9. Standby Diesel Generator Fuel Oil Storage and Transfer System & Air Intake and Exhaust System Diagram .....	9.5-72
Figure 9.5-9a. Ancillary Diesel Generator Fuel Oil Storage and Transfer System Diagram.....	9.5-73
Figure 9.5-10. Standby Diesel Generator Jacket Cooling Water System Diagram.....	9.5-74
Figure 9.5-11. Standby Diesel Generator Starting Air System Diagram.....	9.5-75
Figure 9.5-12. Standby Diesel Generator Lubrication System Diagram.....	9.5-76

Figure 9A.2-1. Nuclear Island Fire Protection Zones ESBWR DCD EL -11500..... 9A.2-17

Figure 9A.2-2. Nuclear Island Fire Protection Zones ESBWR DCD EL -6400..... 9A.2-18

Figure 9A.2-3. Nuclear Island Fire Protection Zones ESBWR DCD EL 1000..... 9A.2-20

Figure 9A.2-4. Nuclear Island Fire Protection Zones ESBWR DCD EL 4650..... 9A.2-23

Figure 9A.2-5. Nuclear Island Fire Protection Zones ESBWR DCD EL 9060..... 9A.2-25

Figure 9A.2-6. Nuclear Island Fire Protection Zones ESBWR DCD EL 13570..... 9A.2-27

Figure 9A.2-7. Nuclear Island Fire Protection Zones ESBWR DCD EL 17500..... 9A.2-28

Figure 9A.2-8. Nuclear Island Fire Protection Zones ESBWR DCD EL 27000..... 9A.2-30

Figure 9A.2-9. Nuclear Island Fire Protection Zones ESBWR DCD EL 34000..... 9A.2-31

Figure 9A.2-10. Nuclear Island Fire Protection Zones ESBWR DCD SEC A-A ..... 9A.2-33

Figure 9A.2-11. Nuclear Island Fire Protection Zones ESBWR DCD Section “B-B” ..... 9A.2-36

Figure 9A.2-12. Turbine Island Fire Protection Zones ESBWR DCD EL. -1400..... 9A.2-37

Figure 9A.2-13. Turbine Building Fire Protection Zones ESBWR DCD EL 4650 ..... 9A.2-39

Figure 9A.2-14. Turbine Island Fire Protection Zones ESBWR DCD EL. 12000..... 9A.2-41

Figure 9A.2-15. Turbine Island Fire Protection Zones ESBWR DCD EL. 20000..... 9A.2-43

Figure 9A.2-16. Turbine Island Fire Protection Zones ESBWR DCD EL. 28000..... 9A.2-45

Figure 9A.2-16a. Turbine Building Fire Protection Zones ESBWR DCD EL 35000..... 9A.2-47

Figure 9A.2-17. Turbine Island Fire Protection Zones ESBWR DCD EL. Various ..... 9A.2-48

Figure 9A.2-18. Turbine Building Fire Protection Zones ESBWR DCD Section A-A ..... 9A.2-50

Figure 9A.2-19. Turbine Building Fire Protection Zones ESBWR DCD Section B-B..... 9A.2-52

Figure 9A.2-20. Radwaste Building Fire Protection Zones ESBWR DCD EL -9350 ..... 9A.2-54

Figure 9A.2-21. Radwaste Building Fire Protection Zones ESBWR DCD EL -2350..... 9A.2-56

Figure 9A.2-22. Radwaste Building Fire Protection Zones ESBWR DCD EL 4650..... 9A.2-58

Figure 9A.2-23. Radwaste Building Fire Protection Zones ESBWR DCD EL 10650..... 9A.2-60

Figure 9A.2-24. Radwaste Building Fire Protection Zones ESBWR DCD Section A-A .. 9A.2-63

Figure 9A.2-25. Electrical Building Fire Protection Zone ESBWR DCD EL 4650 ..... 9A.2-65

Figure 9A.2-26. Electrical Building Fire Protection Zone ESBWR DCD EL 9800 ..... 9A.2-67

Figure 9A.2-27. DELETED..... 9A.2-68

Figure 9A.2-28. Electrical Building Fire Protection Zone ESBWR DCD EL 18000 ..... 9A.2-70

Figure 9A.2-29. DELETED..... 9A.2-71

Figure 9A.2-30. Electrical Building Fire Protection Zone ESBWR DCD EL 27000 ..... 9A.2-73

Figure 9A.2-31. Electrical Building Fire Protection Zone ESBWR DCD EL (Various) ... 9A.2-75

Figure 9A.2-32. Electrical Building Fire Protection Zone ESBWR DCD Section A-A .... 9A.2-77

Figure 9A.2-33. Site Fire Protection Zone ESBWR DCD Plot Plan..... 9A.2-79

Figure 9B-1. Time-Temperature Curve and Fire Endurance Curves ..... 15

Figure 11.2-1. Liquid Waste Management System Processing Diagram .....	11.2-18
Figure 11.2-1a. Equipment Drain .....	11.2-19
Figure 11.2-1b. Floor Drain .....	11.2-20
Figure 11.2-2. Liquid Waste Management System Processing Stream Information Directory .....	11.2-21
Figure 11.2-3. Detergent Drain .....	11.2-22
Figure 11.2-4. Chemical Drain .....	11.2-23
Figure 11.3-1. Offgas System .....	11.3-25
Figure 11.4-1. Solid Waste Management System Process Diagram .....	11.4-14
Figure 11.4-2. SWMS Collection Subsystem .....	11.4-15
Figure 11.4-3. SWMS Processing Subsystem .....	11.4-16
Figure 11.4-4. Dry Active Waste Processing .....	11.4-17
Figure 11.5-1. Location of Radiation Monitors .....	11.5-57
Figure 11.5-2. PRMS Channel Block Diagram .....	11.5-58

Figure 12.2-1. Radiation Source Model..... 12.2-87

Figure 12.3-1. Nuclear Island Radiation Zones for Full Power and Shutdown Operation -  
Elevation -11500 mm..... 12.3-52

Figure 12.3-2. Nuclear Island Radiation Zones for Full Power and Shutdown Operation -  
Elevation -6400 mm..... 12.3-53

Figure 12.3-3. Nuclear Island Radiation Zones for Full Power and Shutdown Operation -  
Elevation -1000 mm..... 12.3-54

Figure 12.3-4. Nuclear Island Radiation Zones for Full Power and Shutdown Operation –  
Elevation 4650 mm ..... 12.3-55

Figure 12.3-5. Nuclear Island Radiation Zones for Full Power and Shutdown Operation -  
Elevation 9060 mm ..... 12.3-56

Figure 12.3-6. Nuclear Island Radiation Zones for Full Power and Shutdown Operation -  
Elevation 13570 mm ..... 12.3-57

Figure 12.3-7. Nuclear Island Radiation Zones for Full Power and Shutdown Operation -  
Elevation 17500 mm ..... 12.3-58

Figure 12.3-8. Nuclear Island Radiation Zones for Full Power and Shutdown Operation -  
Elevation 27000 mm ..... 12.3-59

Figure 12.3-9. Nuclear Island Radiation Zones for Full Power and Shutdown Operation -  
Elevation 34000 mm ..... 12.3-60

Figure 12.3-10. Nuclear Island Radiation Zones for Full Power and Shutdown Operation  
Section A-A..... 12.3-61

Figure 12.3-11. Nuclear Island Radiation Zones for Full Power and Shutdown Operation  
Section B-B ..... 12.3-62

Figure 12.3-12. Turbine Building Radiation Zones - Elevation -1400 mm..... 12.3-63

Figure 12.3-13. Turbine Building Radiation Zones - Elevation 4650 mm..... 12.3-64

Figure 12.3-14. Turbine Building Radiation Zones - Elevation 12000 mm..... 12.3-65

Figure 12.3-15. Turbine Building Radiation Zones - Elevation 20000 mm..... 12.3-66

Figure 12.3-16. Turbine Building Radiation Zones - Elevation 28000 mm..... 12.3-67

Figure 12.3-17. Turbine Building Radiation Zones - Elevation 35000 mm..... 12.3-68

Figure 12.3-18. Turbine Building Radiation Zones at Roof Elevation Various..... 12.3-69

Figure 12.3-19. Radwaste Building Radiation Zones - Elevation -9350 mm..... 12.3-70

Figure 12.3-20. Radwaste Building Radiation Zones - Elevation -2350 mm..... 12.3-71

Figure 12.3-21. Radwaste Building Radiation Zones - Elevation 4650 mm..... 12.3-72

Figure 12.3-22. Radwaste Building Radiation Zones - Elevation 10650 mm..... 12.3-73

Figure 12.3-22a: Radiation Zones in the Access Tunnel to the Electrical Building –  
Elevation -2000 mm..... 12.3-74

Figure 12.3-22b: Radiation Zones in the Access Tunnel to the Electrical Building and Radwaste  
Building – Elevation 1300 mm ..... 12.3-75

Figure 12.3-23. Nuclear Island Area Radiation Monitors - Elevation -11500 mm ..... 12.3-76

Figure 12.3-24. Nuclear Island Area Radiation Monitors - Elevation -6400 mm ..... 12.3-77

Figure 12.3-25. Nuclear Island Area Radiation Monitors - Elevation -1000 mm ..... 12.3-78

Figure 12.3-26. Nuclear Island Area Radiation Monitors - Elevation 4650 mm ..... 12.3-79

Figure 12.3-27. Nuclear Island Area Radiation Monitors - Elevation 9060 mm ..... 12.3-80

Figure 12.3-28. Nuclear Island Area Radiation Monitors - Elevation 13570 mm ..... 12.3-81

Figure 12.3-29. Nuclear Island Area Radiation Monitors - Elevation 17500 mm ..... 12.3-82



Figure 12.3-30. Nuclear Island Area Radiation Monitors - Elevation 27000 mm ..... 12.3-83

Figure 12.3-31. Nuclear Island Area Radiation Monitors - Elevation 34000 mm ..... 12.3-84

Figure 12.3-32. Turbine Building Area Radiation Monitors - Elevation -1400 mm ..... 12.3-85

Figure 12.3-33. Turbine Building Area Radiation Monitors - Elevation 4650 mm ..... 12.3-86

Figure 12.3-34. Turbine Building Area Radiation Monitors - Elevation 12000 mm ..... 12.3-87

Figure 12.3-35. Turbine Building Area Radiation Monitors - Elevation 20000 mm ..... 12.3-88

Figure 12.3-36. Turbine Building Area Radiation Monitors - Elevation 28000 mm ..... 12.3-89

Figure 12.3-37. Turbine Building Area Radiation Monitors - Elevation 35000 mm ..... 12.3-90

Figure 12.3-38. Turbine Building Area Radiation Monitors at Various Elevations..... 12.3-91

Figure 12.3-39. Radwaste Building Area Radiation Monitors - Elevation -9350 mm ..... 12.3-92

Figure 12.3-40. Radwaste Building Area Radiation Monitors - Elevation -2350 mm ..... 12.3-93

Figure 12.3-41. Radwaste Building Area Radiation Monitors - Elevation 4650 mm ..... 12.3-94

Figure 12.3-42. Radwaste Building Area Radiation Monitors - Elevation 10650 mm ..... 12.3-95

Figure 12.3-43. Nuclear Island Post Accident Radiation Zones - Elevation -11500 mm .... 12.3-96

Figure 12.3-44. Nuclear Island Post Accident Radiation Zones - Elevation -6400 mm ..... 12.3-97

Figure 12.3-45. Nuclear Island Post Accident Radiation Zones - Elevation -1000 mm ..... 12.3-98

Figure 12.3-46. Nuclear Island Post Accident Radiation Zones - Elevation 4650 mm..... 12.3-99

Figure 12.3-47. Nuclear Island Post Accident Radiation Zones - Elevation 9060 mm..... 12.3-100

Figure 12.3-48. Nuclear Island Post Accident Radiation Zones - Elevation 13570 mm.... 12.3-101

Figure 12.3-49. Nuclear Island Post Accident Radiation Zones - Elevation 17500 mm.... 12.3-102

Figure 12.3-50. Nuclear Island Post Accident Radiation Zones - Elevation 27000 mm.... 12.3-103

Figure 12.3-51. Nuclear Island Post Accident Radiation Zones - Elevation 34000 mm.... 12.3-104

Figure 12.3-51a. Post Accident Radiation Zones Electrical Building -  
Elevation 4650 mm ..... 12.3-105

Figure 12.3-51b. Post Accident Radiation Zones Electrical Building -  
Elevation 9800 mm ..... 12.3-106

Figure 12.3-51c. Post Accident Radiation Zones Electrical Building -  
Elevation 18000 mm ..... 12.3-107

Figure 12.3-51d. Post Accident Radiation Zones Electrical Building -  
Elevation 27000 mm ..... 12.3-108

Figure 12.3-51e. Post Accident Radiation Zones, Service Building Floor -  
Elevation 1300 mm ..... 12.3-109

Figure 12.3-51f. Post Accident Radiation Zones, Service Building Floor -  
Elevation 4650 mm ..... 12.3-110

Figure 12.3-54. Reactor, Fuel, & Control Buildings Personnel Egress Routes -  
Elevation -1000 mm..... 12.3-113

Figure 12.3-55. Reactor, Fuel, & Control Buildings Personnel Egress Routes -  
Elevation 4650 mm ..... 12.3-114

Figure 12.3-56. Reactor, Fuel, & Control Buildings Personnel Egress Routes -  
Elevation 9060 mm ..... 12.3-115

Figure 12.3-57. Reactor, Fuel, & Control Buildings Personnel Egress Routes -  
Elevation 13570 mm ..... 12.3-116

Figure 12.3-58. Reactor, Fuel, & Control Buildings Personnel Egress Routes -  
Elevation 17500 mm ..... 12.3-117

Figure 12.3-59. Reactor, Fuel, & Control Buildings Personnel Egress Routes -  
Elevation 27000 mm ..... 12.3-118

Figure 12.3-60. Reactor, Fuel, & Control Buildings Personnel Egress Routes - Elevation 34000 mm .....	12.3-119
Figure 12.3-61. Radwaste Building Personnel Egress Routes - Elevation -9350 mm .....	12.3-120
Figure 12.3-62. Radwaste Building Personnel Egress Routes - Elevation -2350 mm .....	12.3-121
Figure 12.3-63. Radwaste Building Personnel Egress Routes - Elevation 4650 mm.....	12.3-122
Figure 12.3-64. Radwaste Building Personnel Egress Routes - Elevation 10650 mm.....	12.3-123
Figure 12.3-65. Turbine Building Personnel Egress Routes - Elevation -1400 mm .....	12.3-124
Figure 12.3-66. Turbine Building Personnel Egress Routes - Elevation 4650 mm.....	12.3-125
Figure 12.3-67. Turbine Building Personnel Egress Routes - Elevation 12000 mm.....	12.3-126
Figure 12.3-68. Turbine Building Personnel Egress Routes - Elevation 20000 mm.....	12.3-127
Figure 12.3-69. Turbine Building Personnel Egress Routes - Elevation 28000 mm.....	12.3-128
Figure 12.3-70. Turbine Building Personnel Egress Routes - Elevation 35000 mm.....	12.3-129
Figure 12.3-70a. Turbine Building Personnel Egress Routes at Various Elevations .....	12.3-130
Figure 12.3-71. Reactor Building Rooms Adjacent to the RWCU/SDC and FAPCS Demineralizers - Elevation -11500 mm .....	12.3-131
Figure 12.3-72. Reactor Building RWCU/SDC and FAPCS Demineralizer Rooms and Adjacent Rooms - Elevation -6400 mm .....	12.3-132
Figure 12.3-73. Reactor Building Rooms Adjacent to the RWCU/SDC and FAPCS Demineralizers - Elevation -1000 mm .....	12.3-133
Figure 12.3-74. Areas Requiring Post-Accident Access - Elevation -11500 mm .....	12.3-134
Figure 12.3-75. Areas Requiring Post-Accident Access - Elevation -6400 mm .....	12.3-135
Figure 12.3-76. Areas Requiring Post-Accident Access - Elevation from -2000 to -1000 mm.....	12.3-136
Figure 12.3-77. Areas Requiring Post-Accident Access - Elevation 1300 mm.....	12.3-137
Figure 12.3-78. Areas Requiring Post-Accident Access - Elevation 4650 mm.....	12.3-138
Figure 12.3-79. Areas Requiring Post-Accident Access - Elevation 9060 mm.....	12.3-139
Figure 12.3-80. Areas Requiring Post-Accident Access - Elevation 9800 mm.....	12.3-140
Figure 12.3-81. Areas Requiring Post-Accident Access - Elevation 13570 mm.....	12.3-141
Figure 12.3-82. Areas Requiring Post-Accident Access - Elevation 17500 mm.....	12.3-142
Figure 12.3-83. Areas Requiring Post-Accident Access - Elevation 18000 mm.....	12.3-143
Figure 12.3-84. Areas Requiring Post-Accident Access - Elevation 27000 mm.....	12.3-144
Figure 12.3-85. Areas Requiring Post-Accident Access (Electrical Building) - Elevation 27000 mm .....	12.3-145
Figure 12.3-86. Areas Requiring Post-Accident Access - Elevation 34000 mm.....	12.3-146

Figure 15.1-1. Event Diagram Format.....	15.1-30
Figure 15.1-2. Event Diagram – Loss of Feedwater Heating.....	15.1-31
Figure 15.1-3. Event Diagram – Closure of One Turbine Control Valve.....	15.1-32
Figure 15.1-4. Event Diagram – Generator Load Rejection with Turbine Bypass.....	15.1-33
Figure 15.1-5. Event Diagram – Generator Load Rejection with a Single Failure in the Turbine Bypass System.....	15.1-34
Figure 15.1-6. Event Diagram – Turbine Trip with Turbine Bypass.....	15.1-35
Figure 15.1-7. Event Diagram – Turbine Trip with a Single Failure in the Turbine Bypass System.....	15.1-36
Figure 15.1-8. Event Diagram – Closure of One Main Steamline Isolation Valve.....	15.1-37
Figure 15.1-9. Event Diagram – Closure of All Main Steamline Isolation Valves.....	15.1-38
Figure 15.1-10. Event Diagram – Loss of Condenser Vacuum.....	15.1-39
Figure 15.1-11. Event Diagram – Loss of Shutdown Cooling Function of RWCU/SDC System.....	15.1-40
Figure 15.1-12. Event Diagram – Inadvertent Isolation Condenser Initiation.....	15.1-41
Figure 15.1-13. Event Diagram – Runout of One Feedwater Pump.....	15.1-42
Figure 15.1-14. Event Diagram – Opening of One Turbine Control or Bypass Valve.....	15.1-43
Figure 15.1-15. Event Diagram – Loss of Non-Emergency AC Power to Station Auxiliaries.....	15.1-44
Figure 15.1-16. Event Diagram – Loss of All Feedwater Flow.....	15.1-45
Figure 15.1-17. Event Diagram – Loss of Feedwater Heating With Failure of SCRRI and SRI.....	15.1-46
Figure 15.1-18. Event Diagram – Feedwater Controller Failure – Maximum Flow Demand.....	15.1-47
Figure 15.1-19. Event Diagram – Pressure Regulator Failure – Opening of All Turbine Control and Bypass Valves.....	15.1-48
Figure 15.1-20. Event Diagram – Pressure Regulator Failure – Closure of All Turbine Control and Bypass Valves.....	15.1-49
Figure 15.1-21. Event Diagram – Generator Load Rejection with Total Bypass Failure (at High Power).....	15.1-50
Figure 15.1-22. Event Diagram – Turbine Trip with Total Bypass Failure (at High Power).....	15.1-51
Figure 15.1-23. Event Diagram – Control Rod Withdrawal Error During Refueling.....	15.1-52
Figure 15.1-24a. Event Diagram – Control Rod Withdrawal Error During Startup.....	15.1-53
Figure 15.1-24b. Event Diagram – Control Rod Withdrawal Error During Startup With Failure of Control Rod Block.....	15.1-54
Figure 15.1-25a. Event Diagram – Control Rod Withdrawal Error During Power Operation with ATLM Failure.....	15.1-55
Figure 15.1-25b. Event Diagram – Control Rod Withdrawal Error During Power Operation.....	15.1-56
Figure 15.1-26. Event Diagram – Fuel Assembly Loading Error – Mislocated Bundle.....	15.1-57
Figure 15.1-27. Event Diagram – Fuel Assembly Loading Error – Misoriented Bundle.....	15.1-58
Figure 15.1-28. Event Diagram – Inadvertent SDC Function Operation.....	15.1-59

Figure 15.1-29. Event Diagram – Inadvertent Opening of a Safety Relief Valve.....	15.1-60
Figure 15.1-30. Event Diagram – Inadvertent Opening of a Depressurization Valve.....	15.1-61
Figure 15.1-31. Event Diagram – Stuck Open Safety Relief Valve .....	15.1-62
Figure 15.1-32. Event Diagram – Liquid-Containing Tank Failure .....	15.1-63
Figure 15.1-33. Event Diagram – Fuel Handling Accident .....	15.1-64
Figure 15.1-34a. Event Diagram – Loss-of-Coolant Accident Inside Containment.....	15.1-65
Figure 15.1-34b. Event Diagram – Loss-of-Coolant Accident Inside Containment .....	15.1-66
Figure 15.1-35a. Event Diagram – Main Steamline Break Outside Containment.....	15.1-67
Figure 15.1-35b. Event Diagram – Main Steamline Break Outside Containment .....	15.1-68
Figure 15.1-36. Event Diagram – Control Rod Drop Accident.....	15.1-69
Figure 15.1-37a. Event Diagram – Feedwater Line Break Outside Containment .....	15.1-70
Figure 15.1-37b. Event Diagram – Feedwater Line Break Outside Containment.....	15.1-71
Figure 15.1-38a. Event Diagram – Failure of Small Line Carrying Primary Coolant Outside Containment .....	15.1-72
Figure 15.1-38b. Event Diagram – Failure of Small Line Carrying Primary Coolant Outside Containment .....	15.1-73
Figure 15.1-39a. Event Diagram – RWCU/SDC System Line Failure Outside Containment .....	15.1-74
Figure 15.1-39b. Event Diagram – RWCU/SDC System Line Failure Outside Containment .....	15.1-75
Figure 15.1-40. Event Diagram – Spent Fuel Cask Drop Accident.....	15.1-76
Figure 15.1-41. Event Diagram – MSIV Closure With Flux Scram (Overpressure Protection) .....	15.1-77
Figure 15.1-42. Event Diagram – Shutdown Without Control Rods (Standby Liquid Control System Capability).....	15.1-78
Figure 15.1-43. Event Diagram – Shutdown from Outside Main Control Room.....	15.1-79
Figure 15.1-44a. Event Diagram – Anticipated Transients Without Scram .....	15.1-80
Figure 15.1-44b. Event Diagram – Anticipated Transients Without Scram.....	15.1-81
Figure 15.1-45a. Event Diagram – Station Blackout.....	15.1-82
Figure 15.1-46. Event Diagram – Safe Shutdown Fire.....	15.1-84
Figure 15.1-47. Event Diagram – Waste Gas System Leak or Failure.....	15.1-85
Figure 15.2-1a. Loss of Feedwater Heating.....	15.2-54
Figure 15.2-1b. Loss of Feedwater Heating.....	15.2-54
Figure 15.2-1c. Loss of Feedwater Heating.....	15.2-55
Figure 15.2-1d. Loss of Feedwater Heating.....	15.2-55
Figure 15.2-1e. Loss of Feedwater Heating.....	15.2-56
Figure 15.2-1f. Loss of Feedwater Heating.....	15.2-56
Figure 15.2-1g. Loss of Feedwater Heating.....	15.2-57
Figure 15.2-2a. Fast Closure of One Turbine Control Valve .....	15.2-58
Figure 15.2-2b. Fast Closure of One Turbine Control Valve .....	15.2-58
Figure 15.2-2c. Fast Closure of One Turbine Control Valve .....	15.2-59
Figure 15.2-2d. Fast Closure of One Turbine Control Valve .....	15.2-59
Figure 15.2-2e. Fast Closure of One Turbine Control Valve .....	15.2-60
Figure 15.2-2f. Fast Closure of One Turbine Control Valve.....	15.2-60
Figure 15.2-2g. Fast Closure of One Turbine Control Valve .....	15.2-61
Figure 15.2-3a. Slow Closure of One Turbine Control Valve.....	15.2-62

Figure 15.2-3b. Slow Closure of One Turbine Control Valve.....	15.2-62
Figure 15.2-3c. Slow Closure of One Turbine Control Valve.....	15.2-63
Figure 15.2-3d. Slow Closure of One Turbine Control Valve.....	15.2-63
Figure 15.2-3e. Slow Closure of One Turbine Control Valve.....	15.2-64
Figure 15.2-3f. Slow Closure of One Turbine Control Valve .....	15.2-64
Figure 15.2-3g. Slow Closure of One Turbine Control Valve.....	15.2-65
Figure 15.2-4a. Generator Load Rejection with Turbine Bypass .....	15.2-66
Figure 15.2-4b. Generator Load Rejection with Turbine Bypass.....	15.2-66
Figure 15.2-4c. Generator Load Rejection with Turbine Bypass .....	15.2-67
Figure 15.2-4d. Generator Load Rejection with Turbine Bypass.....	15.2-67
Figure 15.2-4e. Generator Load Rejection with Turbine Bypass .....	15.2-68
Figure 15.2-4f. Generator Load Rejection with Turbine Bypass.....	15.2-68
Figure 15.2-4g. Generator Load Rejection with Turbine Bypass.....	15.2-69
Figure 15.2-4h. Generator Load Rejection with Turbine Bypass (Figure 15.2-4a from 0 to 30 s).....	15.2-69
Figure 15.2-5a. Generator Load Rejection with a Single Failure In the Turbine Bypass System .....	15.2-70
Figure 15.2-5b. Generator Load Rejection with a Single Failure In the Turbine Bypass System .....	15.2-70
Figure 15.2-5c. Generator Load Rejection with a Single Failure In the Turbine Bypass System .....	15.2-71
Figure 15.2-5d. Generator Load Rejection with a Single Failure In the Turbine Bypass System .....	15.2-71
Figure 15.2-5e. Generator Load Rejection with a Single Failure In the Turbine Bypass System .....	15.2-72
Figure 15.2-5f. Generator Load Rejection with a Single Failure In the Turbine Bypass System .....	15.2-72
Figure 15.2-5g. Generator Load Rejection with a Single Failure In the Turbine Bypass System .....	15.2-73
Figure 15.2-6a. Turbine Trip with Turbine Bypass.....	15.2-74
Figure 15.2-6b. Turbine Trip with Turbine Bypass.....	15.2-74
Figure 15.2-6c. Turbine Trip with Turbine Bypass.....	15.2-75
Figure 15.2-6d. Turbine Trip with Turbine Bypass.....	15.2-75
Figure 15.2-6e. Turbine Trip with Turbine Bypass.....	15.2-76
Figure 15.2-6f. Turbine Trip with Turbine Bypass.....	15.2-76
Figure 15.2-6g. Turbine Trip with Turbine Bypass.....	15.2-77
Figure 15.2-7a. Turbine Trip with a Single Failure in the Turbine Bypass System.....	15.2-78
Figure 15.2-7b. Turbine Trip with a Single Failure in the Turbine Bypass System.....	15.2-78
Figure 15.2-7c. Turbine Trip with a Single Failure in the Turbine Bypass System.....	15.2-79
Figure 15.2-7d. Turbine Trip with a Single Failure in the Turbine Bypass System.....	15.2-79
Figure 15.2-7e. Turbine Trip with a Single Failure in the Turbine Bypass System.....	15.2-80
Figure 15.2-7f. Turbine Trip with a Single Failure in the Turbine Bypass System.....	15.2-80
Figure 15.2-7g. Turbine Trip with a Single Failure in the Turbine Bypass System.....	15.2-81
Figure 15.2-8a. One MSIV Closure.....	15.2-82
Figure 15.2-8b. One MSIV Closure.....	15.2-82
Figure 15.2-8c. One MSIV Closure.....	15.2-83

Figure 15.2-8d. One MSIV Closure.....	15.2-83
Figure 15.2-8e. One MSIV Closure.....	15.2-84
Figure 15.2-8f. One MSIV Closure.....	15.2-84
Figure 15.2-8g. One MSIV Closure.....	15.2-85
Figure 15.2-9a. MSIV Closure.....	15.2-86
Figure 15.2-9b. MSIV Closure.....	15.2-86
Figure 15.2-9c. MSIV Closure.....	15.2-87
Figure 15.2-9d. MSIV Closure.....	15.2-87
Figure 15.2-9e. MSIV Closure.....	15.2-88
Figure 15.2-9f. MSIV Closure.....	15.2-88
Figure 15.2-9g. MSIV Closure.....	15.2-89
Figure 15.2-10a. Loss of Condenser Vacuum.....	15.2-90
Figure 15.2-10b. Loss of Condenser Vacuum.....	15.2-90
Figure 15.2-10c. Loss of Condenser Vacuum.....	15.2-91
Figure 15.2-10d. Loss of Condenser Vacuum.....	15.2-91
Figure 15.2-10e. Loss of Condenser Vacuum.....	15.2-92
Figure 15.2-10f. Loss of Condenser Vacuum.....	15.2-92
Figure 15.2-10g. Loss of Condenser Vacuum.....	15.2-93
Figure 15.2-11a. Inadvertent Isolation Condenser Initiation.....	15.2-94
Figure 15.2-11b. Inadvertent Isolation Condenser Initiation.....	15.2-94
Figure 15.2-11c. Inadvertent Isolation Condenser Initiation.....	15.2-95
Figure 15.2-11d. Inadvertent Isolation Condenser Initiation.....	15.2-95
Figure 15.2-11e. Inadvertent Isolation Condenser Initiation.....	15.2-96
Figure 15.2-11f. Inadvertent Isolation Condenser Initiation.....	15.2-96
Figure 15.2-11g. Inadvertent Isolation Condenser Initiation.....	15.2-97
Figure 15.2-12. Simplified Block Diagram of Fault-Tolerant Digital Controller System.....	15.2-98
Figure 15.2-13a. Runout of One Feedwater Pump.....	15.2-99
Figure 15.2-13b. Runout of One Feedwater Pump.....	15.2-99
Figure 15.2-13c. Runout of One Feedwater Pump.....	15.2-100
Figure 15.2-13d. Runout of One Feedwater Pump.....	15.2-100
Figure 15.2-13e. Runout of One Feedwater Pump.....	15.2-101
Figure 15.2-13f. Runout of One Feedwater Pump.....	15.2-101
Figure 15.2-13g. Runout of One Feedwater Pump.....	15.2-102
Figure 15.2-14a. Opening of One Turbine Control or Bypass Valve.....	15.2-103
Figure 15.2-14b. Opening of One Turbine Control or Bypass Valve.....	15.2-103
Figure 15.2-14c. Opening of One Turbine Control or Bypass Valve.....	15.2-104
Figure 15.2-14d. Opening of One Turbine Control or Bypass Valve.....	15.2-104
Figure 15.2-14e. Opening of One Turbine Control or Bypass Valve.....	15.2-105
Figure 15.2-14f. Opening of One Turbine Control or Bypass Valve.....	15.2-105
Figure 15.2-14g. Opening of One Turbine Control or Bypass Valve.....	15.2-106
Figure 15.2-15a. Loss of Non-Emergency AC Power to Station Auxiliaries.....	15.2-107
Figure 15.2-15b. Loss of Non-Emergency AC Power to Station Auxiliaries.....	15.2-107
Figure 15.2-15c. Loss of Non-Emergency AC Power to Station Auxiliaries.....	15.2-108
Figure 15.2-15d. Loss of Non-Emergency AC Power to Station Auxiliaries.....	15.2-108
Figure 15.2-15e. Loss of Non-Emergency AC Power to Station Auxiliaries.....	15.2-109

Figure 15.2-15f. Loss of Non-Emergency AC Power to Station Auxiliaries .....	15.2-109
Figure 15.2-15g. Loss of Non-Emergency AC Power to Station Auxiliaries .....	15.2-110
Figure 15.2-15h. Loss of Non-Emergency AC Power to Station Auxiliaries (Figure 15.2-15a from 50 to 70 s) .....	15.2-110
Figure 15.2-16a. Loss of All Feedwater Flow .....	15.2-111
Figure 15.2-16b. Loss of All Feedwater Flow .....	15.2-111
Figure 15.2-16c. Loss of All Feedwater Flow .....	15.2-112
Figure 15.2-16d. Loss of All Feedwater Flow .....	15.2-112
Figure 15.2-16e. Loss of All Feedwater Flow .....	15.2-113
Figure 15.2-16f. Loss of All Feedwater Flow .....	15.2-113
Figure 15.2-16g. Loss of All Feedwater Flow .....	15.2-114
Figure 15.2-16h. Loss of All Feedwater Flow (Figure 15.2-16a from 50 to 70 s) .....	15.2-114
Figure 15.3-1a. Loss of Feedwater Heating with SCRRI/SRI Failure .....	15.3-51
Figure 15.3-1b. Loss of Feedwater Heating with SCRRI/SRI Failure .....	15.3-52
Figure 15.3-1c. Loss of Feedwater Heating with SCRRI/SRI Failure .....	15.3-53
Figure 15.3-1d. Loss of Feedwater Heating with SCRRI/SRI Failure .....	15.3-54
Figure 15.3-1e. Loss of Feedwater Heating with SCRRI/SRI Failure .....	15.3-55
Figure 15.3-1f. Loss of Feedwater Heating with SCRRI/SRI Failure .....	15.3-56
Figure 15.3-1g. Loss of Feedwater Heating with SCRRI/SRI Failure .....	15.3-58
Figure 15.3-2a. Feedwater Controller Failure – Maximum Flow Demand .....	15.3-59
Figure 15.3-2b. Feedwater Controller Failure – Maximum Flow Demand .....	15.3-60
Figure 15.3-2c. Feedwater Controller Failure – Maximum Flow Demand .....	15.3-61
Figure 15.3-2d. Feedwater Controller Failure – Maximum Flow Demand .....	15.3-61
Figure 15.3-2e. Feedwater Controller Failure – Maximum Flow Demand .....	15.3-62
Figure 15.3-2f. Feedwater Controller Failure – Maximum Flow Demand .....	15.3-62
Figure 15.3-2g. Feedwater Controller Failure – Maximum Flow Demand .....	15.3-64
Figure 15.3-3a. Pressure Regulator Failure – Opening of All Turbine Control and Bypass Valves .....	15.3-65
Figure 15.3-3b. Pressure Regulator Failure – Opening of All Turbine Control and Bypass Valves .....	15.3-66
Figure 15.3-3c. Pressure Regulator Failure – Opening of All Turbine Control and Bypass Valves .....	15.3-67
Figure 15.3-3d. Pressure Regulator Failure – Opening of All Turbine Control and Bypass Valves .....	15.3-67
Figure 15.3-3e. Pressure Regulator Failure – Opening of All Turbine Control and Bypass Valves .....	15.3-68
Figure 15.3-3f. Pressure Regulator Failure – Opening of All Turbine Control and Bypass Valves .....	15.3-68
Figure 15.3-3g. Pressure Regulator Failure – Opening of All Turbine Control and Bypass Valves .....	15.3-70
Figure 15.3-4a. Pressure Regulator Failure – Closure of All Turbine Control and Bypass Valves .....	15.3-71
Figure 15.3-4b. Pressure Regulator Failure – Closure of All Turbine Control and Bypass Valves .....	15.3-72
Figure 15.3-4c. Pressure Regulator Failure – Closure of All Turbine Control and Bypass Valves .....	15.3-73

Figure 15.3-4d. Pressure Regulator Failure – Closure of All Turbine Control and Bypass Valves .....	15.3-73
Figure 15.3-4e. Pressure Regulator Failure – Closure of All Turbine Control and Bypass Valves .....	15.3-74
Figure 15.3-4f. Pressure Regulator Failure – Closure of All Turbine Control and Bypass Valves .....	15.3-74
Figure 15.3-4g. Pressure Regulator Failure – Closure of All Turbine Control and Bypass Valves .....	15.3-76
Figure 15.3-5a. Generator Load Rejection With Total Turbine Bypass Failure .....	15.3-77
Figure 15.3-5b. Generator Load Rejection With Total Turbine Bypass Failure .....	15.3-78
Figure 15.3-5c. Generator Load Rejection With Total Turbine Bypass Failure .....	15.3-79
Figure 15.3-5d. Generator Load Rejection With Total Turbine Bypass Failure .....	15.3-80
Figure 15.3-5e. Generator Load Rejection With Total Turbine Bypass Failure .....	15.3-81
Figure 15.3-5f. Generator Load Rejection With Total Turbine Bypass Failure .....	15.3-82
Figure 15.3-5g. Generator Load Rejection With Total Turbine Bypass Failure .....	15.3-84
Figure 15.3-5h. Generator Load Rejection With Total Turbine Bypass Failure (short term) .....	15.3-85
Figure 15.3-6a. Turbine Trip With Total Turbine Bypass Failure .....	15.3-86
Figure 15.3-6b. Turbine Trip With Total Turbine Bypass Failure .....	15.3-87
Figure 15.3-6c. Turbine Trip With Total Turbine Bypass Failure .....	15.3-88
Figure 15.3-6d. Turbine Trip With Total Turbine Bypass Failure .....	15.3-88
Figure 15.3-6e. Turbine Trip With Total Turbine Bypass Failure .....	15.3-89
Figure 15.3-6f. Turbine Trip With Total Turbine Bypass Failure .....	15.3-89
Figure 15.3-6g. Turbine Trip With Total Turbine Bypass Failure .....	15.3-91
Figure 15.3-7. (Deleted) .....	15.3-92
Figure 15.3-7a. Transient Changes for Control Rod Withdrawal Error During Startup With Failure of Control Rod Block .....	15.3-93
Figure 15.3-7b. Causes of Control Rod Withdrawal Error During Startup With Failure of Control Rod Block .....	15.3-93
Figure 15.3-8a. Inadvertent SRV Opening .....	15.3-94
Figure 15.3-8b. Inadvertent SRV Opening .....	15.3-95
Figure 15.3-8c. Inadvertent SRV Opening .....	15.3-96
Figure 15.3-8d. Inadvertent SRV Opening .....	15.3-96
Figure 15.3-8e. Inadvertent SRV Opening .....	15.3-97
Figure 15.3-8f. Inadvertent SRV Opening .....	15.3-97
Figure 15.3-8g. Inadvertent SRV Opening .....	15.3-98
Figure 15.3-9a. Stuck Open Safety Relief Valve .....	15.3-99
Figure 15.3-9b. Stuck Open Safety Relief Valve .....	15.3-100
Figure 15.3-9c. Stuck Open Safety Relief Valve .....	15.3-101
Figure 15.3-9d. Stuck Open Safety Relief Valve .....	15.3-101
Figure 15.3-9e. Stuck Open Safety Relief Valve .....	15.3-102
Figure 15.3-9f. Stuck Open Safety Relief Valve .....	15.3-102
Figure 15.3-9g. Stuck Open Safety Relief Valve .....	15.3-103
Figure 15.4-1. LOCA Radiological Paths .....	15.4-89
Figure 15.4-2. Airborne CsI for Removal Coefficient Determination .....	15.4-90



Figure 15.4-3. Removal Coefficient Determination for Low Pressure Bottom Line Break (Accident Scenario-1) .....	15.4-92
Figure 15.4-4. Control Room Doses for Fuel Handling Accident vs. Control Room Unfiltered Inleakage.....	15.4-93
Figure 15.5-1a. MSIV Closure with ARI.....	15.5-34
Figure 15.5-1b. MSIV Closure with ARI .....	15.5-35
Figure 15.5-1c. MSIV Closure with ARI.....	15.5-36
Figure 15.5-1d. MSIV Closure with ARI .....	15.5-37
Figure 15.5-2a. MSIV Closure with FMCRD Run-in .....	15.5-38
Figure 15.5-2b. MSIV Closure with FMCRD Run-in .....	15.5-39
Figure 15.5-2c. MSIV Closure with FMCRD Run-in .....	15.5-40
Figure 15.5-2d. MSIV Closure with FMCRD Run-in .....	15.5-41
Figure 15.5-3a. MSIV Closure - SLC System Bounding Case.....	15.5-43
Figure 15.5-3b. MSIV Closure - SLC System Bounding Reactor Vessel Pressure Case.....	15.5-45
Figure 15.5-3c. MSIV Closure - SLC System Bounding Case.....	15.5-47
Figure 15.5-3d. MSIV Closure - SLC System Bounding Case .....	15.5-48
Figure 15.5-3e. MSIV Closure - SLC System Bounding Pool Temperature Case (Deleted) .....	15.5-49
Figure 15.5-3f. MSIV Closure - SLC System Bounding Pool Temperature Case (Deleted) .....	15.5-49
Figure 15.5-3g. MSIV Closure - SLC System Bounding Pool Temperature Case (Deleted) .....	15.5-49
Figure 15.5-4a. Loss of Condenser Vacuum SLC System Bounding Case.....	15.5-51
Figure 15.5-4b. Loss of Condenser Vacuum SLC System Bounding Case.....	15.5-53
Figure 15.5-4c. Loss of Condenser Vacuum SLC System Bounding Case.....	15.5-55
Figure 15.5-4d. Loss of Condenser Vacuum SLC System Bounding Case.....	15.5-56
Figure 15.5-4e. Loss of Condenser Vacuum SLC System Bounding Pool Temperature Case (Deleted) .....	15.5-57
Figure 15.5-4f. Loss of Condenser Vacuum SLC System Bounding Pool Temperature Case (Deleted) .....	15.5-57
Figure 15.5-4g. Loss of Condenser Vacuum SLC System Bounding Pool Temperature Case (Deleted) .....	15.5-57
Figure 15.5-4h. Loss of Condenser Vacuum SLC System Bounding Pool Temperature Case (Deleted) .....	15.5-57
Figure 15.5-5a. Loss of Feedwater Heating with Boron Injection .....	15.5-58
Figure 15.5-5b. Loss of Feedwater Heating with Boron Injection .....	15.5-59
Figure 15.5-5c. Loss of Feedwater Heating with Boron Injection .....	15.5-60
Figure 15.5-5d. Loss of Feedwater Heating with Boron Injection .....	15.5-61
Figure 15.5-6a. Loss of Normal AC Power to Station Auxiliaries with Boron Injection .....	15.5-62
Figure 15.5-6b. Loss of Normal AC Power to Station Auxiliaries with Boron Injection .....	15.5-63
Figure 15.5-6c. Loss of Normal AC Power to Station Auxiliaries with Boron Injection .....	15.5-64

Figure 15.5-6d. Loss of Normal AC Power to Station Auxiliaries with Boron Injection .....	15.5-65
Figure 15.5-7a. Loss of Feedwater Flow with Boron Injection.....	15.5-67
Figure 15.5-7b. Loss of Feedwater Flow with Boron Injection.....	15.5-69
Figure 15.5-7c. Loss of Feedwater Flow with Boron Injection.....	15.5-71
Figure 15.5-7d. Loss of Feedwater Flow with Boron Injection.....	15.5-72
Figure 15.5-8a. Load Rejection with a Single Failure in the Turbine Bypass System with Boron Injection.....	15.5-73
Figure 15.5-8b. Load Rejection with a Single Failure in the Turbine Bypass System with Boron Injection.....	15.5-74
Figure 15.5-8c. Load Rejection with a Single Failure in the Turbine Bypass System with Boron Injection.....	15.5-75
Figure 15.5-8d. Load Rejection with a Single Failure in the Turbine Bypass System with Boron Injection.....	15.5-76
Figure 15.5-9. Core Stability During Turbine Trip with Full Bypass ATWS Event.....	15.5-77
Figure 15.5-10a. Pressure Vessel Response for SBO.....	15.5-78
Figure 15.5-10b. Vessel inventory Makeup Flow Response for SBO.....	15.5-78
Figure 15.5-10c. Water Level Response for SBO .....	15.5-79
Figure 15.5-10d. Pressure Response for SBO .....	15.5-79
Figure 15.5-10e. Core Void Fraction And Fuel Temperature Response For SBO.....	15.5-80
Figure 15.5-11a. MSIV Closure With Flux Scram.....	15.5-81
Figure 15.5-11b. MSIV Closure With Flux Scram.....	15.5-81
Figure 15.5-11c. MSIV Closure With Flux Scram.....	15.5-82
Figure 15.5-11d. MSIV Closure With Flux Scram.....	15.5-82
Figure 15.5-11e. MSIV Closure With Flux Scram.....	15.5-83
Figure 15.5-11f. MSIV Closure With Flux Scram .....	15.5-83
Figure 15A-1. DPV Initiation Logic.....	15A-38
Figure 15A-2a. Fault Tree – Inadvertent Opening of a Depressurization Valve (page 1 of 8).....	15A-39
Figure 15A-2b. Fault Tree – Inadvertent Opening of a Depressurization Valve (page 2 of 8).....	15A-40
Figure 15A-2c. Fault Tree – Inadvertent Opening of a Depressurization Valve (page 3 of 8).....	15A-41
Figure 15A-2d. Fault Tree – Inadvertent Opening of a Depressurization Valve (page 4 of 8).....	15A-42
Figure 15A-2e. Fault Tree – Inadvertent Opening of a Depressurization Valve (page 5 of 8).....	15A-43
Figure 15A-2f. Fault Tree – Inadvertent Opening of a Depressurization Valve (page 6 of 8).....	15A-44
Figure 15A-2g. Fault Tree – Inadvertent Opening of a Depressurization Valve (page 7 of 8).....	15A-45
Figure 15A-2h. Fault Tree – Inadvertent Opening of a Depressurization Valve (page 8 of 8).....	15A-46
Figure 15A-3a. Fault Tree – Inadvertent Shutdown Cooling Function Operation (page 1 of 3).....	15A-47

Figure 15A-3b. Fault Tree – Inadvertent Shutdown Cooling Function Operation (page 2 of 3).....	15A-48
Figure 15A-3c. Fault Tree – Inadvertent Shutdown Cooling Function Operation (page 3 of 3).....	15A-49
Figure 15A-4a. Fault Tree - Inadequate Reactivity Insertion Given a Loss of FW Heating (page 1 of 2).....	15A-50
Figure 15A-4b. Fault Tree for Inadequate Reactivity Insertion Given a Loss of FW Heating (page 2 of 2).....	15A-51
Figure 15B-1. Iodine Airborne Inventory in Primary Containment as a Function of Time (Deleted).....	15B-3
Figure 15C-1. Pool pH Calculation Results for a Low Pressure Bottom Line Break (Accident Scenario 1).....	15C-8
Figure 15C-2. Pool pH Calculation Results for a High Pressure Bottom Line Break (Accident Scenario 2).....	15C-9
Figure 15C-3. Pool pH Calculation Results for a Loss of Feedwater/Loss of A/C Power (Accident Scenario 3) .....	15C-10

Figure 18.1-1. HFE Implementation Process..... 18.1-9

Figure 19.3-1. BiMAC Pipes and Protective Ceramic Layer ..... 19.3-16

Figure 19B-1 Finite Element Model Showing Steady State Thermal Condition.....19B-27

Figure 19B-2 Concrete Compressive Stress, Level C Analysis, 0.992 MPaG  
(144 psig) Pressure.....19B-28

Figure 19B-3 Concrete Cracking Strain, Level C Analysis, 0.992 MPaG  
(144 psig) Pressure.....19B-29

Figure 19B-4 Liner Maximum Principal Strain, Level C Analysis, 0.992  
MPaG (144 psig) Pressure .....19B-30

Figure 19B-5 Maximum Principal Strains in Liner Near Discontinuities,  
Level C Analysis.....19B-31

Figure 19B-6 Liner Membrane Strain at Representative Locations, Level C  
Analysis.....19B-32

Figure 19B-7 (DELETED)  
State OF Liner at Top Slab Connection at 100% MWR Pressure .....19B-33

Figure 19B-8 (DELETED)  
Liner Membrane Strain at Top Slab Connection, Level C  
Analysis with Thermal Stress .....19B-34

Figure 19B-7 Finite Element Model for Drywell Head Capacity Study.....19B-35

Figure 19B-8 Displacement at Crown in Buckling Test Analysis .....19B-36

Figure 19B-9 Post Buckled Shape of Test Analysis Model.....19B-37

Figure 19B-10 Finite Element Model For Buckling Analysis of ESBWR  
Drywell Head.....19B-38

Figure 19B-11 Performance of ESBWR Drywell Head Under Internal Pressure  
at 260°C (500°F).....19B-39

Figure 19B-12 Plastic Strains, Nominal Geometry, 260°C (500°F).....10B-40

Figure 19B-13 Mid-Thickness Plastic Strain at Crown Under Increasing  
Pressure at 260°C (500°F) .....19B-41

Figure 19C-1 Calculation of Variance due to Modeling Uncertainty .....19C-31

Figure 19C-2 Finite Element Model Showing the 260°C (500°F) Steady State  
Thermal Condition.....19C-32

Figure 19C-3 Structural Response of RCCV at 1.24 MPaG (180 psig)  
Pressure.....19C-33

Figure 19C-4 Critical Location for Liner Tearing in RCCV.....19C-34

Figure 19C-5 Pressure Fragility for RCCV Wall Capacity with Temperature .....19C-35

Figure 19C-6 Pressure Fragility for RCCV Liner Tearing with Temperature .....19C-35

Figure 19C-7 Local Finite Element Model for Drywell Head.....19C-36

Figure 19C-8 Thermal Contours and Deformation for 260°C (500°F) Thermal  
Condition.....19C-37

Figure 19C-9 Equivalent Plastic Strains in Steel Components at 2.17 MPaG  
(315 psig) .....19C-38

Figure 19C-10 Bolt Stresses in Drywell Head for 260°C (500°F) Thermal  
Condition.....19C-39

Figure 19C-11 Pressure Fragility with Temperature for Leakage at Drywell  
Head.....19C-40

Figure 19C-12 Local Model of Drywell Equipment Hatch .....19C-41

Figure 19C-13 Plastic Strains in EQ Hatch Steel Components, 260°C (500°F)  
Conditions ..... 19C-42

Figure 19C-14 Plastic Strains in Liner for Local Effects Slice Model ..... 19C-43

Figure 19C-15 Pressure Fragility with Temperature for Leakage at Equipment  
Hatch ..... 19C-44

Figure 19C-16 Pressure Fragility at 260°C (500°F) Steady State Thermal  
Conditions ..... 19C-44

**List of Acronyms**

10 CFR	Title 10, Code of Federal Regulations
A/D	Analog-to-Digital
ABA	Amplitude Based Algorithm
ABS	Auxiliary Boiler System
ABWR	Advanced Boiling Water Reactor
AC	Alternating Current
ACLCO	Availability Control Limiting Condition for Operation
ACM	Availability Controls Manual
ACSR	Availability Control Surveillance Requirement
ADB	Ancillary Diesel Building
ADG	Ancillary Diesel Generator
ADS	Automatic Depressurization System
AEO	Auxiliary Equipment Operators
AFC	Automatic Frequency Control
AFIP	Automated Fixed In-Core Probe
AFU	Air Filtration Unit
AHS	Auxiliary Heat Sink
AHU	Air Handling Unit
ALARA	As Low As Reasonably Achievable
ALI	Annual Limits on Intake
ALWR	Advanced Light Water Reactor
AMS	Alarm Management System
AO	Air Operated
AOF	Allocation of Functions
AOO	Anticipated Operational Occurrence
AOP	Abnormal Operating Procedures
APD	Annulus Pressurization Loads (Anchor Displacement Loads)
APF	Automated Program Functions
APR	Automatic Power Regulator
APRM	Average Power Range Monitor
ARI	Alternate Rod Insertion

ARM	Area Radiation Monitoring
ARMS	Area Radiation Monitoring System
ARP	Annunciator Response Procedures
ARS	Amplified Response Spectra
ASD	Adjustable Speed Drive
ASDC	Alternate Shutdown Cooling
ASI	Adverse Systems Interactions
AST	Alternate Source Term
ATLM	Automated Thermal Limit Monitor
ATM	Analog Trip Modules
ATWS	Anticipated Transient Without Scram
B&PV	Boiler and Pressure Vessel
BAF	Bottom of Active Fuel
BDL	Bottom Drain Line
BiMAC	Basemat Internal Melt Arrest Coolability
BISI	Bypass and Inoperable Status Indication
BOC	Beginning of Cycle
BOP	Balance of Plant
BOPCWS	Balance of Plant Chilled Water Subsystem
BPU	Bypass Unit
BPVC	Boiler and Pressure Vessel Code
BRR	Baseline Record Review
BSP	Backup Stability Protection
BTP	Branch Technical Position
BWR	Boiling Water Reactor
BWROG	Boiling Water Reactor Owners Group
BWRVIP	Boiling Water Reactor Vessel Internals Program
C&FS	Condensate and Feedwater System
CAS	Central Alarm Station
CB	Control Building
CBGAVS	Control Building General Area HVAC Subsystem
CBVS	Control Building HVAC System



CCF	Common Cause Failure
CCFP	Conditional Containment Failure Probability
CCI	Core-Concrete Interaction
CCTV	Closed Circuit Television
CDF	Core Damage Frequency
CFR	Code of Federal Regulations
CIM	Communication Interface Module
CIRC	Circulating Water System
CIS	Containment Inerting System
CIV	Containment Isolation Valve
CLAVS	Clean Area HVAC Subsystem
CMF	Common Mode Failure
CMS	Containment Monitoring System
CO	Condensation Oscillation
COL	Combined License
COLA	Combined License Application
COLR	Core Operating Limits Report
CONAVS	Contaminated Area HVAC Subsystem
CPR	Critical Power Ratio
CPS	Condensate Purification System
CPU	Central Processing Unit
CQC	Complete Quadratic Combination
CRC	Cyclic Redundancy Checking
CRD	Control Rod Drive
CRDA	Control Rod Drop Accident
CRDH	Control Rod Drive Housing
CRDM	Control Rod Drive Mechanism
CRGT	Control Rod Guide Tube
CRHA	Control Room Habitability Area
CRHAVS	Control Room Habitability Area HVAC Subsystem
CRHS	Control Room Habitability System
CRT	Cathode Ray Tube

CS&TS	Condensate Storage and Transfer System
CSAU	Code Scaling, Applicability, and Uncertainty
CSDRS	Certified Seismic Design Response Spectra
CST	Condensate Storage Tank
CVCS	Chemical and Volume Control System
CWS	Chilled Water System
D/A	Digital-to-Analog
D/F	Diaphragm Floor
D/SP	Dryer /Separator Pool
D3	Defense-in-Depth and Diversity
DAC	Derived Air Concentrations
DAW	Dry Active Waste
DBA	Design Basis Accident
DBE	Design Basis Event
DBT	Design Basis Threat
DC	Direct Current
DCD	Design Control Document
DCFF	Design Characteristic, Feature or Function
DCH	Direct Containment Heating
DCIS	Distributed Control and Information System
DCPSS	Direct Current Power Supply System
DCS	Drywell Cooling System
DEG	Double-Ended Guillotine
DF	Decontamination Factor
DG	Diesel-Generator
DGVS	Diesel Generators HVAC Subsystem
DLF	Dynamic Load Factor
DM	Dissimilar Metal
DOF	Degree of Freedom
DPS	Diverse Protection System
DPV	Depressurization Valve
DQR	Dynamic Qualification Report

D-RAP	Design Reliability Assurance Program
DRC	Doppler Reactivity Coefficient
DRS	Design Report Summary
DSS	Detect and Suppress Solution
DSS-CD	Detect and Suppress Solution - Confirmation Density
DTM	Digital Trip Module
DW	Drywell
EAB	Exclusion Area Boundary
EAL	Emergency Action Level
EB	Electrical Building
EBVS	Electrical Building HVAC System
ECCS	Emergency Core Cooling System
ECP	Engineering Computer Program
EER	Electric and Electronic Rooms
EERVS	Electric and Electronic Rooms HVAC Subsystem
EFDS	Equipment and Floor Drain System
EFU	Emergency Filter Unit
EHC	Electrohydraulic Control (Pressure Regulator)
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ENS	Emergency Notification System
EOC	End of Cycle
EOF	Emergency Operations Facility
EOL	End of Life
EOP	Emergency Operating Procedures
EPDS	Electric Power Distribution System
EPG	Emergency Procedure Guidelines
EQ	Environmental Qualification
EQD	Environmental Qualification Document
EQEDC	Equipment Qualification Environmental Design Criteria
EQT	Torsional Seismic Loads
EQZ	Vertical Seismic Loads

ERDS	Emergency Response Data System
ERFBS	Electrical Raceway Fire Barrier Systems
ERI	Emergency Rod Insertion
ERICP	Emergency Rod Insertion Control Panel
ERIP	Emergency Rod Insertion Panel
ESF	Engineered Safety Feature
ESFAS	Engineered Safety Features Actuation System
ESP	Early Site Permit
ESW	Emergency (or Essential) Service Water
ETD	Emergency Trip Device
ETS	Emergency Trip System
ETSB	Effluent Treatment Systems Branch
EVE	Ex-Vessel Steam Explosion
EX	Explosively Actuated
FAC	Flow-Accelerated Corrosion
FAPCS	Fuel and Auxiliary Pools Cooling System
FATT	Fracture Appearance Transition Temperature
FB	Fuel Building
FPAVS	Fuel Pool Area HVAC Subsystem
FBGAVS	Fuel Building General Area HVAC Subsystem
FBVS	Fuel Building HVAC System
FC	Fail Closed
FCISL	Fuel Cladding Integrity Safety Limit
FCM	File Control Module
FCS	Flammability Control System
FCU	Fan Cooling Unit
FD	Failure to Detect an IC Failure
FDA	Final Design Approval
FEA	Finite Element Analysis
FFT	Fast Fourier Transform
FFWTR	Final Feedwater Temperature Reduction
FHA	Fire Hazards Analysis

FHM	Fuel Handling Machine
FIV	Flow Induced Vibration
FM	Factory Mutual
FMCRD	Fine Motion Control Rod Drive
FME	Foreign Materials Exclusion
FMEA	Failure Modes and Effects Analysis
FOAK	First Of A Kind
FPE	Fire Pump Enclosure
FPM	Fuel Preparation Machine
FPS	Fire Protection System
FRA	Functional Requirements Analysis
FRS	Floor Response Spectra
FSAR	Final Safety Analysis Report
FSGT	Fuel Support and Guide Tube
FSP	Fuel Storage Pool
FTDC	Fault-Tolerant Digital Controller
FTS	Fuel Transfer System
FUHA	Fuel Handling Accident
FW	Feedwater
FWCS	Feedwater Control System
FWL	Feedwater Line
FWLB	Feedwater Line Break
FWS	Firewater Storage Tank
FWSC	Firewater Service Complex
G/F	Ground Floor
GALL	Generic Aging Lessons Learned
GCS	Generator Cooling System
GDC	General Design Criteria (or Criterion)
GDCS	Gravity-Driven Cooling System
GE	General Electric Company
GEEN	General Electric Energy Nuclear
GEH	General Electric Hitachi Nuclear Energy

GEN	Generator System
GENE	General Electric Nuclear Energy
GES	Generator Excitation System
GF	Geometry Factor
GLSOS	Generator Lube and Seal Oil System
GM	Geiger-Mueller Counter
GMAW	Gas Metal Arc Welding
GNF	Global Nuclear Fuel
GPP	General Plant Procedures
GRA	Growth Rate Algorithm
GSi	Generic Safety Issue
GTAW	Gas Tungsten Arc Welding
GTG	General Training Guidelines
GWSR	Ganged Withdrawal Sequence Restriction
HA	Human Actions
HAZ	Heat-Affected Zone
HCLPF	High Confidence Low Probability of Failure
HCTL	Heat Capacity Temperature Limit
HCU	Hydraulic Control Unit
HCW	High Conductivity Waste
HDVS	Heater Drain and Vent System
HED	Human Engineering Discrepancy
HELB	High Energy Line Break
HELSA	High Energy Line Separation Analysis
HEP	Human Error Probability
HEPA	High Efficiency Particulate Air
HF V&V	Human Factors Verification and Validation
HFE	Human Factors Engineering
HFEITS	Human Factors Engineering Issues Tracking System
HGCS	Hydrogen Gas Control System
HIC	High Integrity Container
HID	High Intensity Discharge

HMR	Hydrometeorology Report
HP CRD	High Pressure Control Rod Drive
HP/LP	High Pressure/Low Pressure
HPCF	High Pressure Core Flooder
HPCI	High Pressure Coolant Injection
HPM	Human Performance Monitoring
HPME	High Pressure Core Melt Ejection
HPNSS	High Pressure Nitrogen Supply System
HRA	Human Reliability Assessment
HRO	High Regulatory Oversight
HSI	Human-System Interface
HSS	High Safety Significant
HV	High Voltage
HVAC	Heating, Ventilation and Air Conditioning
HVL	Horizontal Vent Chugging
HWC	Hydrogen Water Chemistry
HWCS	Hydrogen Water Chemistry System
HWL	High Water Level
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
IBL	Intermediate Break LOCA
IC/PCCS	Isolation Condenser/Passive Containment Cooling System
ICD	Interface Control Diagram
ICGT	In-Core Guide Tubes
ICM	In-Core Monitor
ICMGT	In-Core Monitor Guide Tubes
ICMH	In-Core Monitor Housing
ICPR	Initial Critical Power Ratio

ICS	Isolation Condenser System
IFC	International Fire Code
IFTS	Inclined Fuel Transfer System
IGA	Intergranular Attack
IGSCC	Intergranular Stress Corrosion Cracking
ILRT	Integrated Leak Rate Test
IMCC	Induction Motor Controller Cabinet
INOP	Inoperative
IOP	Integrated Operating Procedure
IORV	Inadvertent Opening of a Relief Valve
IOT	Infrequent Operational Transient
IPEEE	Individual Plant Examination of External Events
IR	Intermediate Resonance
IRV	Inside Reactor Vessel
ISI	Inservice Inspection
ISLOCA	Intersystem Loss-of-Coolant-Accident
ISLT	Inservice Leak Test
ISM	Independent Support Motion
IST	Inservice Testing
ITA	Inspections, Tests or Analyses
ITAAC	Inspections, Tests, Analyses and Acceptance Criteria
ITP	Initial Test Program
ITS	Issue Tracking System
JI	Jet Impingement
LBB	Leak Before Break
LBL	Large Break LOCA
LCD	Load Capacity Datasheet
LCO	Limiting Condition for Operation
LCS	Leakage Control System
LCW	Low Conductivity Waste
LD&IS	Leak Detection and Isolation System
LDA	Lay Down Area



LDV	Load Driver and Voter
LDW	Lower Drywell
LFCV	Low Flow Control Valve
LHGR	Linear Heat Generation Rate
LIE	Liquid Impingement Erosion
LLD	Lower Limit of Detection
LLRT	Local Leak Rate Test
LMFBR	Liquid Metal Fast Breeder Reactor
LO	Lube Oil
LOCA	Loss-of-Coolant-Accident
LOFW	Loss of Feedwater
LOFWH	Loss of Feedwater Heating
LOOP	Loss of Offsite Power
LOPP	Loss of Preferred Power
LPCI	Low Pressure Coolant Injection
LPCRD	Locking Piston Control Rod Drive
LPCS	Low Pressure Core Spray
LPFL	Low Pressure Flooder
LPMS	Loose Parts Monitoring System
LPRM	Local Power Range Monitor
LPSP	Low Power Setpoint
LPZ	Low Population Zone
LRF	Large Release Frequency
LRO	Low Regulatory Oversight
LSB	Last Stage Blade
LSPS	Lighting and Service Power System
LTR	Licensing Topical Report
LVDT	Linear Variable Differential Transformer
LWMS	Liquid Waste Management System
LWR	Light Water Reactor
MAC	Media Access Control
MBB	Motor Built-In Brake

MCC	Motor Control Center
MCES	Main Condenser Evacuation System
MCPR	Minimum Critical Power Ratio
MCR	Main Control Room
MCRBP	Main Control Room Back Panel
MCRP	Main Control Room Panel
MDRFP	Motor Driven Reactor Feed Pump
MELB	Moderate Energy Line Break
MERV	Minimum Efficiency Reporting Value
MFAP	Main Fire Alarm Panel
MLHGR	Maximum Linear Heat Generation Rate
MMI	Man-Machine Interface
MMIS	Man-Machine Interface Systems
MOC	Middle of Cycle
MOD	Motor Operated Disconnect
MODCOF	Moderator Temperature Coefficient
MOP	Mechanical Overpower
MPL	Master Parts List
MRBM	Multi-Channel Rod Block Monitor
MS	Main Steam
MSF	Mode Shape Factor
MSIV	Main Steam Isolation Valve
MSL	Main Steamline
MSLB	Main Steamline Break
MSLBA	Main Steamline Break Accident
MSR	Moisture Separator Reheater
MST	Main Steam Tunnel
MSV	Mean Square Voltage
MTBF	Mean Time Between Failure
MTBS	Main Turbine Bypass System
MTS	Maintenance Transfer Switch
MTTF	Mean Time to Failure

MTTR	Mean Time To Repair
MUX	Mutliplexer
MVD	Medium Voltage Distribution System
MVP	Mechanical Vacuum Pump
MWR	Metal Water Reaction
MWS	Makeup Water System
NBR	Nuclear Boiler Rated
NBS	Nuclear Boiler System
N-DCIS	Nonsafety-Related Distributed Control and Information System
NDE	Nondestructive Examination
ND-OSUTL	Normal Distribution One-Sided Upper Tolerance Limit
NDT	Nil Ductility Temperature
NDTT	Nil-Ductility Transition Temperature
NFI	New Fuel Inspection
NFS	New Fuel Storage
NG	Noble Gas
NI	Nuclear Island
NICWS	Nuclear Island Chilled Water Subsystem
NLF	Non-LOCA Fault
NMS	Neutron Monitoring System
NPHS	Normal Power Heat Sink
NPRD	Nonelectronic Parts Reliability Data
NPSH	Net Positive Suction Head
NQA	Nuclear Quality Assurance
NRC	Nuclear Regulatory Commission
NRHX	Non-Regenerative Heat Exchanger
NSOA	Nuclear Safety Operational Analysis
NSSS	Nuclear Steam Supply System
NTSP	Nominal Trip Setpoint
NUMAC	Nuclear Measurement Analysis and Control
NWL	Normal Water Level
O&M	Operation and Maintenance

OBCV	Overboard Control Valve
OBE	Operating Basis Earthquake
ODCM	Offsite Dose Calculation Manual
OER	Operating Experience Review
OGS	Offgas System
OHLH	Overhead Heavy Load Handling
OIS	Oxygen Injection System
OL	Other Location
OLMCPR	Operating Limit Minimum Critical Power Ratio
OLMLHGR	Operating Limit Maximum Linear Heat Generation Rate
OLP	On-Line Procedures
OLU	Output Logic Unit
OM	Operations and Maintenance
OOS	Out-Of-Service
OPDRV	Operation with Potential to Drain the Reactor Vessel
OPRM	Oscillation Power Range Monitor
OSC	Operational Support Center
OSI	Open Systems Interconnect
OSUTL	One-Sided Upper Tolerance Limit
OV	Open Vessel
P&ID	Piping and Instrumentation Diagram
PA	Protected Area
PA/PL	Plant Page/Party-Line
PABX	Private Automatic Branch (Telephone) Exchange
PAM	Post Accident Monitoring
PAR	Passive Autocatalytic Recombiner
PARS	Passive Autocatalytic Recombiner System
PAS	Plant Automation System
PASS	Post-Accident Sampling Stations
PB	Pressure Boundary
PBA	Period Based Algorithm
PBDA	Period Based Detection Algorithm

PBX	Private Branch Exchange
PCCS	Passive Containment Cooling System
PCD	Plant Configuration Database
PCF	Plant Computer Functions
PCI	Pellet Clad Interaction
PCP	Process Control Program
PCS	Power Conversion System
PCT	Peak Cladding Temperature
PCTMS	Plant Cooling Tower Makeup System
PCV	Primary Containment Vessel
PDA	Piping Design Analysis
PFD	Process Flow Diagram
PG	Power Generation
PGA	Peak Ground Acceleration
PGCS	Power Generation and Control Subsystem
PHE	Peak Hot Excess
PIP	Plant Investment Protection
PIRT	Phenomena Identification and Ranking Table
PLC	Programmable Logic Controllers
PMC	Performance Monitoring and Control
PMCS	Performance Monitoring and Control Subsystem
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PMS	Pool Monitoring Subsystems
PMWP	Probable Maximum Winter Precipitation
p-p	Peak-to-Peak
PPQS	Product Performance Qualification Specification
PPS	Preferred Power Supply
PRA	Probabilistic Risk Assessment
PRM	Process Radiation Monitor
PRMS	Process Radiation Monitoring System
PRNM	Power Range Neutron Monitoring

PROM	Programmable Read-Only Memory
PS	Pool Swell
PSD	Power Spectra Density
PSI	Preservice Inspection
PSS	Process Sampling System
PSV	Pseudovelocitv Response Spectrum
PSWS	Plant Service Water System
PTLR	Pressure and Temperature Limit Report
PTS	Pressurized Thermal Shock
PWR	Pressurized Water Reactor
PWSS	Pretreated Water Supply System
PWSW	Potable Water and Sanitary Waste System
QA	Quality Assurance
QAPD	Quality Assurance Program Description
QC	Quality Control
Q-DCIS	Safety-Related Distributed Control and Information System
R/W	Reactor Well
RACS	Rod Action Control Subsystem
RAM	Reliability, Availability and Maintainability
RAP	Reliability Assurance Program
RAPI	Rod Action and Position Information
RAT	Reserve Auxiliary Transformer
RAW	Risk Achievement Worth
RB	Reactor Building
RBC	Rod Brake Controller
RBCC	Rod Brake Controller Cabinet
RBS	Rod Block Setpoint
RBV	Reactor Building Vibration
RBVS	Reactor Building HVAC System
RC&IS	Rod Control and Information System
RCCV	Reinforced Concrete Containment Vessel
RCCWS	Reactor Component Cooling Water System

RCIC	Reactor Core Isolation Cooling
RCPB	Reactor Coolant Pressure Boundary
RCS	Reactor Coolant System
RDA	Rod Drop Accident
RDC	Resolver-to-Digital Converter
REPAVS	Refueling and Pool Area HVAC Subsystem
RETS	Radiological Effluent Technical Specifications
RFI	Radio Frequency Interference
RFP	Reactor Feed Pump
RH	Relative Humidity
RHR	Residual Heat Removal
RHX	Regenerative Heat Exchanger
RIP	Reactor Internal Pump
RIPD	Reactor Internal Pressure Differences
RLP	Reference Loading Pattern
RMS	Root Mean Square
RMU	Remote Multiplexer Unit
ROAAM	Risk-Oriented Accident Analysis Methodology
ROM	Read-Only Memory
RPS	Reactor Protection System
RPSM	Reactor Protection System Monitoring
RPT	Recirculation Pump Trip
RPV	Reactor Pressure Vessel
RPVSB	RPV Support Bracket
RRPS	Reference Rod Pull Sequence
RRS	Required Response Spectra
RSM	Rod Server Module
RSPC	Rod Server Processing Channel
RSR	Results Summary Report
RSS	Remote Shutdown System
RSSM	Reed Switch Sensor Module
RSW	Reactor Shield Wall

RT	Radiographic Examination
RTIF	Reactor Trip and Isolation Function(s)
RTNSS	Regulatory Treatment of Non-Safety Systems
RTS	Reactor Trip System
RVC	Reactor Vessel Cavity
RW	Radwaste Building
RWCR	Radwaste Building Control Room
RWCRVS	Radwaste Building Control Room HVAC Subsystem
RWCU	Reactor Water Cleanup
RWE	Rod Withdrawal Error
RWGA	Radwaste Building General Area
RWGAVS	Radwaste Building General Area HVAC Subsystem
RWM	Rod Worth Minimizer
RWP	Radwaste Processing System
RWVS	Radwaste Building HVAC System
S&A	Sampling and Analysis
S&Q	Staffing and Qualifications
S/DRSRO	Single/Dual Rod Sequence Restriction Override
SACF	Single Active Component Failure
SAG	Severe Accident Guideline
SAR	Safety Analysis Report
SAS	Service Air System
SAW	Submerged Arc Welding
SB	Service Building
SB&PC	Steam Bypass and Pressure Control
SBL	Small Break LOCA
SBO	Station Blackout
SBWR	Simplified Boiling Water Reactor
SCBA	Self-Contained Breathing Apparatus
SCC	Stress Corrosion Cracking
SCEW	System Component Evaluation Work
SCF	Stress Concentration Factor



SCG	Startup Coordinating Group
SCMP	Software Configuration Management Plan
SCRRI	Selected Control Rod Run-in
SCU	Signal Conditioning Units
SCWS	Stator Cooling Water System
SD	Scintillation Detector
SDC	Shutdown Cooling
SDG	Standby Diesel Generator
SDM	Shutdown Margin
SDP	Software Development Plan
SDPM	Software Development Plan Module
SDS	System Design Specification
SER	Safety Evaluation Report
SF/WT	Service Water/Water Treatment Building
SFGA	System Functional Gap Analysis
SFmin	Minimum Safety Factor
SFP	Spent Fuel Pool
SI	Système International d'Unités (International System of Units)
SIL	Service Information Letter
SIP	Separation Indicator Probe
SIT	Structural Integrity Test
SIU	Signal Interface Unit
SJAE	Steam Jet Air Ejector
SLC	Standby Liquid Control
SLMCPR	Safety Limit Minimum Critical Power Ratio
SMAW	Shielded Metal Arc Welding
SMP	Software Management Plan
SMPM	Software Management Plan Module
SOP	System Operating Procedures
SORV	Stuck Open Relief Valve
SOT	System Operational Transient
SP	Setpoint

SPC	Suppression Pool Cooling
SPDS	Safety Parameter Display System
SPTM	Suppression Pool Temperature Monitoring
SQAP	Software Quality Assurance Plan
SQAR	Supplier Quality Assurance Requirements
SR	Surveillance Requirement
SRI	Select Rod Insert
SRM	Source Range Monitor
SRNM	Startup Range Neutron Monitor
SRO	Senior Reactor Operator
SRP	Standard Review Plan
SRSS	Square Root of the Sum of the Squares
SRV	Safety Relief Valve
SSAR	Standard Safety Analysis Report
SSC	Structure, System, or Component
SSE	Safe Shutdown Earthquake
SSI	Soil-Structure Interaction
SSLC	Safety System Logic and Control
SSLC/ESF	Safety System Logic and Control Engineered Safety Feature
SSP	Software Safety Plan
SSPV	Scram Solenoid Pilot Valve
ST	Steam Tunnel
STI	Startup Test Instructions
STPT	Simulated Thermal Power Trip
STRAP	Scram Time Recording and Analysis Panel
STS	Standard Technical Specifications
SV	Safety Valve
SVVP	Software Verification and Validation Plan
SWC	Surge Withstand Capability
SWMS	Solid Waste Management System
SWS	Station Water System
TA	Task Analysis

TAF	Top of Active Fuel
TAPD	Test and Analysis Program Description
TASS	Turbine Auxiliary Steam System
TB	Turbine Building
TBAS	Turbine Building Air Supply
TBCE	Turbine Building Compartment Exhaust
TBD	To Be Determined
TBDRE	Turbine Building Decontamination Room Exhaust
TBE	Turbine Building Exhaust
TBLOE	Turbine Building Lube Oil Area Exhaust
TBS	Turbine Bypass System
TBV	Turbine Bypass Valve
TBVS	Turbine Building HVAC System
TCCWS	Turbine Component Cooling Water System
TCV	Turbine Control Valve
TE	Thermal Expansion
TEDE	Total Effective Dose Equivalent
TG	Turbine Generator
TGCS	Turbine Generator Control System
TGSS	Turbine Gland Seal System
THA	Time-History Accelerograph
TID	Time-Integrated Dose
TIP	Traversing In-Core Probe
TLOS	Turbine Lube Oil System
TLU	Trip Logic Unit
TMI	Three Mile Island
TMSS	Turbine Main Steam System
TOC	Total Organic Carbon
TOP	Thermal Overpower
TPM&D	Thermal Performance Monitor and Diagnostic
TRA	Transient Recording and Analysis
TRS	Test Response Spectra

TS	Technical Specification(s)
TSC	Technical Support Center
TSCVS	Technical Support Center HVAC Subsystem
TSI	Turbine Supervisory Instrument
TSM	Technical Specification Monitoring
TSV	Turbine Stop Valve
UAT	Unit Auxiliary Transformer
UDW	Upper Drywell
UHS	Ultimate Heat Sink
UPS	Uninterruptible Power Supply
URD	Utilities Requirements Document
URS	Ultimate Rupture Strength
USE	Upper Shelf Energy
USI	Unresolved Safety Issue
USM	Uniform Support Motion
UT	Ultrasonic
V&V	Verification and Validation
Vac / VAC	Volts Alternating Current
VB	Vacuum Breaker
VBS	Vehicle Barrier System
Vdc / VDC	Volts Direct Current
VDU	Video Display Unit
VLU	Voter Logic Unit
VRLA	Valve Regulated Lead Acid
VW	Vent Wall
WDP	Wide Display Panel
WS	Water Storage
WW	Wetwell
XLPE-FR	Cross-Linked Polyethylene, Flame Retardant
ZNIS	Zinc Injection System
ZPA	Zero Period Acceleration

### List of Abbreviations

AASHTO	American Association of Highway and Transportation Officials
ABMA	Anti-Friction Bearing Manufacturers Association
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
AEC	Atomic Energy Commission
AGMA	American Gear Manufacturer's Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANI	American Nuclear Insurers
ANS	American Nuclear Society
ANSI	American National Standards Institute
API	American Petroleum Institute
ASA	Acoustical Society of America
ASA	American Standards Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASQ	American Society for Quality
ASTM	American Society for Testing and Materials (ASTM International)
AWS	American Welding Society
AWWA	American Water Works Association
BNL	Brookhaven National Laboratory
CEA	Consumer Electronics Association
CMAA	Crane Manufacturers Association of America
CTI	Cooling Technology Institute
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
ECA	Electronic Components Assemblies Materials Association
EIA	Electronic Industries Alliance

EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
FAA	Federal Aviation Administration
FCI	Fluid Controls Institute Inc.
HEI	Heat Exchange Institute
ICC	International Code Council
IEC	International Electrotechnical Commission
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
INPO	Institute of Nuclear Power Operations
MIT	Massachusetts Institute of Technology
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
NFPA	National Fire Protection Association
NIRMA	Nuclear Information and Records Management Association, Inc.
NIST	National Institute of Standard Technology
NOAA	National Oceanic and Atmospheric Administration
NSSFC	National Severe Storms Forecast Center
NUMARC	Nuclear Utilities Management and Resources Council
NWS	National Weather Service
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
RG	Regulatory Guide
SECY	Secretary of the Commission, Office of the (NRC)
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SSPC	The Society for Protective Coverings
TEMA	Tubular Exchanger Manufacturers' Association
TIA	Telecommunications Industry Association
UL	Underwriter's Laboratories, Inc.