

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
CHAPTER 3	DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS	3.1-1
3.1	Conformance With Nuclear Regulatory Commission General Design Criteria	3.1-1
3.1.1	Overall Requirements	3.1-1
3.1.2	Protection by Multiple Fission Product Barriers	3.1-5
3.1.3	Protection and Reactivity Control Systems	3.1-12
3.1.4	Fluid Systems	3.1-18
3.1.5	Reactor Containment	3.1-30
3.1.6	Fuel and Reactivity Control	3.1-34
3.1.7	Combined License Information	3.1-37
3.1.8	References	3.1-37
3.2	Classification of Structures, Components, and Systems	3.2-1
3.2.1	Seismic Classification	3.2-1
3.2.1.1	Definitions	3.2-1
3.2.1.2	Classifications	3.2-3
3.2.1.3	Classification of Building Structures	3.2-3
3.2.2	AP600 Classification System	3.2-3
3.2.2.1	Classification Definitions	3.2-3
3.2.2.2	Application of Classification	3.2-4
3.2.2.3	Equipment Class A	3.2-5
3.2.2.4	Equipment Class B	3.2-5
3.2.2.5	Equipment Class C	3.2-6
3.2.2.6	Equipment Class D	3.2-8
3.2.2.7	Other Equipment Classes	3.2-11
3.2.2.8	Instrumentation and Control Line Interface Criteria	3.2-12
3.2.2.9	Electrical Classifications	3.2-12
3.2.3	Inspection Requirements	3.2-13
3.2.4	Application of AP600 Safety-Related Equipment and Seismic Classification System	3.2-13
3.2.5	Combined License Information	3.2-17
3.2.6	References	3.2-17
3.3	Wind and Tornado Loadings	3.3-1
3.3.1	Wind Loadings	3.3-1
3.3.1.1	Design Wind Velocity	3.3-1
3.3.1.2	Determination of Applied Forces	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 Failure of Structures or Components Not Designed for Tornado Loads	3.3-3
3.3.2.4	Tornado Loads on the Passive Containment Cooling System Air Baffle	3.3-4

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
	3.3.3 Combined License Information	3.3-4
	3.3.4 References	3.3-4
3.4	Water Level (Flood) Design	3.4-1
	3.4.1 Flood Protection	3.4-1
	3.4.1.1 Flood Protection Measures for Seismic Category I Structures, Systems, and Components	3.4-1
	3.4.1.2 Evaluation of Flooding Events	3.4-4
	3.4.1.3 Permanent Dewatering System	3.4-24
	3.4.2 Analytical and Test Procedures	3.4-24
	3.4.3 Combined License Information	3.4-24
	3.4.4 References	3.4-24
3.5	Missile Protection	3.5-1
	3.5.1 Missile Selection and Description	3.5-4
	3.5.1.1 Internally Generated Missiles (Outside Containment)	3.5-4
	3.5.1.2 Internally Generated Missiles (Inside Containment)	3.5-8
	3.5.1.3 Turbine Missiles	3.5-12
	3.5.1.4 Missiles Generated by Natural Phenomena	3.5-12
	3.5.1.5 Missiles Generated by Events Near the Site	3.5-13
	3.5.1.6 Aircraft Hazards	3.5-13
	3.5.2 Protection from Externally Generated Missiles	3.5-13
	3.5.3 Barrier Design Procedures	3.5-13
	3.5.3.1 Ductility Factors for Steel Structures	3.5-16
	3.5.4 Combined License Information	3.5-17
	3.5.5 References	3.5-17
3.6	Protection Against the Dynamic Effects Associated with the Postulated Rupture of Piping	3.6-1
	3.6.1 Postulated Piping Failures in Fluid Systems Inside and Outside Containment	3.6-2
	3.6.1.1 Design Basis	3.6-3
	3.6.1.2 Description	3.6-7
	3.6.1.3 Safety Evaluation	3.6-9
	3.6.2 Determination of Break Locations and Dynamic Effects Associated with the Postulated Rupture of Piping	3.6-12
	3.6.2.1 Criteria Used to Define High- and Moderate-Energy Break and Crack Locations and Configurations	3.6-12
	3.6.2.2 Analytical Methods to Define Jet Thrust Forcing Functions and Response Models	3.6-21
	3.6.2.3 Dynamic Analysis Methods to Verify Integrity and Operability	3.6-23
	3.6.2.4 Protective Assembly Design Criteria	3.6-27

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
	3.6.2.5 Evaluation of Dynamic Effects of Pipe Ruptures	3.6-27
	3.6.2.6 Evaluation of Flooding Effects from Pipe Failures	3.6-30
	3.6.2.7 Evaluation of Spray Effects from High- and Moderate-Energy Through-Wall Cracks	3.6-30
3.6.3	Leak-before-Break Evaluation Procedures	3.6-31
	3.6.3.1 Application of Mechanistic Pipe Break Criteria	3.6-32
	3.6.3.2 Design Criteria for Leak-before-Break	3.6-33
	3.6.3.3 Analysis Methods and Criteria	3.6-35
	3.6.3.4 Documentation of Leak-before-Break Evaluations	3.6-37
3.6.4	Combined License Information	3.6-37
	3.6.4.1 Pipe Break Hazard Analysis	3.6-37
	3.6.4.2 Leak-before-Break Evaluation	3.6-37
3.6.5	References	3.6-38
3.7	Seismic Design	3.7-1
	3.7.1 Seismic Input	3.7-1
	3.7.1.1 Design Response Spectra	3.7-1
	3.7.1.2 Design Time History	3.7-3
	3.7.1.3 Critical Damping Values	3.7-5
	3.7.1.4 Supporting Media for Seismic Category I Structures	3.7-5
3.7.2	Seismic System Analysis	3.7-7
	3.7.2.1 Seismic Analysis Methods	3.7-8
	3.7.2.2 Natural Frequencies and Response Loads	3.7-10
	3.7.2.3 Procedure Used for Modeling	3.7-12
	3.7.2.4 Soil-Structure Interaction	3.7-16
	3.7.2.5 Development of Floor Response Spectra	3.7-17
	3.7.2.6 Three Components of Earthquake Motion	3.7-18
	3.7.2.7 Combination of Modal Responses	3.7-20
	3.7.2.8 Interaction of Seismic Category II and Nonseismic Structures with Seismic Category I Structures, Systems or Components	3.7-20
	3.7.2.9 Effects of Parameter Variations on Floor Response Spectra	3.7-22
	3.7.2.10 Use of Constant Vertical Static Factors	3.7-22
	3.7.2.11 Method Used to Account for Torsional Effects	3.7-22
	3.7.2.12 Comparison of Responses	3.7-23
	3.7.2.13 Methods for Seismic Analysis of Dams	3.7-23
	3.7.2.14 Determination of Seismic Category I Structure Overturning Moments	3.7-23
	3.7.2.15 Analysis Procedure for Damping	3.7-23

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
3.7.3	Seismic Subsystem Analysis	3.7-24
3.7.3.1	Seismic Analysis Methods	3.7-24
3.7.3.2	Determination of Number of Earthquake Cycles	3.7-24
3.7.3.3	Procedure Used for Modeling	3.7-25
3.7.3.4	Basis for Selection of Frequencies	3.7-26
3.7.3.5	Equivalent Static Load Method of Analysis	3.7-26
3.7.3.6	Three Components of Earthquake Motion	3.7-27
3.7.3.7	Combination of Modal Responses	3.7-28
3.7.3.8	Analytical Procedure for Piping	3.7-33
3.7.3.9	Combination of Support Responses	3.7-38
3.7.3.10	Vertical Static Factors	3.7-40
3.7.3.11	Torsional Effects of Eccentric Masses	3.7-40
3.7.3.12	Seismic Category I Buried Piping Systems and Tunnels	3.7-41
3.7.3.13	Interaction of Other Systems with Seismic Category I Systems	3.7-41
3.7.3.14	Seismic Analyses for Reactor Internals	3.7-47
3.7.3.15	Analysis Procedure for Damping	3.7-48
3.7.3.16	Analysis of Seismic Category I Tanks	3.7-48
3.7.3.17	Time History Analysis of Piping Systems	3.7-48
3.7.4	Seismic Instrumentation	3.7-50
3.7.4.1	Comparison with Regulatory Guide 1.12	3.7-50
3.7.4.2	Location and Description of Instrumentation	3.7-50
3.7.4.3	Control Room Operator Notification	3.7-52
3.7.4.4	Comparison of Measured and Predicted Responses	3.7-52
3.7.4.5	Tests and Inspections	3.7-52
3.7.5	Combined License Information	3.7-52
3.7.5.1	Seismic Analysis of Dams	3.7-52
3.7.5.2	Post-Earthquake Procedures	3.7-52
3.7.5.3	Seismic Interaction Review	3.7-53
3.7.5.4	Reconciliation of Seismic Analyses of Nuclear Island Structures	3.7-53
3.7.6	References	3.7-53
3.8	Design of Category I Structures	3.8-1
3.8.1	Concrete Containment	3.8-1
3.8.2	Steel Containment	3.8-1
3.8.2.1	Description of the Containment	3.8-1
3.8.2.2	Applicable Codes, Standards, and Specifications	3.8-4
3.8.2.3	Loads and Load Combinations	3.8-5
3.8.2.4	Design and Analysis Procedures	3.8-6
3.8.2.5	Structural Criteria	3.8-16

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
	3.8.2.6 Materials, Quality Control, and Special Construction Techniques	3.8-16
	3.8.2.7 Testing and In-Service Inspection Requirements	3.8-17
3.8.3	Concrete and Steel Internal Structures of Steel Containment	3.8-18
	3.8.3.1 Description of the Containment Internal Structures	3.8-18
	3.8.3.2 Applicable Codes, Standards, and Specifications	3.8-21
	3.8.3.3 Loads and Load Combinations	3.8-22
	3.8.3.4 Analysis Procedures	3.8-24
	3.8.3.5 Design Procedures and Acceptance Criteria	3.8-31
	3.8.3.6 Materials, Quality Control, and Special Construction Techniques	3.8-39
	3.8.3.7 In-Service Testing and Inspection Requirements	3.8-40
	3.8.3.8 Construction Inspection	3.8-40
3.8.4	Other Category I Structures	3.8-41
	3.8.4.1 Description of the Structures	3.8-41
	3.8.4.2 Applicable Codes, Standards, and Specifications	3.8-46
	3.8.4.3 Loads and Load Combinations	3.8-47
	3.8.4.4 Design and Analysis Procedures	3.8-49
	3.8.4.5 Structural Criteria	3.8-52
	3.8.4.6 Materials, Quality Control, and Special Construction Techniques	3.8-54
	3.8.4.7 In-Service Testing and Inspection Requirements	3.8-57
	3.8.4.8 Construction Inspection	3.8-57
3.8.5	Foundations	3.8-58
	3.8.5.1 Description of the Foundations	3.8-58
	3.8.5.2 Applicable Codes, Standards, and Specifications	3.8-58
	3.8.5.3 Loads and Load Combinations	3.8-58
	3.8.5.4 Design and Analysis Procedures	3.8-59
	3.8.5.5 Structural Criteria	3.8-67
	3.8.5.6 Materials, Quality Control, and Special Construction Techniques	3.8-70
	3.8.5.7 In-Service Testing and Inspection Requirements	3.8-70
	3.8.5.8 Construction Inspection	3.8-70
3.8.6	Combined License Information	3.8-71
	3.8.6.1 Containment Vessel Design Adjacent to Large Penetrations	3.8-71
	3.8.6.2 Passive Containment Cooling System Water Storage Tank Examinations	3.8-71
	3.8.6.3 As-Built Summary Report	3.8-71
3.8.7	References	3.8-71

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
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	3.9-28
3.9.1.3	Experimental Stress Analysis	3.9-29
3.9.1.4	Considerations for the Evaluation of the Faulted Conditions	3.9-29
3.9.1.5	Module Interaction, Coupling, and Other Issues	3.9-29
3.9.2	Dynamic Testing and Analysis	3.9-30
3.9.2.1	Piping Vibration, Thermal Expansion, and Dynamic Effects	3.9-30
3.9.2.2	Seismic Qualification Testing of Safety-Related Mechanical Equipment	3.9-33
3.9.2.3	Dynamic Response Analysis of Reactor Internals under Operational Flow Transients and Steady-State Conditions	3.9-35
3.9.2.4	Pre-operational Flow-Induced Vibration Testing of Reactor Internals	3.9-38
3.9.2.5	Dynamic System Analysis of the Reactor Internals Under Faulted Conditions	3.9-41
3.9.2.6	Correlation of Reactor Internals Vibration Tests with the Analytical Results	3.9-45
3.9.3	ASME Code Classes 1, 2, and 3 Components, Component Supports, and Core Support Structures	3.9-45
3.9.3.1	Loading Combinations, Design Transients, and Stress Limits	3.9-46
3.9.3.2	Pump and Valve Operability Assurance	3.9-63
3.9.3.3	Design and Installation Criteria of Class 1, 2, and 3 Pressure Relieving Devices	3.9-65
3.9.3.4	Component and Piping Supports	3.9-67
3.9.3.5	Instrumentation Line Supports	3.9-71
3.9.4	Control Rod Drive System (CRDS)	3.9-72
3.9.4.1	Descriptive Information of CRDS	3.9-72
3.9.4.2	Applicable CRDS Design Specifications	3.9-78
3.9.4.3	Design Loads, Stress Limits, and Allowable Deformations	3.9-81
3.9.4.4	Control Rod Drive Mechanism Performance Assurance Program	3.9-82

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
3.9.5	Reactor Pressure Vessel Internals	3.9-82
3.9.5.1	Design Arrangements	3.9-82
3.9.5.2	Design Loading Conditions	3.9-85
3.9.5.3	Design Bases	3.9-86
3.9.6	Inservice Testing of Pumps and Valves	3.9-88
3.9.6.1	Inservice Testing of Pumps	3.9-89
3.9.6.2	Inservice Testing of Valves	3.9-90
3.9.6.3	Relief Requests	3.9-96
3.9.7	Integrated Head Package	3.9-96
3.9.7.1	Design Bases	3.9-97
3.9.7.2	Design Description	3.9-98
3.9.7.3	Design Evaluation	3.9-100
3.9.7.4	Inspection and Testing Requirements	3.9-101
3.9.8	Combined License Information	3.9-101
3.9.8.1	Reactor Internals Vibration Response	3.9-101
3.9.8.2	Design Specifications and Reports	3.9-101
3.9.8.3	Snubber Operability Testing	3.9-101
3.9.8.4	Valve Inservice Testing	3.9-101
3.9.8.5	Surge Line Thermal Monitoring	3.9-101
3.9.8.6	Piping Benchmark Program	3.9-102
3.9.9	References	3.9-102
3.10	Seismic and Dynamic Qualification of Seismic Category I Mechanical and Electrical Equipment	3.10-1
3.10.1	Seismic and Dynamic Qualification Criteria	3.10-2
3.10.1.1	Qualification Standards	3.10-2
3.10.1.2	Performance Requirements for Seismic Qualification	3.10-3
3.10.1.3	Performance Criteria	3.10-3
3.10.2	Methods and Procedures for Qualifying Electrical Equipment, Instrumentation, and Mechanical Components	3.10-3
3.10.2.1	Seismic Qualification of Instrumentation and Electrical Equipment	3.10-4
3.10.2.2	Seismic and Operability Qualification of Active Mechanical Equipment	3.10-5
3.10.2.3	Valve Operator Qualification	3.10-7
3.10.2.4	Seismic Qualification of Other Seismic Category I Mechanical Equipment	3.10-7
3.10.3	Method and Procedures for Qualifying Supports of Electrical Equipment, Instrumentation, and Mechanical Components	3.10-7
3.10.4	Documentation	3.10-7
3.10.5	Standard Review Plan Evaluation	3.10-8

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
	3.10.6 Combined License Information Item on Experienced-Based Qualification	3.10-8
	3.10.7 References	3.10-8
3.11	Environmental Qualification of Mechanical and Electrical Equipment	3.11-1
	3.11.1 Equipment Identification and Environmental Conditions	3.11-1
	3.11.1.1 Equipment Identification	3.11-1
	3.11.1.2 Definition of Environmental Conditions	3.11-1
	3.11.1.3 Equipment Operability Times	3.11-3
	3.11.1.4 Standard Review Plan Evaluation	3.11-3
	3.11.2 Qualification Tests and Analysis	3.11-3
	3.11.2.1 Environmental Qualification of Electrical Equipment	3.11-3
	3.11.2.2 Environmental Qualification of Mechanical Equipment	3.11-4
	3.11.3 Loss of Ventilation	3.11-5
	3.11.4 Estimated Radiation and Chemical Environment	3.11-5
	3.11.5 Combined License Information Item for Equipment Qualification File	3.11-6
	3.11.6 References	3.11-6

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
APPENDIX 3A	HVAC DUCTS AND DUCT SUPPORTS	3A-1
3A.1	Codes and Standards	3A-1
3A.2	Loads and Load Combinations	3A-1
3A.2.1	Loads	3A-1
3A.2.1.1	Dead Load (D)	3A-1
3A.2.1.2	Construction Live Load (L)	3A-2
3A.2.1.3	Pressure (P)	3A-2
3A.2.1.4	Safe Shutdown Earthquake (E_s)	3A-2
3A.2.1.5	Wind Loads (W)	3A-2
3A.2.1.6	Tornado Loads (W_t)	3A-2
3A.2.1.7	External Pressure Differential Loads (P_A)	3A-2
3A.2.1.8	Thermal (T_o/T_A)	3A-2
3A.2.2	Load Combinations	3A-3
3A.3	Analysis and Design	3A-3
3A.3.1	Response Due to Seismic Loads	3A-3
3A.3.2	Deflection Criteria	3A-4
3A.3.3	Relative Movement	3A-4
3A.3.4	Allowable Stresses	3A-4
3A.3.5	Connections	3A-4
APPENDIX 3B	LEAK-BEFORE-BREAK EVALUATION OF THE AP600 PIPING	3B-1
3B.1	Leak-Before-Break Criteria for AP600 Piping	3B-2
3B.2	Potential Failure Mechanisms for AP600 Piping	3B-2
3B.2.1	Erosion-Corrosion Induced Wall Thinning	3B-2
3B.2.2	Stress Corrosion Cracking	3B-3
3B.2.3	Water Hammer	3B-5
3B.2.4	Fatigue	3B-7
3B.2.5	Thermal Aging	3B-7
3B.2.6	Thermal Stratification	3B-8
3B.2.7	Other Mechanisms	3B-9
3B.3	Leak-Before-Break Bounding Analysis	3B-10
3B.3.1	Procedure for Stainless Steel Piping	3B-11
3B.3.1.1	Pipe Geometry, Material and Operating Conditions	3B-11
3B.3.1.2	Pipe Physical Properties	3B-11
3B.3.1.3	Low Normal Stress Case (Case 1)	3B-12
3B.3.1.4	High Normal Stress Case (Case 2)	3B-12
3B.3.1.5	Develop the Bounding Analysis Curve	3B-13
3B.3.2	Procedure for Non-Stainless Steel Piping	3B-13
3B.3.2.1	Pipe Geometry, Material and Operating Conditions	3B-13
3B.3.2.2	Calculations Steps	3B-13
3B.3.2.3	Low Normal Stress Case (Case 1)	3B-14

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
	3B.3.2.4 High Normal Stress Case (Case 2)	3B-14
	3B.3.2.5 Develop the Bounding Analysis Curve	3B-15
3B.3.3	Evaluation of Piping System Using Bounding Analysis Curves	3B-15
	3B.3.3.1 Calculation of Stresses	3B-15
	3B.3.3.2 Normal Loads	3B-16
	3B.3.3.3 Maximum Loads	3B-17
	3B.3.3.4 Bounding Analysis Curve Comparison	3B-17
3B.3.4	Bounding Analysis Results	3B-17
3B.4	Differences in Leak-Before-Break Analysis for Stainless Steel and Ferritic Steel Pipe	3B-18
3B.5	Differences in Inspection Criteria for Class 1, 2, and 3 Systems	3B-18
3B.6	Differences in Fabrication Requirements of ASME Class 1, Class 2, and Class 3 Piping	3B-18
3B.7	Sensitivity Study for the Constraint Effect on LBB	3B-18
3B.8	References	3B-19
APPENDIX 3C	REACTOR COOLANT LOOP ANALYSIS METHODS	3C-1
3C.1	Reactor Coolant Loop Model Description	3C-1
3C.1.1	Steam Generator Model	3C-1
	3C.1.1.1 Steam Generator Mass and Geometrical Model	3C-1
	3C.1.1.2 Steam Generator Supports	3C-1
3C.1.2	Reactor Coolant Pump Model	3C-2
	3C.1.2.1 Static Model	3C-2
	3C.1.2.2 Seismic Model	3C-2
	3C.1.2.3 Reactor Coolant Pump Supports	3C-2
3C.1.3	Reactor Pressure Vessel Model	3C-2
	3C.1.3.1 Mass and Geometrical Model	3C-2
	3C.1.3.2 Reactor Pressure Vessel Supports	3C-2
3C.1.4	Containment Interior Building Structure Model	3C-3
3C.1.5	Reactor Coolant Loop Piping Model	3C-3
3C.2	Design Requirements	3C-3
3C.3	Static Analyses	3C-4
	3C.3.1 Deadweight Analysis	3C-4
	3C.3.2 Internal Pressure Analysis	3C-4
	3C.3.3 Thermal Expansion Analysis	3C-4
3C.4	Seismic Analyses	3C-4
3C.5	Reactor Coolant Loop Piping Stresses	3C-5
3C.6	Description of Computer Programs	3C-5

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
APPENDIX 3D	METHODOLOGY FOR QUALIFYING AP600 SAFETY-RELATED ELECTRICAL AND MECHANICAL EQUIPMENT	3D-1
3D.1	Purpose	3D-2
3D.2	Scope	3D-2
3D.3	Introduction	3D-3
3D.4	Qualification Criteria	3D-3
3D.4.1	Qualification Guides	3D-3
3D.4.1.1	IEEE Standards	3D-4
3D.4.1.2	NRC Regulatory Guides	3D-5
3D.4.2	Definitions	3D-7
3D.4.3	Mild versus Harsh Environments	3D-7
3D.4.4	Test Sequence	3D-8
3D.4.5	Aging	3D-9
3D.4.5.1	Design Life	3D-9
3D.4.5.2	Shelf Life	3D-9
3D.4.5.3	Qualified Life	3D-9
3D.4.5.4	Qualified Life Reevaluation	3D-11
3D.4.6	Operability Time	3D-12
3D.4.7	Performance Criterion	3D-12
3D.4.8	Margin	3D-12
3D.4.8.1	Normal and Abnormal Extremes	3D-13
3D.4.8.2	Aging	3D-14
3D.4.8.3	Radiation	3D-15
3D.4.8.4	Seismic Conditions	3D-15
3D.4.8.5	High-Energy Line Break Conditions	3D-15
3D.4.9	Treatment of Failures	3D-15
3D.4.10	Traceability	3D-16
3D.4.10.1	Auditable Link Document	3D-16
3D.4.10.2	Similarity	3D-17
3D.5	Design Specifications	3D-17
3D.5.1	Normal Operating Conditions	3D-17
3D.5.1.1	Pressure, Temperature, and Humidity	3D-17
3D.5.1.2	Radiation Dose	3D-18
3D.5.2	Abnormal Operating Conditions	3D-18
3D.5.2.1	Abnormal Environments Inside Containment	3D-19
3D.5.2.2	Abnormal Environments Outside Containment	3D-19
3D.5.3	Seismic Events	3D-20
3D.5.4	Containment Test Environment	3D-20

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
	3D.5.5 Design Basis Event Conditions	3D-20
	3D.5.5.1 High-Energy Line Break Accidents Inside Containment . .	3D-20
	3D.5.5.2 High-Energy Line Break Accidents Outside Containment .	3D-24
3D.6	Qualification Methods	3D-24
	3D.6.1 Type Test	3D-24
	3D.6.2 Analysis	3D-25
	3D.6.2.1 Similarity	3D-25
	3D.6.2.2 Substitution	3D-26
	3D.6.2.3 Analysis of Safety-Related Mechanical Equipment	3D-26
	3D.6.3 Operating Experience	3D-29
	3D.6.4 On-Going Qualification	3D-29
	3D.6.5 Combinations of Methods	3D-30
	3D.6.5.1 Use of Existing Qualification Reports	3D-30
3D.7	Documentation	3D-31
	3D.7.1 Equipment Qualification Data Package	3D-31
	3D.7.2 Specifications	3D-32
	3D.7.2.1 Equipment Identification	3D-32
	3D.7.2.2 Installation Requirements	3D-32
	3D.7.2.3 Electrical Requirements	3D-32
	3D.7.2.4 Auxiliary Devices	3D-32
	3D.7.2.5 Preventive Maintenance	3D-33
	3D.7.2.6 Performance Requirements	3D-33
	3D.7.2.7 Environmental Conditions	3D-33
	3D.7.3 Qualification Program	3D-34
	3D.7.4 Qualification by Test	3D-34
	3D.7.4.1 Specimen Description	3D-34
	3D.7.4.2 Number Tested	3D-34
	3D.7.4.3 Mounting	3D-35
	3D.7.4.4 Connections	3D-35
	3D.7.4.5 Test Sequence	3D-35
	3D.7.4.6 Simulated Service Conditions	3D-35
	3D.7.4.7 Measured Variables	3D-35
	3D.7.4.8 Type Test Summary	3D-36
	3D.7.5 Qualification by Analysis	3D-37
	3D.7.6 Qualification by Experience	3D-37
	3D.7.7 Qualification Program Conclusions	3D-37
	3D.7.8 Combined License Information	3D-37
3D.8	References	3D-37
	Appendix 3D-Attachment A - Sample Equipment Qualification Data Package	3D-69

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
Appendix 3D-Attachment B - Aging Evaluation Program		3D-87
B.1	Introduction	3D-87
B.2	Objectives	3D-87
B.3	Basic Approach	3D-87
B.4	Subprogram A	3D-88
B.4.1	Scope	3D-88
B.4.2	Aging Mechanisms	3D-88
B.4.3	Time	3D-88
B.4.4	Operational Stresses	3D-89
B.4.5	External Stresses	3D-89
B.4.6	Synergism	3D-91
B.4.7	Design Basis Event Testing	3D-91
B.4.8	Aging Sequence	3D-91
B.4.9	Performance Criterion	3D-91
B.4.10	Failure Treatment	3D-91
B.5	Subprogram B	3D-92
B.5.1	Scope	3D-93
B.5.2	Performance Criteria	3D-93
B.5.3	Failure Treatment	3D-93
Appendix 3D-Attachment C - Effects of Gamma Radiation Doses Below 10^4 Rads on the Mechanical Properties of Materials		3D-96
C.1	Introduction	3D-96
C.2	Scope	3D-97
C.3	Discussion	3D-97
C.4	Conclusions	3D-98
C.5	References	3D-98
Appendix 3D-Attachment D - Accelerated Thermal Aging Parameters		3D-103
D.1	Introduction	3D-103
D.2	Arrhenius Model	3D-103
D.3	Activation Energy	3D-105
D.4	Thermal Aging (Normal/Abnormal Operating Conditions)	3D-106
D.4.1	Normal Operation Temperature	3D-106
D.4.1.1	External Ambient Temperature	3D-106
D.4.1.2	Temperature Rise in Enclosure	3D-107
D.4.1.3	Self-Heating Effects	3D-107
D.4.2	Accelerated Aging Temperature	3D-107
D.4.3	Examples of Arrhenius Calculations	3D-107
D.4.3.1	For a Normally Energized Component Aged Energized	3D-107
D.4.3.2	For a Normally De-energized Component Aged Energized	3D-108

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
D.5	Post-Accident Thermal Aging	3D-108
D.5.1	Post-Accident Operating Temperatures	3D-108
D.5.2	Accelerated Thermal Aging Parameters for Post-Accident Conditions	3D-109
D.6	References	3D-109
Appendix 3D-Attachment E	Seismic Qualification Techniques	3D-115
E.1	Purpose	3D-115
E.2	Definitions	3D-115
E.2.1	1/2 Safe Shutdown Earthquake	3D-115
E.2.2	Seismic Category I Equipment	3D-115
E.2.3	Active Equipment	3D-115
E.2.4	Passive Equipment	3D-115
E.3	Qualification Methods	3D-116
E.3.1	Use of Qualification by Testing	3D-116
E.3.2	Use of Qualification by Analysis	3D-116
E.4	Requirements	3D-117
E.4.1	Damping	3D-117
E.4.1.1	Testing	3D-117
E.4.1.2	Analysis	3D-117
E.4.2	Interface Requirements	3D-117
E.4.3	Mounting Simulation	3D-118
E.4.4	1/2 Safe Shutdown Earthquake	3D-118
E.4.5	Safe Shutdown Earthquake	3D-118
E.4.6	Other Dynamic Loads	3D-118
E.5	Qualification by Test	3D-118
E.5.1	Qualification of Hard-Mounted Equipment	3D-119
E.5.2	Qualification of Line-Mounted Equipment	3D-120
E.5.2.1	Seismic Qualification Test Sequence	3D-121
E.5.2.2	Line Vibration Aging	3D-121
E.5.2.3	Single Frequency Testing	3D-121
E.5.2.4	Seismic Aging	3D-122
E.5.2.5	Static Pull Testing of Valves	3D-122
E.5.3	Operational Conditions	3D-122
E.5.4	Resonant Search Testing	3D-123
E.6	Qualification by Analysis	3D-123
E.6.1	Modeling	3D-124
E.6.2	Qualification by Static Analysis	3D-124

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
E.6.3	Qualification by Dynamic Analysis	3D-124
E.6.3.1	Response Analysis	3D-125
E.6.3.2	Static Coefficient Method	3D-125
E.6.3.3	Time History	3D-125
E.7	Performance Criteria	3D-126
E.7.1	Equipment Qualification by Test	3D-126
E.7.2	Equipment Qualification by Analysis	3D-126
E.7.2.1	Structural Integrity	3D-126
E.7.2.2	Operability	3D-126
APPENDIX 3E	HIGH-ENERGY PIPING IN THE NUCLEAR ISLAND	3E-1
APPENDIX 3F	CABLE TRAYS AND CABLE TRAY SUPPORTS	3F-1
3F.1	Codes and Standards	3F-1
3F.2	Loads and Load Combinations	3F-1
3F.2.1	Loads	3F-1
3F.2.1.1	Dead Load (D)	3F-1
3F.2.1.2	Construction Live Load (L)	3F-2
3F.2.1.3	Safe Shutdown Earthquake (E_s)	3F-2
3F.2.1.4	Thermal Load	3F-2
3F.2.2	Load Combinations	3F-2
3F.3	Analysis and Design	3F-2
3F.3.1	Damping	3F-2
3F.3.2	Seismic Analysis	3F-3
3F.3.3	Allowable Stresses	3F-3
3F.3.4	Connections	3F-3
APPENDIX 3G	CRITERIA FOR BUCKLING EVALUATION OF CONTAINMENT	
	VESSEL	3G-1
3G.1	Notation	3G-1
3G.2	Factors of Safety	3G-2
3G.3	Capacity Reduction Factors	3G-2
3G.3.1	Cylindrical Shells	3G-2
3G.3.1.1	Axial Compression	3G-2
3G.3.1.2	Hoop Compression	3G-3
3G.3.1.3	Shear	3G-3
3G.3.2	Spherical Shells	3G-3
3G.3.2.1	Uniaxial Compression	3G-3
3G.3.2.2	Equal Biaxial Compression	3G-3

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
	3G.3.2.3 Unequal Biaxial Compression	3G-3
	3G.3.2.4 Shear	3G-3
	3G.3.3 Ellipsoidal Shells	3G-3
3G.4	Plasticity Reduction Factor	3G-4
	3G.4.1 Cylindrical Shells	3G-4
	3G.4.1.1 Axial Compression	3G-4
	3G.4.1.2 Hoop Compression	3G-4
	3G.4.1.3 Shear	3G-4
	3G.4.2 Spherical Shells	3G-4
	3G.4.2.1 Meridional Compression and/or Hoop Compression	3G-4
	3G.4.3 Ellipsoidal Shells	3G-5
	3G.4.3.1 Meridional Compression and/or Hoop Compression	3G-5
3G.5	Theoretical Buckling Values	3G-5
	3G.5.1 Cylindrical Shells	3G-5
	3G.5.1.1 Axial Compression	3G-5
	3G.5.1.2 External Pressure	3G-5
	3G.5.1.3 Shear	3G-6
	3G.5.2 Spherical Shells	3G-6
	3G.5.2.1 Equal Biaxial Compression	3G-6
	3G.5.2.2 Unequal Biaxial Compression	3G-6
	3G.5.2.3 Shear	3G-6
	3G.5.3 Ellipsoidal Shells	3G-6
3G.6	Interaction Equations for Local Buckling	3G-6
	3G.6.1 Elastic Buckling	3G-6
	3G.6.1.1 Cylindrical Shells	3G-7
	3G.6.1.2 Spherical Shells	3G-7
	3G.6.1.3 Ellipsoidal Shells	3G-8
	3G.6.2 Inelastic Buckling	3G-9
	3G.6.2.1 Cylindrical Shells	3G-9
	3G.6.2.2 Spherical Shells	3G-10
	3G.6.2.3 Ellipsoidal Shells	3G-10
APPENDIX 3H AUXILIARY BUILDING CRITICAL SECTIONS		
3H.1	Introduction	3H-1
3H.2	Description of Auxiliary Building	3H-1
3H.3	Design Criteria	3H-2
	3H.3.1 Governing Codes and Standards	3H-3
	3H.3.2 Seismic Input	3H-3
	3H.3.3 Loads	3H-3
	3H.3.4 Load Combinations and Acceptance Criteria	3H-7

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
3H.4	Seismic Analyses	3H-8
3H.4.1	Live Load for Seismic Design	3H-8
3H.5	Structural Design of Critical Sections	3H-9
3H.5.1	Shear Walls	3H-10
3H.5.1.1	Exterior Wall at Column Line 1	3H-11
3H.5.1.2	Wall at Column Line 7.3	3H-11
3H.5.1.3	Wall at Column Line L	3H-12
3H.5.1.4	Wall at Column Line 11	3H-12
3H.5.1.5	Shield Building Cylinder at Elevation 180'-0"	3H-13
3H.5.2	Composite Structures (Floors and Roof)	3H-13
3H.5.2.1	Roof at Elevation 180'-0", Area 6 (Critical Section is between Col. Lines N & K-2 and 3 & 4)	3H-15
3H.5.2.2	Floor at Elevation 135'-3", Area 1 (Between Column Lines M and P)	3H-17
3H.5.3	Reinforced Concrete Slabs	3H-18
3H.5.3.1	Tagging Room Ceiling	3H-18
3H.5.4	Concrete Finned Floors	3H-20
3H5.4.1	MCR Ceiling (Floor at Elevation 135'-3")	3H-21
3H.5.5	Structural Modules	3H-21
3H.5.5.1	West Wall of Spent Fuel Pool	3H-22
3H.5.6	Shield Building Roof	3H-23
3H.5.6.1	Tension Ring	3H-23
3H.5.6.2	Column (shear wall) Between Air Inlets	3H-24
3H.5.6.3	Exterior Wall of the Passive Containment Cooling System Tank	3H-24

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
3.2-1	Comparison of Safety Classification Requirements	3.2-19
3.2-2	Seismic Classification of Building Structures	3.2-20
3.2-3	AP600 Classification of Mechanical and Fluid Systems, Components, and Equipment (Sheets 1 - 67)	3.2-21
3.6-1	High-Energy and Moderate-Energy Fluid Systems Considered for Protection of Essential Systems	3.6-39
3.6-2	Subcompartments and Postulated Pipe Ruptures (Pages 1 - 7)	3.6-40
3.6-3	NI Rooms with Postulated High Energy Line Breaks/Essential Targets/Pipe Whip Restraints and Related Hazard Source	3.6-47
3.7.1-1	Safe Shutdown Earthquake Damping Values	3.7-57
3.7.1-2	Embedment Depth and Related Dimensions of Category I Structures	3.7-58
3.7.1-3	AP600 Design Response Spectra Amplification Factors for Control Points . . .	3.7-59
3.7.2-1	Coupled Shield and Auxiliary Buildings Lumped-Mass Stick Model Modal Properties	3.7-60
3.7.2-2	Steel Containment Vessel Lumped-Mass Stick Model Modal Properties	3.7-61
3.7.2-3	Containment Internal Structures (Without RCL Lumped-Mass Stick Model Modal Properties) (Sheets 1 - 3)	3.7-62
3.7.2-4	Nuclear Island Combined Lumped-Mass Stick Model Modal Properties (Sheets 1 - 2)	3.7-65
3.7.2-5	Maximum Absolute Nodal Acceleration (ZPA) Coupled Auxiliary & Shield Buildings (Sheets 1 - 4)	3.7-67
3.7.2-6	Maximum Absolute Nodal Acceleration (ZPA) Steel Containment Vessel (Sheets 1 - 4)	3.7-71
3.7.2-7	Maximum Absolute Nodal Acceleration (ZPA) Containment Internal Structure (Sheets 1 - 4)	3.7-75
3.7.2-8	Maximum Displacement Relative to Top of Basemat Coupled Auxiliary & Shield Buildings (Sheets 1 - 4)	3.7-79
3.7.2-9	Maximum Displacement Relative to Top of Basemat Steel Containment Vessel (Sheets 1 - 4)	3.7-83
3.7.2-10	Maximum Displacement Relative to Top of Basemat Containment Internal Structure (Sheets 1 - 4)	3.7-87
3.7.2-11	Maximum Member Forces and Moments Coupled Auxiliary & Shield Buildings (Sheets 1 - 4)	3.7-91
3.7.2-12	Maximum Member Forces and Moments Steel Containment Vessel (Sheets 1 - 4)	3.7-95
3.7.2-13	Maximum Member Forces and Moments Containment Internal Structures (Sheets 1 - 4)	3.7-99
3.7.2-14	Summary of Models and Analysis Methods (Sheets 1 - 2)	3.7-103
3.7.2-15	Comparison of Frequencies for Containment Vessel Seismic Model	3.7-105
3.7.2-16	Summary of Dynamic Analyses & Combination Techniques	3.7-106

LIST OF TABLES (Cont.)

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
3.7.2-17	Comparison of Maximum Absolute Nodal Acceleration (ZPA) Due to Time History (TH) and Response Spectrum (RSA) Analyses (Sheets 1 - 3)	3.7-107
3.7.2-18	Comparison of Maximum Member Forces Due to Time History (TH) and Response Spectrum (RSA) Analyses (Sheets 1 - 4)	3.7-110
3.7.2-19	Comparison of Maximum Member Moments Due to Time History (TH) and Response Spectrum (RSA) Analyses (Sheets 1 - 4)	3.7-114
3.7.2-20	Comparison of Frequencies in Seismic Models	3.7-118
3.7.2-21	Comparison of Maximum Absolute Nodal Acceleration (ZPA) Nuclear Island Structures Soft-to-Medium Soil Conditions, 2 x G_{MAX}	3.7-119
3.7.2-22	Comparison of Maximum Member Forces and Moments at Elevation 100' Containment Internal Structures and Steel Containment Vessel Soft-to-Medium Soil Conditions, 2 x G_{MAX}	3.7-120
3.7.2-23	Comparison of Maximum Member Forces Coupled Auxiliary and Shield Buildings Soft-to-Medium Soil Conditions, 2 x G_{MAX} Maximum Forces (x 1000 Kips) (Sheets 1 - 2)	3.7-121
3.7.3-1	Seismic Category I Equipment Outside Containment by Room Number (Sheets 1 - 3)	3.7-123
3.7.3-2	Equipment Classified as Sensitive Targets for Seismically Analyzed Piping, HVAC Ducting, Cable Trays	3.7-126
3.8.2-1	Load Combinations and Service Limits for Containment Vessel	3.8-75
3.8.2-2	Containment Vessel Pressure Capabilities	3.8-76
3.8.2-3	Analysis and Test Results of Fabricated Heads	3.8-77
3.8.2-4	Summary of Containment Vessel Models and Analysis Methods	3.8-78
3.8.3-1	Shear and Flexural Stiffnesses of Structural Module Walls	3.8-79
3.8.3-2	Summary of Containment Internal Structures Models and Analysis Methods	3.8-80
3.8.3-3	Definition of Critical Locations and Thicknesses for Containment Internal Structures	3.8-81
3.8.3-4	Design Summary of West Wall of Refueling Cavity Design Loads, Load Combinations and Comparison to Acceptance Criteria (Sheets 1 - 3)	3.8-82
3.8.3-5	Design Summary of South Wall of Steam Generator Cavity Design Loads, Load Combinations and Comparison to Acceptance Criteria (Sheets 1 - 3)	3.8-85
3.8.3-6	Design Summary of North East Wall of IRWST Design Loads, Load Combinations and Comparison to Acceptance Criteria (Sheets 1 - 3)	3.8-88
3.8.3-7	Design Summary of Steel Wall of IRWST Load Combinations	3.8-91
3.8.4-1	Load Combinations and Load Factors for Seismic Category I Steel Structures	3.8-93

LIST OF TABLES (Cont.)

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
3.8.4-2	Load Combinations and Load Factors for Seismic Category I Concrete Structures	3.8-94
3.8.4-3	Acceptance Tests for Concrete Aggregates	3.8-95
3.8.4-4	Criteria for Water Used in Production of Concrete	3.8-96
3.8.4-5	Types of Water Reducing Agents Used in Production of Concrete	3.8-97
3.8.4-6	Materials Used in Structural and Miscellaneous Steel	3.8-98
3.8.4-7	Definition of Critical Locations and Thicknesses for Shield and Auxiliary Buildings (Sheets 1 - 6)	3.8-99
3.8.5-1	Minimum Required Factor of Safety for Overturning and Sliding of Structures	3.8-105
3.8.5-2	Factors of Safety for Flotation, Overturning and Sliding of Nuclear Island Structures	3.8-106
3.8.5-3	Definition of Critical Locations and Thicknesses for Nuclear Island Basemat	3.8-107
3.9-1	Reactor Coolant System Design Transients (Sheets 1 - 2)	3.9-104
3.9-2	Pump Starting/Stopping Conditions	3.9-106
3.9-3	Loadings for ASME Class 1, 2, 3, CS and Supports (Sheets 1 - 2)	3.9-107
3.9-4	First Plant AP600 Reactor Internals Vibration Measurement Program Transducer Locations	3.9-109
3.9-5	Minimum Design Loading Combinations for ASME Class 1, 2, 3 and CS Systems and Components	3.9-110
3.9-6	Additional Load Combinations and Stress Limits for ASME Class 1 Piping	3.9-112
3.9-7	Additional Load Combinations and Stress Limits for ASME Class 2, 3 Piping	3.9-113
3.9-8	Minimum Design Loading Combinations for Supports for ASME Class 1, 2, 3 Piping and Components	3.9-114
3.9-9	Stress Criteria for ASME Code Section III Class 1 Components and Supports and Class CS Core Supports	3.9-115
3.9-10	Stress Criteria for ASME Code Section III Class 2 and 3 Components and Supports	3.9-117
3.9-11	Piping Functional Capability - ASME Class 1, 2, and 3	3.9-119
3.9-12	List of ASME Class 1, 2, and 3 Active Valves (Sheets 1 - 7)	3.9-120
3.9-13	Control Rod Drive Mechanism Production Tests	3.9-127
3.9-14	Maximum Deflections Allowed for Reactor Internal Support Structures	3.9-128
3.9-15	Computer Programs for Seismic Category 1 Components	3.9-129
3.9-16	Valve Inservice Test Requirements (Sheets 1 - 19)	3.9-131
3.9-17	System Level Operability Testing Requirements	3.9-173
3.9-18	AP600 Pressure Isolation Valves	3.9-175

LIST OF TABLES (Cont.)

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
3.11-1	Environmentally Qualified Electrical and Mechanical Equipment (Sheets 1 - 47)	3.11-7
3B-1	AP600 Leak-Before-Break Scope of Piping Systems	3B-20
3B-2	AP600 Leak-Before-Break Bounding Analysis Systems and Corresponding Figures	3B-21
3D.4-1	Typical Mild Environment Parameter Limits	3D-39
3D.4-2	Equipment Post-Accident Operability Times	3D-40
3D.4-3	AP600 EQ Program Margin Requirements (Sheets 1 - 2)	3D-41
3D.5-1	Normal Operating Environments (Sheets 1 - 4)	3D-43
3D.5-2	60-Year Normal Operating Doses	3D-47
3D.5-3	Abnormal Operating Environments Inside Containment	3D-48
3D.5-4	Abnormal Operating Environments Outside Containment	3D-49
3D.5-5	Accident Environments	3D-50
3D.6-1	Mechanical Equipment Components Requiring Environmental Qualification	3D-51
3D.B-1	Typical Class 1E Equipment Scope and Subprogram Allocation	3D-94
3D.B-2	Aging Mechanism Sequence	3D-95
3D.C-1	Radiation-Induced Degradation of Material Mechanical Properties (Sheets 1 - 2)	3D-100
3D.D-1	Activation Energies From Westinghouse Reports (Sheets 1 - 2)	3D-110
3F-1	Tank Wall Peak Pressures (*)	3F-1
3F-2	Tank Wall and Sparger Discharge Pressure Time Histories (12.0 - 12.4 seconds) (*)	3F-1
3F-3	Tank Wall and Sparger Discharge Pressure Time Histories (13.9 - 14.3 seconds) (*)	3F-1
3F-4	Test Tank Finite Element Model (*)	3F-1
3F-5	Comparison of Predicted vs. Test Tank Wall Pressures Interval I (12.0 - 12.4 seconds) (*)	3F-1
3F-6	Comparison of Predicted vs. Test Tank Wall Pressures Interval II (13.0 - 13.4 seconds) (*)	3F-1
3F-7	IRWST Fluid Structure Finite Element Model Structural Model (*)	3F-1
3F-8	IRWST Fluid Structure Finite Element Model Fluid Model (*)	3F-1
3F-9	IRWST Fluid Structure Finite Element Model Sparger Region Detail (*)	3F-1
3H.5-1	Nuclear Island: Design Temperatures for Thermal Gradient	3H-25
3H.5-2	Exterior Wall at Column Line 1: Forces and Moments in Critical Locations (Sheets 1-2)	3H-26
3H.5-3	Exterior Wall at Column Line 1: Details of Wall Reinforcement	3H-28
3H.5-4	Interior Wall at Column Line 7.3: Forces and Moments in Critical Locations	3H-29

LIST OF TABLES (Cont.)

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
3H.5-5	Interior Wall at Column Line 7.3: Details of Wall Reinforcement	3H-30
3H.5-6	Interior Wall at Column Line L: Forces and Moments in Critical Locations . .	3H-31
3H.5-7	Interior Wall at Column Line L: Details of Wall Reinforcement	3H-32
3H.5-8	Design Summary of Spent Fuel Pool Wall Design Loads and Load Combinations and Comparisons to Acceptance Criteria (Sheets 1-5)	3H-33
3H.5-9	Shield Building Roof Reinforcement Summary (Sheets 1-3)	3H-38

LIST OF FIGURES

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
3.3-1	Velocity Pressure Variation with Radius from Center of Tornado	3.3-6
3.4-1	Nuclear Island Waterproofing Below Grade	3.4-25
3.6-1	Typical U-Bar Restraint	3.6-49
3.6-2	Typical Energy Absorbing Material Restraint	3.6-50
3.6-3	Terminal Ends Definitions	3.6-51
3.7.1-1	Horizontal Design Response Spectra Safe Shutdown Earthquake	3.7-127
3.7.1-2	Vertical Design Response Spectra Safe Shutdown Earthquake	3.7-128
3.7.1-3	Design Horizontal Time History, "H1" Acceleration, Velocity & Displacement Plots	3.7-129
3.7.1-4	Design Horizontal Time History, "H2" Acceleration, Velocity & Displacement Plots	3.7-130
3.7.1-5	Design Vertical Time History, Acceleration, Velocity & Displacement Plots	3.7-131
3.7.1-6	Acceleration Response Spectra of Design Horizontal Time History, "H1"	3.7-132
3.7.1-7	Acceleration Response Spectra of Design Horizontal Time History, "H2"	3.7-133
3.7.1-8	Acceleration Response Spectra of Design Vertical Time History	3.7-134
3.7.1-9	Minimum Power Spectral Density Curve (Normalized to 0.3g)	3.7-135
3.7.1-10	Power Spectral Density of Design Horizontal Time History, "H1"	3.7-136
3.7.1-11	Power Spectral Density of Design Horizontal Time History, "H2"	3.7-137
3.7.1-12	Power Spectral Density of Design Vertical Time History	3.7-138
3.7.1-13	Damping Values for Cable Trays & Supports	3.7-139
3.7.1-14	Strain Dependent Properties of Rock Material	3.7-140
3.7.1-15	Strain Dependent Properties of Soil Material	3.7-141
3.7.1-16	Nuclear Island Structures Dimensions	3.7-142
3.7.1-17	Shear Wave Velocity of Design Soil Profiles	3.7-143
3.7.1-18	Free-Field Motions at Foundation Level (40 ft. Depth) Envelope of Horizontal Motions	3.7-144
3.7.1-19	Free-Field Motions at Foundation Level (40 ft. Depth) Envelope of Vertical Motions	3.7-145
3.7.2-1	3-D Finite Element Model of Coupled Shield & Auxiliary Building	3.7-146
3.7.2-2	3-D Finite Element Model of Containment Internal Structures	3.7-147
3.7.2-3	Coupled Shield & Auxiliary Building Finite Element Model (Sheets 1 - 2)	3.7-148
3.7.2-4	Coupled Shield & Auxiliary Building Lumped Mass Stick Model (Sheets 1 - 2)	3.7-150
3.7.2-5	Steel Containment Vessel Lumped Mass Stick Model	3.7-152
3.7.2-6	Containment Internal Structure Mass Stick Model (Sheets 1 - 2)	3.7-153
3.7.2-7	Reactor Coolant Loop Lumped Mass Stick Model	3.7-155

LIST OF FIGURES (Cont.)

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
3.7.2-8	Foundation of the Seismic Analysis Model for the Nuclear Island	3.7-156
3.7.2-9	Coupled Shield & Auxiliary Buildings Modeshape Plots (Sheets 1 - 16)	3.7-157
3.7.2-10	Steel Containment Vessel Modeshape Plots (Sheets 1 - 4)	3.7-173
3.7.2-11	Containment Internal Structures Without RCL Modeshape Plots (Sheets 1 - 12)	3.7-177
3.7.2-12	Nuclear Island Key Structural Dimensions Plan (Sheets 1 - 12)	3.7-189
3.7.2-13	3D Seismic Analysis Model Plan (Sheets 1 - 3)	3.7-213
3.7.2-14	Typical Design Floor Response Spectrum	3.7-216
3.7.2-15	Coupled Shield & Auxiliary Buildings SSE Floor Response Spectra (Sheets 1 - 12)	3.7-217
3.7.2-16	Steel Containment Vessel SSE Floor Response Spectra (Sheets 1 - 6)	3.7-229
3.7.2-17	Containment Internal Structures SSE Floor Response Spectra (Sheets 1 - 9) .	3.7-235
3.7.2-18	Containment Between Lumped Mass Stick Model (Sheets 1 - 2)	3.7-244
3.7.2-19	Annex Building Key Structural Dimensions (Sheets 1 - 10)	3.7-247
3.7.2-20	Coupled Shield and Auxiliary Building SSE Floor Response Spectra (Sheets 1 - 3)	3.7-267
3.7.3-1	Impact Evaluation Zone	3.7-270
3.7.3-2	Impact Evaluation Zone and Seismic Supported Piping	3.7-271
3.8.2-1	Containment Vessel General Outline (Sheets 1 - 3)	3.8-108
3.8.2-2	Equipment Hatches	3.8-113
3.8.2-3	Personnel Airlock	3.8-115
3.8.2-4	Containment Penetrations (Sheets 1 - 6)	3.8-117
3.8.2-5	Containment Vessel Response to Internal Pressure of 45 psig Deflections (Sheets 1 - 4)	3.8-125
3.8.2-6	Containment Vessel Axisymmetric Model	3.8-129
3.8.2-7	Finite Element Model for Local Buckling Analyses	3.8-130
3.8.2-8	Location of Containment Seal (Sheet 1)	3.8-131
3.8.2-8	Seal Sections and Details (Sheet 2)	3.8-132
3.8.3-1	Structural Modules in Containment Internal Structures (Sheets 1-3)	3.8-133
3.8.3-2	Typical Structural Wall Module	3.8-136
3.8.3-3	Typical Structural Floor Module	3.8-137
3.8.3-4	Reactor Vessel Supports	3.8-139
3.8.3-5	Steam Generator Supports (Sheets 1 - 3)	3.8-141
3.8.3-6	Pressurizer Support Columns (Sheet 1)	3.8-147
3.8.3-6	Pressurizer Lower Lateral Supports (Sheet 2)	3.8-148
3.8.3-6	Pressurizer Lower Supports (Sheet 3)	3.8-149
3.8.3-6	Pressurizer Upper Supports (Sheet 4)	3.8-150
3.8.3-7	Containment Internal Structures (Sheets 1 - 9)	3.8-151
3.8.3-8	Structural Modules - Typical Design Details (Sheets 1 - 3)	3.8-169

LIST OF FIGURES (Cont.)

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
3.8.3-9	Test Tank Finite Element Model	3.8-175
3.8.3-10	IRWST Fluid Structure Finite Element Model CIS Structural Model (IRWST Sheets 1 - 2)	3.8-176
3.8.3-11	IRWST Fluid Structure Finite Element Model Fluid Model	3.8-178
3.8.3-12	IRWST Fluid Structure Finite Element Model Sparger Region Detail	3.8-179
3.8.3-13	Effective Sections For Floor Modules	3.8-180
3.8.3-14	Typical M-1 Module	3.8-181
3.8.3-15	Typical M-1 Module (Sheets 1 - 2)	3.8-183
3.8.3-16	Typical Liner Modules	3.8-187
3.8.3-17	Structural Modules - Typical Design Details (Sheets 1 - 2)	3.8-189
3.8.3-18	Location of Structural Wall Modules	3.8-193
3.8.4-1	Containment Air Baffle General Arrangement (Sheets 1 - 4)	3.8-195
3.8.4-2	Deleted	3.8-199
3.8.4-3	Deleted	3.8-200
3.8.4-4	Deleted	3.8-201
3.8.4-5	Structural Modules in Auxiliary Building (Sheets 1 - 5)	3.8-202
3.8.4-6	Deleted	3.8-207
3.8.4-7	Passive Containment Cooling Tank	3.8-210
3.8.4-8	Deleted	3.8-211
3.8.4-9	Finite Element Model of Shield Building Roof	3.8-213
3.8.5-1	Foundation Plan	3.8-215
3.8.5-2	Nuclear Island Finite Element Model (Sheets 1 -2)	3.8-217
3.8.5-3	Basemat Reinforcement (Sheets 1 - 5)	3.8-219
3.9-1	Reactor Vessel Submodel	3.9-176
3.9-2	Reactor Vessel Lower Internals Submodel	3.9-177
3.9-3	Reactor Vessel Upper Internals and Fuel Submodel	3.9-178
3.9-4	Control Rod Drive Mechanism	3.9-179
3.9-5	Lower Reactor Internals	3.9-180
3.9-6	Upper Core Support Structure	3.9-181
3.9-7	Integrated Head Package	3.9-182
3.9-8	Reactor Internals Interface Arrangement	3.9-183
3B-1	Typical Bounding Analysis Curve (BAC)	3B-22
3B-2	Bounding Analysis Curve for Primary Loop Hot Leg	3B-23
3B-3	Bounding Analysis Curve for Primary Loop Cold Leg	3B-24
3B-4	Bounding Analysis Curve for Primary Loop Hot Leg	3B-25
3B-5	Bounding Analysis Curve for Primary Loop Cold Leg	3B-26
3B-6	Bounding Analysis Curve for Primary Loop Cold Leg	3B-27
3B-7	Bounding Analysis Curve for Primary Loop Cold Leg	3B-28
3B-8	Bounding Analysis Curve for Main Steam Line	3B-29
3B-9	Bounding Analysis Curve for Main Steam Line	3B-30
3B-10	Deleted	3B-31

LIST OF FIGURES (Cont.)

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
3B-11	Bounding Analysis Curve for 18" Surge Line	3B-32
3B-12	Bounding Analysis Curve for 18" Surge Line	3B-33
3B-13	Bounding Analysis Curve for 6" Safety	3B-34
3B-14	Bounding Analysis Curve for 14" ADS Stage 2, 3	3B-35
3B-15	Bounding Analysis Curve for 8" ADS Stage 2, 3	3B-36
3B-16	Bounding Analysis Curve for 12" Normal RHR/PRHR Supply/ADS 4	3B-37
3B-17	Bounding Analysis Curve for 10" Normal RHR/PRHR Supply/ADS 4	3B-38
3B-18	Bounding Analysis Curve for 20" Normal RHR	3B-39
3B-19	Bounding Analysis Curve for 10" PRHR Return	3B-40
3B-20	Bounding Analysis Curve for 10" PRHR Return	3B-41
3B-21	Bounding Analysis Curve for 10" PRHR Return	3B-42
3B-22	Bounding Analysis Curve for 10" PRHR Return	3B-43
3B-23	Bounding Analysis Curve for 10" PRHR/ADS 4	3B-44
3B-24	Bounding Analysis Curve for 10" PRHR/ADS 4	3B-45
3B-25	Bounding Analysis Curve for 8" DVI A&B	3B-46
3B-26	Bounding Analysis Curve for 8" DVI A&B	3B-47
3B-27	Bounding Analysis Curve for 8" DVI A&B/CMT A&B	3B-48
3B-28	Bounding Analysis Curve for 8" DVI A&B	3B-49
3B-29	Bounding Analysis Curve for 6" DVI A&B	3B-50
3B-30	Bounding Analysis Curve for 6" DVI A&B	3B-51
3B-31	Bounding Analysis Curve for 6" DVI A&B	3B-52
3B-32	Bounding Analysis Curve for 6" DVI A&B	3B-53
3B-33	Bounding Analysis Curve for 8" DVI A&B	3B-54
3B-34	Bounding Analysis Curve for 8" DVI A&B	3B-55
3B-35	Bounding Analysis Curve for 8" CMT A&B	3B-56
3D.5-1	Typical Abnormal Environmental Test Profile (Sheets 1 - 4)	3D-52
3D.5-2	Gamma Dose and Dose Rate Inside Containment After a LOCA	3D-56
3D.5-3	Beta Dose and Dose Rate Inside Containment After a LOCA	3D-57
3D.5-4	Gamma Dose and Dose Rate Inside Containment After a Steam Line Break ..	3D-58
3D.5-5	Beta Dose and Dose Rate Inside Containment After a Steam Line Break	3D-59
3D.5-6	Containment Temperature/Pressure Design Conditions: LOCA (Sheets 1 - 2) ..	3D-60
3D.5-7	Containment Temperature Design Conditions: Steam Line and Feedwater Line Break (Sheets 1 - 2)	3D-62
3D.5-8	Typical Combined LOCA/SLB/PLB Inside Containment Test Envelope (Sheets 1 - 2)	3D-64
3D.5-9	Outside Containment Temperature Test Envelope (Sheet 1)	3D-66
3D.5-9	Outside Containment Temperature Test Envelope - First Five Minutes (Sheet 2)	3D-67
3D.C-1	Histogram of Threshold Gamma Dose for Mechanical Damage to Elastomers, Plastics, and Encapsulation Compounds	3D-102

LIST OF FIGURES (Cont.)

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
3D.D-1	Frequency Distribution of Activation Energies of Various Components/Materials (EPRI Data)	3D-112
3D.D-2	Frequency Distribution of Activation Energies of Various Components/Materials (Westinghouse Data)	3D-113
3D.D-3	Post-Accident Temperature Profile	3D-114
3E-1	High Energy Piping - Steam Generator System (Sheets 1 - 2)	3E-3
3E-2	High Energy Piping - Normal Residual Heat Removal System	3E-7
3E-3	High Energy Piping - Reactor Coolant System (Sheets 1 - 2)	3E-9
3E-4	High Energy Piping - Passive Core Cooling System (Sheets 1 - 2)	3E-13
3E-5	High Energy Piping - Chemical and Volume Control System (Sheets 1 - 2) . . .	3E-17
3H.2-1	General Layout of Auxiliary Building	3H-41
3H.5-1	Nuclear Island Critical Sections Plan (Sheets 1 - 3)	3H-42
3H.5-2	Wall on Column Line 1	3H-45
3H.5-3	Typical Reinforcement and Column Line 1	3H-46
3H.5-4	Typical Reinforcement in Wall 7.3	3H-47
3H.5-5	Concrete Reinforcement in Wall 11 (Sheets 1 - 3)	3H-48
3H.5-6	Auxiliary Building Typical Composite Floor	3H-51
3H.5-7	Auxiliary Building Roof: Typical Reinforcement and Connection to Shield Building	3H-53
3H.5-8	Auxiliary Building Tagging Room Ceiling	3H-55
3H.5-9	Auxiliary Building Finned Floor (Sheets 1 - 3)	3H-57
3H.5-10	Spent Fuel Pool Wall Divider Wall Element Locations	3H-60
3H.5-11	Shield Building Roof: (Sheets 1 - 8)	3H-61
3H.5-12	Typical Reinforcement in Wall L	3H-69