CHAPTER 3 - DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT, AND SYSTEMS

TABLE OF CONTENTS

3.1 CONFORMANCE WITH NRC GENERAL DESIGN CRITERIA

3.2 CLASSIFICATION OF STRUCTURES, COMPONENTS, AND SYSTEMS

3.2.1 Seismic Classification
3.2.2 System Quality Group Classifications
3.2.3 Quality Assurance

3.3 WIND AND TORNADO LOADINGS

3.3.1 Wind Loadings
3.3.1.1 Design Wind Velocity
3.3.1.2 Determination of Applied Forces
3.3.2 Tornado Loadings
3.3.2.1 Applicable Design Parameters
3.3.2.2 Determination of Forces on Structures
3.3.2.3 Effect of Failure of Structures or Components Not Designed for Tornado Loadings
3.3.3 References

3.4 WATER LEVEL (FLOOD) DESIGN

3.4.1 Flood Protection
3.4.1.1 Flood Protection Measures for Seismic Category I Structures
3.4.1.2 Permanent Dewatering System

3.4.2 Analytical and Test Procedures

3.5 MISSILE PROTECTION

3.5.1 Missile Selection and Description
3.5.1.1 Internally Generated Missiles (Outside Primary Containment)
3.5.1.1.1 Rotating Component Failure Missiles
3.5.1.1.2 Pressurized Component Failure Missiles
3.5.1.1.3 Gravitationally Generated Missiles
3.5.1.2 Internally Generated Missiles (Inside Containment)
3.5.1.2.1 Rotating Component Failure Missiles
3.5.1.2.2 Pressurized Component Failure Missiles
3.5.1.2.3 Gravitationally Generated Missiles
3.5.1.3 Turbine Missiles
3.5.1.4 Missiles Generated by Natural Phenomena
3.5.1.5 Missiles Generated by Events Near the Site
3.5.1.6 Aircraft Hazards
3.5.1.6.1 Design of Safety-Related Structures

TABLE OF CONTENTS (Cont'd)

3.5.1.6.2 Analysis Method
3.5.1.6.3 Crash Probabilities
3.5.1.6.4 Probability of Aircraft Strike Resulting in Unacceptable Consequences
3.5.2 Systems to be Protected
3.5.3 Barrier Design Procedures
3.5.4 References

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

3.6.1 Postulated Piping Failures in Fluid Systems
3.6.1.1 Design Bases
3.6.1.2 Description
3.6.1.2.1 High Energy Fluid Systems
3.6.1.2.2 Moderate Energy Fluid Systems
3.6.1.3 Safety Evaluation
3.6.2 Determination of Pipe Failure Locations and Dynamic Effects Associated with Postulated Piping Failures
3.6.2.1 Criteria Used to Determine Pipe Break and Crack Locations and Their Configurations
3.6.2.1.1 Break Locations in High Energy Fluid System Piping
3.6.2.1.2 Crack Locations in Moderate Energy Fluid System Piping
3.6.2.1.3 Types of Breaks and Cracks in Fluid System Piping
3.6.2.2 Analytical Models to Define Forcing Functions and Response Models (Recirculation System Only)
3.6.2.2.1 Analytical Methods to Define Blowdown Forcing Functions
3.6.2.2.2 Pipe Whip Dynamic Response Analyses
3.6.2.3 Analytical Models to Define Forcing Functions and Response Models (Systems Other Than Recirculation System)
3.6.2.4 Dynamic Analysis Methods to Verify Integrity and Operability (Recirculation System Only)
3.6.2.5 Dynamic Analysis Method to Verify Integrity and Operability (Systems Other Than Recirculation System)
3.6.2.5.1 Design Loading Combinations
3.6.2.5.2 Design Stress Limits
3.6.2.6 Guard Pipe Assembly Design Criteria
3.6.3 Definitions
3.6.4 References

3.7 SEISMIC DESIGN

3.7.1 Seismic Input
3.7.1.1 Design Response Spectra
3.7.1.2 Design Time History
3.7.1.3 Critical Damping Values
3.7.1.3.1 Critical Damping Values (NSSS)
3.7.1.3.2 Critical Damping Values (Non-NSSS)
3.7.1.3.3 Alternative Critical Damping Values and Spectral Peak Broadening for Piping (NSSS and Non-NSSS)
3.7.1.4 Supporting Media for Seismic Category I Structures

TABLE OF CONTENTS (Cont'd)

3.7.2 Seismic System Analysis
3.7.2.1 Seismic Analysis Method
3.7.2.1.1 Seismic Analysis Methods (NSSS)
3.7.2.1.2 Seismic Analysis Methods (Non-NSSS)
3.7.2.2 Natural Frequencies and Response Loads
3.7.2.3 Procedures Used for Modeling
3.7.2.3.1 Procedures Used for Modeling (NSSS)
3.7.2.3.2 Procedures Used for Modeling (Non-NSSS)
3.7.2.4 Soil-Structure Interaction
3.7.2.5 Development of Floor Response Spectra
3.7.2.5.1 Floor Response Spectra (NSSS)
3.7.2.5.2 Floor Response Spectra (Non-NSSS)
3.7.2.6 Three Components of Earthquake Motion
3.7.2.6.1 NSSS
3.7.2.6.2 Non-NSSS
3.7.2.7 Combination of Modal Responses
3.7.2.7.1 Combination of Modal Responses (NSSS)
3.7.2.7.2 Combination of Modal Responses (Non-NSSS)
3.7.2.8 Interaction of Non-Category I Structures with Seismic Category I Structures
3.7.2.9 Effects of Parameter Variations on Floor Response Spectra
3.7.2.9.1 Effects of Parameter Variations on Floor Response Spectra (NSSS)
3.7.2.9.2 Effects of Parameter Variations on Floor Response Spectra (Non-NSSS)
3.7.2.10 Use of Constant Vertical Static Factors
3.7.2.11 Methods Used to Account for Torsional Effects
3.7.2.12 Comparison of Responses
3.7.2.13 Methods for Seismic Analysis of Dams
3.7.2.14 Determination of Seismic Category I Structure Overturning Moments
3.7.2.15 Analysis Procedure for Damping
3.7.2.15.1 Analysis Procedure for Damping (NSSS)
3.7.2.15.2 Analysis Procedure for Damping (Non-NSSS)
3.7.3 Seismic Subsystem Analysis
3.7.3.1 Seismic Analysis Methods
3.7.3.1.1 Equipment
3.7.3.1.2 Piping Systems
3.7.3.1.3 Class 1E Cable Trays
3.7.3.1.4 Supports for Seismic Category I HVAC Ducts
3.7.3.1.5 Supports for Seismic Category I Electrical Raceway Systems
3.7.3.2 Determination of Number of Earthquake Cycles
3.7.3.2.1 Determination of Number of Earthquake Cycles (NSSS)
3.7.3.2.2 Determination of Number of Earthquake Cycles (Non-NSSS)
3.7.3.3 Procedures Used for Modeling
3.7.3.3.1 Procedures Used for Modeling (NSSS)
3.7.3.3.2 Procedures Used for Modeling (Non-NSSS)
3.7.3.4 Basis of Selection of Frequencies
3.7.3.4.1 Basis of Selection of Frequencies (NSSS)
3.7.3.4.2 Basis of Selection of Frequencies (Non-NSSS)
3.7.3.5 Use of Equivalent Static Load Method of Analysis (Non-NSSS)
3.7.3.6 Three Components of Earthquake Motion
3.7.3.6.1 Three Components of Earthquake Motion (NSSS)
3.7.3.6.2 Three Components of Earthquake Motion (Non-NSSS)

TABLE OF CONTENTS (Cont'd)

3.7.3.7 Combination of Modal Responses
3.7.3.7.1 Combination of Modal Responses (NSSS)
3.7.3.7.2 Combination of Modal Responses (Non-NSSS)
3.7.3.8 Analytical Procedure for Piping
3.7.3.8.1 Analytical Procedure for Piping (NSSS)
3.7.3.8.2 Analytical Procedure for Piping (Non-NSSS)
3.7.3.9 Multiple Supported Equipment Components with Distinct Inputs
3.7.3.9.1 Multiple Supported Equipment Components with Distinct Inputs (NSSS)
3.7.3.9.2 Multiple Supported Equipment Components with Distinct Inputs (Non-NSSS)
3.7.3.10 Use of Constant Vertical Static Factors
3.7.3.10.1 Use of Constant Vertical Static Factors (NSSS)
3.7.3.10.2 Use of Constant Vertical Static Factors (Non-NSSS)
3.7.3.11 Torsional Effects of Eccentric Masses
3.7.3.11.1 Torsional Effects of Eccentric Masses (NSSS)
3.7.3.11.2 Torsional Effects of Eccentric Masses (Non-NSSS)
3.7.3.12 Buried Seismic Category I Piping Systems and Tunnels (Non-NSSS)
3.7.3.13 Interaction of Other Piping with Seismic Category I Piping
3.7.3.13.1 Interaction of Other Piping with Seismic Category I Piping (NSSS)
3.7.3.13.2 Interaction of Other Piping with Seismic Category I Piping (Non-NSSS)
3.7.3.14 Seismic Analysis for Reactor Internals (NSSS)
3.7.3.15 Analysis Procedures for Damping
3.7.3.15.1 Analysis Procedures for Damping (NSSS)
3.7.3.15.2 Analysis Procedure for Damping (Non-NSSS)
3.7.4 Seismic Instrumentation
3.7.4.1 Comparison with Regulatory Guide 1.12 (Rev 1)
3.7.4.2 Location and Description of Instrumentation
3.7.4.2.1 Triaxial Time History Accelerographs
3.7.4.2.2 Triaxial Peak Recording Accelerographs
3.7.4.2.3 Triaxial Seismic Switch
3.7.4.2.4 Response Spectrum Analyzer
3.7.4.2.5 System Control Panel
3.7.4.3 Control Room Operator Notification
3.7.4.4 Comparison of Measured and Predicted Responses
3.7.5 References

TABLE OF CONTENTS (Cont'd)

3.8 DESIGN OF CATEGORY I STRUCTURES

3.8.1 Concrete Containment
3.8.1.1 Description of the Containment
3.8.1.1.1 Base Foundation Slab
3.8.1.1.2 Containment Wall
3.8.1.2 Applicable Codes, Standards, and Specifications
3.8.1.3 Loads and Loading Combinations
3.8.1.3.1 Dead Load
3.8.1.3.2 Live Load
3.8.1.3.3 Design Basis Accident Pressure Load
3.8.1.3.4 Thermal Loads
3.8.1.3.5 Wind and Tornado Loads
3.8.1.3.6 Seismic Loads
3.8.1.3.7 External Pressure Load
3.8.1.3.8 Pipe Rupture Loads
3.8.1.3.9 Prestress Loads
3.8.1.4 Design and Analysis Procedures
3.8.1.4.1 Containment Wall
3.8.1.4.2 Base Foundation Slab
3.8.1.4.3 Analysis of Area Around Equipment Hatches
3.8.1.4.4 Liner Plate and Anchorages
3.8.1.5 Structural Acceptance Criteria
3.8.1.5.1 Reinforced Concrete
3.8.1.5.2 Liner Plate and Anchorages
3.8.1.6 Materials, Quality Control, and Special Construction Techniques
3.8.1.6.1 Concrete Containment
3.8.1.6.2 Liner Plate, Anchorages, and Attachments
3.8.1.7 Testing and Inservice Surveillance Requirements
3.8.1.7.1 Preoperational Testing
3.8.1.7.2 Inservice Leak Rate Testing
3.8.2 ASME Class MC Steel Components of the Containment
3.8.2.1 Description of the ASME Class MC Components
3.8.2.1.1 Drywell Head Assembly
3.8.2.1.2 Equipment Hatches and Personnel Lock
3.8.2.1.3 Suppression Chamber Access Hatches
3.8.2.1.4 Control Rod Drive Removal Hatch
3.8.2.1.5 Piping and Electrical Penetrations
3.8.2.2 Applicable Codes, Standards, and Specifications
3.8.2.3 Loads and Loading Combinations
3.8.2.3.1 Dead and Live Load
3.8.2.3.2 Design Basis Accident Pressure Load
3.8.2.3.3 External Pressure Load
3.8.2.3.4 Thermal Loads
3.8.2.3.5 Seismic Loads
3.8.2.3.6 Pipe Rupture Loads
3.8.2.3.7 Missile Impact Loads
3.8.2.4 Design and Analysis Procedures

TABLE OF CONTENTS (Cont'd)

3.8.2.4.1 Drywell Head Assembly
3.8.2.4.2 Access Hatches
3.8.2.4.3 Piping and Electrical Penetrations
3.8.2.5 Structural Acceptance Criteria
3.8.2.6 Materials, Quality Control, and Special Construction Techniques
3.8.2.6.1 Materials
3.8.2.6.2 Welding
3.8.2.6.3 Nondestructive Examination of Welds
3.8.2.6.4 Quality Control
3.8.2.6.5 Erection Tolerances
3.8.2.7 Testing and Inservice Inspection Requirements
3.8.2.7.1 Preoperational Testing
3.8.2.7.2 Inservice Leak Rate Testing
3.8.3 Containment Internal Structures
3.8.3.1 Description of the Internal Structures
3.8.3.1.1 Diaphragm Slab
3.8.3.1.2 Reactor Pedestal
3.8.3.1.3 Reactor Shield Wall
3.8.3.1.4 Suppression Chamber Columns
3.8.3.1.5 Drywell Platforms
3.8.3.1.6 Seismic Truss and Reactor Vessel Stabilizer
3.8.3.2 Applicable Codes, Standards, and Specifications
3.8.3.3 Loads and Loading Combinations
3.8.3.3.1 Diaphragm Slab and Reactor Pedestal
3.8.3.3.2 Reactor Shield Wall
3.8.3.3.3 Suppression Chamber Columns
3.8.3.3.4 Pipe Whip Restraints/Drywell Platforms
3.8.3.3.5 Seismic Truss
3.8.3.4 Design and Analysis Procedures
3.8.3.4.1 Diaphragm Slab
3.8.3.4.2 Diaphragm Slab Liner Plate and Anchorages
3.8.3.4.3 Reactor Pedestal
3.8.3.4.4 Reactor Shield Wall
3.8.3.4.5 Suppression Chamber Columns
3.8.3.4.6 Drywell Platforms
3.8.3.4.7 Seismic Truss
3.8.3.5 Structural Acceptance Criteria
3.8.3.5.1 Reinforced Concrete
3.8.3.5.2 Diaphragm Slab Liner Plate and Anchorages
3.8.3.5.3 Structural Steel
3.8.3.6 Materials, Quality Control, and Special Construction Techniques
3.8.3.6.1 Concrete Containment Internal Structures
3.8.3.6.2 Diaphragm Slab Liner Plate, Anchorages, and Attachments
3.8.3.6.3 Reactor Shield Wall and Seismic Truss
3.8.3.6.4 Suppression Chamber Columns
3.8.3.6.5 Drywell Platforms
3.8.3.6.6 Quality Control
3.8.3.7 Testing and Inservice Inspection Requirements
3.8.3.7.1 Preoperational Testing
3.8.3.7.2 Inservice Leak Rate Testing

TABLE OF CONTENTS (Cont'd)

3.8.4 Other Seismic Category I Structures
3.8.4.1 Description of Structures
3.8.4.1.1 Secondary Containment
3.8.4.1.2 Control Structure
3.8.4.1.3 Diesel Generator Enclosure
3.8.4.1.4 Spray Pond Pump Structure
3.8.4.1.5 Spray Pond
3.8.4.1.6 Miscellaneous Structures
3.8.4.1.7 Radwaste Enclosure
3.8.4.1.8 Turbine Enclosure
3.8.4.2 Applicable Codes, Standards, and Specifications
3.8.4.3 Loads and Load Combinations
3.8.4.3.1 Description of Loads
3.8.4.3.2 Load Combinations
3.8.4.4 Design and Analysis Procedures
3.8.4.5 Structural Acceptance Criteria
3.8.4.5.1 Reinforced and Prestressed Concrete
3.8.4.5.2 Structural Steel
3.8.4.5.3 Concrete Masonry Block Walls
3.8.4.6 Materials, Quality Control, and Special Construction Techniques
3.8.4.6.1 Reinforced Concrete, Masonry, and Prestressed Concrete
3.8.4.6.2 Structural Steel
3.8.4.6.3 Quality Control
3.8.4.6.4 Special Construction Techniques
3.8.4.7 Testing and Inservice Inspection Requirements
3.8.5 Foundations
3.8.5.1 Description of the Foundations
3.8.5.1.1 Reactor Enclosure and Control Structure
3.8.5.1.2 Diesel Generator Enclosure
3.8.5.1.3 Spray Pond Pump Structure
3.8.5.1.4 Radwaste Enclosure
3.8.5.1.5 Turbine Enclosure
3.8.5.1.6 Miscellaneous Structures
3.8.5.2 Applicable Codes, Standards, and Specifications
3.8.5.3 Loads and Load Combinations
3.8.5.4 Design and Analysis Procedures
3.8.5.5 Structural Acceptance Criteria
3.8.5.6 Materials, Quality Control, and Special Construction Techniques
3.8.5.7 Testing and Inservice Inspection Requirements
3.8.6 Concrete, Reinforcing, Prestressed Concrete, and Masonry Materials
3.8.6.1 Concrete and Concrete Materials
3.8.6.1.1 Concrete Material Qualifications
3.8.6.1.2 Concrete Mix Design
3.8.6.1.3 Grout
3.8.6.1.4 Batching, Placing, Curing, and Protection
3.8.6.1.5 Construction Testing of Concrete and Concrete Materials
3.8.6.2 Concrete Reinforcement Materials

TABLE OF CONTENTS (Cont'd)

3.8.6.2.1 Qualification
3.8.6.2.2 Fabrication
3.8.6.2.3 Construction Testing of Concrete Reinforcement Materials
3.8.6.2.4 Formwork and Construction Joints
3.8.6.3 Prestressed Concrete
3.8.6.3.1 Post-Tensioning System for Prestressed Concrete
3.8.6.3.2 Concrete for Prestressed Members
3.8.6.3.3 Prestressed Steel
3.8.6.3.4 Sheathing
3.8.6.3.5 Anchorage Assembly
3.8.6.3.6 Grout
3.8.6.3.7 Post-Tensioning System Performance Tests
3.8.6.4 Concrete Unit Masonry and Masonry Material
3.8.6.4.1 Material Qualification
3.8.6.4.2 Construction Testing
3.8.7 Computer Programs for Structural Analysis
3.8.7.1 3D/SAP (Finite-Element Analysis of Three-Dimensional Elastic Solids)
3.8.7.1.1 Application
3.8.7.1.2 Program Background
3.8.7.2 ASHSD (Axisymmetric Shell and Solid)
3.8.7.2.1 Application
3.8.7.2.2 Program Background
3.8.7.2.3 Sample Problems
3.8.7.3 CECAP (Concrete Element Cracking Analysis Program)
3.8.7.3.1 Application
3.8.7.3.2 Program Background
3.8.7.3.3 Sample Problems
3.8.7.4 CE668 (Plate Bending Analysis)
3.8.7.4.1 Application
3.8.7.4.2 Sample Problems
3.8.7.5 EASE (Elastic Analysis for Structural Engineering)
3.8.7.5.1 Application
3.8.7.5.2 Program Background
3.8.7.6 E0119
3.8.7.6.1 Application
3.8.7.6.2 Program Background
3.8.7.6.3 Sample Problems
3.8.7.7 E0781 (Shells of Revolution Program)
3.8.7.7.1 Application
3.8.7.7.2 Program Background
3.8.7.7.3 Sample Problems
3.8.7.8 FINEL (Finite-Element Program for Cracking Analysis)
3.8.7.8.1 Application
3.8.7.8.2 Program Background
3.8.7.8.3 Sample Problems
3.8.7.9 ME620 (Transient Temperature Analysis of Plane and Axisymmetric Solids)
3.8.7.9.1 Application
3.8.7.9.2 Program Background

TABLE OF CONTENTS (Cont'd)

3.8.7.9.3 Sample Problems
3.8.7.10 ANSYS
3.8.7.10.1 Application
3.8.7.10.2 Program Background
3.8.8 References

3.9 MECHANICAL SYSTEMS AND COMPONENTS

3.9.1 Special Topics for Mechanical Components
3.9.1.1 Design Transients
3.9.1.1.1 Control Rod Drive Transients
3.9.1.1.2 CRD Housing and Incore Housing Transients
3.9.1.1.3 Hydraulic Control Unit Transients
3.9.1.1.4 Core Support and Reactor Internals Transients
3.9.1.1.5 Main Steam System Transients
3.9.1.1.6 Recirculation System Transients
3.9.1.1.7 Reactor Assembly Transients
3.9.1.1.8 Main Steam Isolation Valve Transients
3.9.1.1.9 Main Steam Relief Valve Transients
3.9.1.1.10 Recirculation Flow Control Valve Transients
3.9.1.1.11 Recirculation Pump Transients
3.9.1.1.12 Recirculation Gate Valve Transients
3.9.1.2 Computer Programs Used in Analysis
3.9.1.2.1 Reactor Vessel and Internals
3.9.1.2.2 Piping
3.9.1.2.3 Pumps and Motors
3.9.1.2.4 Dynamic Loads Analysis
3.9.1.2.5 Residual Heat Removal Heat Exchangers
3.9.1.2.6 Seismic Category I Items Other than NSSS
3.9.1.2.7 Computer Programs Used for Component Supports
3.9.1.3 Experimental Stress Analysis
3.9.1.3.1 Experimental Stress Analysis of NSSS Seismic Category I Items
3.9.1.3.2 Seismic Category I Items Other than NSSS
3.9.1.4 Considerations for the Evaluation of Faulted Conditions
3.9.1.4.1 Control Rod Drive System Components
3.9.1.4.2 Standard Reactor Internal Components
3.9.1.4.3 Reactor Pressure Vessel Assembly
3.9.1.4.4 Core Support Structure
3.9.1.4.5 Main Steam Isolation, Recirculation Gate, and MSRVs
3.9.1.4.6 Main Steam and Recirculation Piping
3.9.1.4.7 NSSS Pumps, Heat Exchangers, and Turbines
3.9.1.4.8 Control Rod Drive Housing Supports
3.9.1.4.9 Fuel Storage Racks
3.9.1.4.10 Fuel Assembly (Including Channel)
3.9.1.4.11 Refueling Equipment
3.9.1.4.12 Seismic Category I Items Other than NSSS
3.9.2 Dynamic Testing and Analysis

TABLE OF CONTENTS (Cont'd)

3.9.2.1a	Piping Vibration, Thermal Expansion, and Dynamic Effects Testing for NSSS Piping
3.9.2.1a.1	Piping Vibration
3.9.2.1a.2	Thermal Expansion Testing of Main Steam and Recirculation Piping
3.9.2.1a.3	Dynamic Effects Testing of Main Steam and Recirculation Piping
3.9.2.1a.4	Test Evaluation and Acceptance Criteria for Main Steam and Recirculation Piping
3.9.2.1a.5	Corrective Actions for Main Steam and Recirculation Piping
3.9.2.1a.6	Measurement Locations for Main Steam and Recirculation Piping
3.9.2.1b	Piping Vibration, Thermal Expansion, and Dynamic Effects Testing for Non-NSSS Piping
3.9.2.1b.1	Piping Dynamic Transient Tests
3.9.2.1b.2	Piping Steady-State Vibration Testing
3.9.2.2	Dynamic Qualification of Safety-Related Mechanical Equipment
3.9.2.2a	Dynamic Qualification of NSSS Safety-Related Mechanical Equipment
3.9.2.2a.1	Tests and Analysis Criteria Methods
3.9.2.2a.2	Dynamic Qualification of Specific NSSS Mechanical Components
3.9.2.2b	Dynamic Qualification of Non-NSSS Safety-Related Mechanical Equipment
3.9.2.2b.1	Dynamic Qualification
3.9.2.2b.2	Criteria
3.9.2.3	Dynamic Response of Reactor Internals Under Operational Flow Transients and Steady-State Conditions
3.9.2.4	Confirmatory Flow-Induced Vibration Testing of Reactor Internals
3.9.2.5	Dynamic System Analysis of the Reactor Internals Under Faulted Conditions
3.9.2.6	Correlations of Reactor Internals Vibration Tests with the Analytical Results
3.9.3	ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures
3.9.3.1	Loading Combinations, Design Transients, and Stress Limits
3.9.3.1.1	Plant Conditions
3.9.3.1.2	Reactor Pressure Vessel Assembly
3.9.3.1.3	Main Steam Piping
3.9.3.1.4	Recirculation Loop Piping
3.9.3.1.5	Recirculation System Valves
3.9.3.1.6	Recirculation Pump
3.9.3.1.7	SLCS Tank
3.9.3.1.8	RHR Heat Exchangers
3.9.3.1.9	RCIC Turbine
3.9.3.1.10	RCIC Pump
3.9.3.1.11	ECCS Pump
3.9.3.1.12	SLCS Pump
3.9.3.1.13	MSIVs and MSRVs
3.9.3.1.14	HPCI Turbine
3.9.3.1.15	HPCI Pump
3.9.3.1.16	RWCU System
3.9.3.1.17	Non-NSSS ASME Code Constructed Items
3.9.3.2a	NSSS Pump and Valve Operability Assurance
3.9.3.2a.1	ECCS Pumps
3.9.3.2a.2	SLCS Pump and Motor Assemblies and RCIC Pump Assembly

TABLE OF CONTENTS (Cont'd)

3.9.3.2a.3 RCIC Turbine
3.9.3.2a.4 ECCS Motors
3.9.3.2a.5 HPCI Pump
3.9.3.2a.6 NSSS Valves
3.9.3.2b Non-NSSS Pump and Valve Operability Assurance
3.9.3.2b.1 Pumps
3.9.3.2b.2 Valves
3.9.3.3 Design and Installation of Pressure Relief Devices
3.9.3.3.1 Main Steam Relief Valves (NSSS)
3.9.3.3.2 Design and Installation Details for Mounting of Pressure Relief Devices in ASME Class 1, 2, and 3 Systems (Non-NSSS)
3.9.3.4 Component Supports Furnished with the NSSS
3.9.3.4.1 Piping
3.9.3.4.2 NSSS Floor-Mounted Equipment (Pumps, Heat Exchangers, and RCIC and HPCI Turbines)
3.9.3.4.3 Supports for ASME Code 1, 2, and 3 Active Components
3.9.3.4.4 RPV Support Skirt
3.9.3.4.5 Bolting Stress Limits (NSSS)
3.9.3.5 Component Supports Not Furnished with the NSSS
3.9.3.5.1 Design Basis
3.9.3.5.2 Snubbers
3.9.3.5.3 Struts
3.9.3.5.4 Bolting Stress Limits (Non-NSSS)
3.9.4 Control Rod Drive System
3.9.4.1 Descriptive Information on CRD System
3.9.4.2 Applicable CRD System Design Specifications
3.9.4.3 Design Loads, Stress Limits, and Allowable Deformation
3.9.4.3.1 CRD Housing Supports
3.9.4.4 CRD Performance Assurance Program
3.9.5 Reactor Pressure Vessel Internals
3.9.5.1 Design Arrangements
3.9.5.1.1 Core Support Structures
3.9.5.2 Design Loading Conditions
3.9.5.2.1 Events to be Evaluated
3.9.5.2.2 Pressure Differential During Rapid Depressurization
3.9.5.2.3 Recirculation Line and Steam Line Break
3.9.5.2.4 Seismic and Hydrodynamic Loads
3.9.5.3 Design Bases
3.9.5.3.1 Safety Design Bases
3.9.5.3.2 Power Generation Design Bases
3.9.5.3.3 Design Loading Categories
3.9.5.3.4 Response of Internals Due to Inside Steam Break Accident
3.9.5.3.5 Stress, Deformation, and Fatigue Limits for ESF Reactor Internals (Except Core Support Structure)
3.9.5.3.6 Stress, Deformation, and Fatigue Limits for Core Support Structure
3.9.6 Inservice Testing of Pumps and Valves
3.9.6.1 Inservice Testing of Pumps
3.9.6.2 Inservice Testing of Valves

TABLE OF CONTENTS (Cont'd)

3.9.7 References

3.10 QUALIFICATION OF SEISMIC CATEGORY I INSTRUMENTATION AND ELECTRICAL EQUIPMENT

3.10.1 Seismic Qualification Criteria
3.10.1.1 Dynamic Loading Design Criteria (NSSS Equipment)
3.10.1.2 Dynamic Loading Design Criteria (Non-NSSS Equipment)
3.10.2 Methods and Procedures for Qualifying Electrical Equipment and Instrumentation
3.10.2.1 Methods and Procedures for Qualifying NSSS Electrical Equipment and Instruments (Excluding Motors and Valve-Mounted Equipment)
3.10.2.1.1 Methods of Showing NSSS Equipment Compliance with IEEE 344 (1971) and Regulatory Guide 1.100
3.10.2.1.2 Testing Procedures for Qualifying NSSS Electrical Equipment and Instruments (Excluding Motors and Valve-Mounted Equipment)
3.10.2.1.3 Qualification for Valve-Mounted Equipment
3.10.2.1.4 Qualification of NSSS Motors
3.10.2.2 Methods and Procedures for Qualifying Non-NSSS Instruments and Electrical Equipment
3.10.2.2.1 Dynamic Analysis
3.10.2.2.2 Dynamic Tests
3.10.3 Methods and Procedures of Analysis or Testing of Supports of Electrical Equipment and Instrumentation
3.10.3.1 Seismic Analysis Testing Procedures and Restraint Measures for NSSS Equipment Supports (Other Than Motors and Valve-Mounted Equipment)
3.10.3.2 Non-NSSS Equipment Supports
3.10.4 Operating License Review
3.10.4.1 NSSS Equipment
3.10.4.1.1 NSSS Control and Electrical Equipment (Other Than Motors and Valve-Mounted Equipment)
3.10.4.1.2 NSSS Motors
3.10.4.1.3 Valve-Mounted Equipment
3.10.4.2 Non-NSSS Equipment

3.11 ENVIRONMENTAL DESIGN OF ELECTRICAL EQUIPMENT

3.11.1 Environmental Design Criteria for Electrical Equipment
3.11.2 Equipment Requiring Environmental Qualification
3.11.3 Environmental Service Conditions
3.11.3.1 Environmental Conditions During Normal Plant Operation
3.11.3.2 Accident Environmental Conditions
3.11.4 Qualification Testing and Analysis of Equipment
3.11.5 Methodology for Evaluating Environmental Qualification to Service Conditions
3.11.6 Maintenance/Surveillance Program
3.11.7 Replacement Parts Program
3.11.8 Mild Environment Qualification

TABLE OF CONTENTS (Cont'd)

3.12 CONTROL OF HEAVY LOADS

3.12.1 Introduction/Licensing Background
3.12.2 Safety Basis
3.12.3 Scope of Heavy Load Handling Systems
3.12.4 Control of Heavy Loads Program
3.12.4.1 Commitments in Response to NUREG-0612, Phase I Elements
3.12.4.2 Reactor Pressure Vessel Head (RPVH) Lifting Procedures
3.12.4.3 Single Failure Proof Cranes for Spent Fuel Casks
3.12.5 Safety Evaluation

Appendix 3A Design Assessment Report (Nonproprietary)

Appendix 3B Design Assessment Report (Proprietary)

LIST OF TABLES

TABLE	TITLE
3.2-1	LGS Design Criteria Summary
3.2-2	Classification and Code Compliance Requirements for Non-NSSS Mechanical Components
3.2-3	Classification and Code Compliance Requirements for NSSS Mechanical Components
3.2-4	Off-Skid Portions of the Emergency Diesel Generator Auxiliary Systems
3.2-5	Chilled Water Piping System for the Control Structure Chilled Water System
3.2-6	Control Room HVAC Chillers
3.2-7	RHR HX "B" Corrosion Monitoring Components connected to RHRSW System Pressure Boundary
3.3-1	Design Wind Loads on Structures
3.3-2	Tornado Protected Systems and Tornado-Resistant Enclosures
3.3-3	Wind Speed and Cumulative Wind Speed Distribution for Tornadoes Within 125 nm of Pottstown, PA
3.3-4	Calculation of Margin Between Design and Maximum Expected Wind Loadings
3.4-1	Flood Levels at Safety-Related Structures
3.4-2	Yard Tanks and Major Piping (Nonseismic)
3.5-1	Aircraft Impact Design Parameters
3.5-2	Characteristics of Learjet
3.5-3	Accumulators Located in Safety-Related Areas
3.5-4	Tornado-Generated Missile Parameters
3.5-5	Railroad Accident Generated Missile Parameters
3.5-6	Potential HVAC Fan Missiles
3.5-7	Missile Barriers and Protected Components for Externally Generated Missiles
3.5-8	Characteristics of Externally Generated Missile Barriers
3.5-9	Turbine System Reliability Criteria
3.6-1	High Energy Fluid System Piping

LIST OF TABLES (cont'd)

TABLE	TITLE
3.6-2	Recirculation Piping System Stress Levels and Pipe Break Data
3.6-3	Reactor Recirculation Piping System Fluid Blowdown Thrust Time Histories
3.6-4	Main Steam Piping Stress Levels and Pipe Break Data
3.6-5	Intentionally Left Blank
3.6-6	Blowdown Data For High Energy Pipe Breaks Outside Primary Containment
3.6-7	Pressure-Temperature Transient Analysis Results for High Energy Pipe Breaks Outside Primary Containment
3.6-8	Feedwater Piping Stress Levels and Pipe Break Data (Portion Inside Primary Containment)
3.6-9	Compartment Design Pressures and Pressure-Temperature Transient Analysis Results
3.6-10	RWCU Piping Stress Levels and Pipe Break Data (Portion Inside Primary Containment)
3.6-11	Intentionally Left Blank
3.6-12	Reactor Vessel Drain Piping Stress Levels and Pipe Break Data
3.6-13	HPCI Steam Supply Piping Stress Levels and Pipe Break Data (Portion Inside Primary Containment)
3.6-14	HPCI Steam Supply Piping Stress Levels and Pipe Break Data (Portion Outside Primary Containment)
3.6-15	RCIC Steam Supply Piping Stress Levels and Pipe Break Data (Portion Inside Primary Containment)
3.6-16	RCIC Steam Supply Piping Stress Levels and Pipe Break Data (Portion Outside Primary Containment)
3.6-17	Main Steam Drainage Piping Stress Levels and Pipe Break Data (Portion Inside Primary Containment)
3.6-18	Intentionally Left Blank
3.6-19	RPV Head Vent Piping Stress Levels and Pipe Break Data
3.6-20	SLCS Injection Piping Stress Levels and Pipe Break Data

LIST OF TABLES (cont'd)

TABLE	TITLE
3.6-21	RHR Shutdown Cooling Piping Stress Levels and Pipe Break Data
3.6-22	LPCI Injection Piping Stress Levels and Pipe Break Data
3.6-23	Core Spray Injection Piping Stress Levels and Pipe Break Data
3.6-24	Restraint Data Used in Verification of Recirculation System Pipe Whip Restraint Design
3.6-25	Comparison of PDA and NSC Codes
3.7-1	Critical Damping Values for NSSS Materials
3.7-2	Critical Damping Values for Non-NSSS Materials
3.7-3	Load Combinations and Allowable Responses for Electrical Raceway System
3.7-4	Results of Fatigue Calculations for the Most Limiting BWR/4 Component
3.7-5	Natural Frequencies of Primary Containment Below 33 Hz
3.7-6	Natural Frequencies of the Reactor Enclosure and Control Structure Below 33 Hz
3.7-7	Primary Containment Seismic Inertia Forces, Displacements, and Accelerations (Horizontal Direction)
3.7-8	Primary Containment Seismic Displacements and Accelerations (Vertical Direction)
3.7-9	Primary Containment Shear Forces and Moments
3.7-10	Primary Containment Axial Forces
3.7-11	Reactor Enclosure and Control Structure E-W Inertia Forces, Displacements, and Accelerations
3.7-12	Reactor Enclosure and Control Structure N-S Inertia Forces, Displacements, and Accelerations
3.7-13	Reactor Enclosure and Control Structure Vertical Inertia Forces, Displacements, and Accelerations
3.7-14	Reactor Enclosure and Control Structure E-W Shear Forces and Moments
3.7-15	Reactor Enclosure and Control Structure N-S Shear Forces and Moments

LIST OF TABLES (cont'd)

TABLE	TITLE
3.7-16	Reactor Enclosure and Control Structure Axial Forces
3.7-17	Structure-Foundation Interaction Coefficients
3.7-18	Number of Dynamic Response Cycles Expected During a Seismic Event for NSSS Systems and Components
3.7-19	Fatigue Evaluation Due to Seismic Load
3.7-20	Reactor Enclosure and Control Structure - Seismic Response Comparison of 2-Component ABS Versus 3-Component SRSS Methods
3.7-21	Spray Pond Pumphouse: Frequencies with and without Eccentricities, Global Direction: E-W
3.7-22	Diesel Generator Enclosure: Frequencies with and without Eccentricities, Global Direction: E-W
3.7-23	Reactor Enclosure: Frequencies with and without Eccentricities, Global Direction: E-W
3.7-24	Spray Pond Pumphouse: Comparison of Torsional Moments from Original Design with Values Obtained from 3-D Model with Eccentricity
3.7-25	Diesel Generator Enclosure: Comparison of Torsional Moments from Original Design with Values Obtained from 3-D Model with Eccentricity
3.7-26	Reactor Enclosure: Comparison of Torsional Moments from Original Design with Values Obtained from 3-D Model with Eccentricity
3.7-27	Reactor Enclosure: Comparison of Diesel Shears and Shears Obtained from 3-D Model with Eccentricity
3.8-1	Codes, Standards, Recommendations, and Specifications Used in Design and Construction of Seismic Category I Structures
3.8-2	Load Combinations for Primary Containment Wall, Diaphragm Slab, and Reactor Pedestal
3.8-3	Primary Containment Design Pressure and Temperature Criteria
3.8-4	Load Combinations and Allowable Stresses for ASME Class MC Components
3.8-5	Load Combination for the Reactor Shield Wall
3.8-6	Load Combinations for the Suppression Chamber Columns

LIST OF TABLES (cont'd)

TABLE	TITLE
3.8-7	Load Combinations for the Pipe Whip Restraints and Drywell Platforms
3.8-8	Load Combination for the Seismic Truss
3.8-9	Load Combinations for the Reactor Enclosure
3.8-10	Load Combinations Applicable to Seismic Category I Structures Other Than Primary Containment and Reactor Enclosure
3.8-11	Load Combinations Applicable to Miscellaneous Structural Components of Seismic Category I Structures
3.8-12	Minimum Testing Frequency for Concrete, Concrete Materials, Concrete Masonry, and Masonry Materials
3.8-13	Membrane Force Resultants from "ASHSD" Program
3.8-14	Comparison of Results from "CECAP" Program and Hand Calculations
3.8-15	Comparison of Results from "CE668" Program and Hand Calculations
3.8-16	Comparison of Results from "E0119" Program and Published Results
3.8-17	Comparison of Results from "E0781" Program and Published Results
3.8-18	Parameters Assumed for "FINEL" Program Verification
3.8-19	Comparison of Results from "FINEL" Program and Hand Calculations
3.8-20	Comparison of Containment Load Combinations with SRP 3.8.3
3.8-21	Comparison of Containment Load Combinations with ASME Code, Article CC-3000
3.9-1	Applicable Thermal Transients
3.9-2	Plant Events
3.9-3	List of Computer Programs Used for Non-NSSS Mechanical Systems, Components, and Component Supports
3.9-4	Comparison of ME912 with ME643 and Analytical Results
3.9-5	Comparison Between Sample Problem and Computer Program ME913 Results
3.9-6	Loading Combinations, Stress Limits, and Allowable Stresses

LIST OF TABLES (cont'd)

TABLE	TITLE
3.9-6(a)	Load Combinations and Acceptance Criteria for ASME Class 1, 2, and 3 NSSS Piping, Equipment, and Supports
3.9-6(b)	Reactor Internals and Associated Equipment
3.9-6(c)	RWCU Heat Exchangers
3.9-6(d)	ASME Code Class 1 Main Steam Piping and Pipe-Mounted Equipment - Highest Stress Summary
3.9-6(e)	ASME Code Class 1 Recirculation Piping and Pipe-Mounted Equipment - Highest Stress Summary
3.9-6(f)	RPV and Shroud Support Assembly
3.9-6(g)	Main Steam Safety/Relief Valves (Pilot-Operated) (ASME Section III, 1968, Including Addenda through Summer 1970)
3.9-6(h)	Main Steam Isolation Valve
3.9-6(i)	Recirculation Pump
3.9-6(j)	Reactor Recirculation System Gate Valves, Structural and Mechanical Loading Criteria
3.9-6(k)	HPCI Turbine
3.9-6(l)	SLCS Pump
3.9-6(m)	SLCS Tank
3.9-6(n)	ECCS Pumps
3.9-6(o)	RHR Heat Exchanger
3.9-6(p)	RWCU Pump
3.9-6(q)	RCIC Turbine
3.9-6(r)	RCIC Pump
3.9-6(s)	Reactor Refueling and Servicing Equipment
3.9-6(t)	HPCI Pump
3.9-6(u)	Control Rod Drive (Indicator Tube)

LIST OF TABLES (cont'd)

TABLE	TITLE
3.9-6(v)	CRD Housing
3.9-6(w)	Jet Pumps
3.9-6(x)	Fuel Assembly (Including Channel)
3.9-6(y)	Highest Stressed Region on the LPCI Coupling (Attachment Ring)
3.9-6(z)	Reactor Vessel Support Equipment: CRD Housing Support
3.9-6(aa)	Control Rod Guide Tube
3.9-6(ab)	Incore Housing
3.9-7	Non-NSSS Piping Systems Power Ascension Testing
3.9-8	Intentionally Left Blank
3.9-9	Dynamic Qualification Summary: Non-NSSS Safety-Related Mechanical Equipment
3.9-10	NSSS Comparison with Regulatory Guide 1.48
3.9-11	Design Loading Combinations for ASME Code Class 1, 2, and 3 Non-NSSS Components
3.9-12	Design Criteria for ASME Code Class 1 Non-NSSS Piping
3.9-13	Design Criteria for Non-NSSS ASME Code Class 1 Valves
3.9-14	Design Criteria for Non-NSSS ASME Code Class 2 and 3 Vessels Designed to NC-3300 and ND-3300
3.9-15	Design Criteria for Non-NSSS ASME Code Class 2 Vessels Designed to Alternate Rules of NC-3200
3.9-16	Design Criteria for Non-NSSS ASME Code Class 2 and 3 Piping
3.9-17	Deleted
3.9-18	Design Criteria for Non-NSSS ASME Code Class 2 and 3 Valves
3.9-19	Seismic Category I Active Pumps and Valves (GE Scope of Supply)
3.9-20	Valve Qualification Test Range (Non-NSSS Scope of Supply)

LIST OF TABLES (cont'd)

TABLE	TITLE
3.9-21	Design Loading Combinations for Supports for ASME Code Class 1, 2 and 3 Components
3.9-22	Fatigue Limit (for Safety Class Reactor Internal Structures Only)
3.9-23	Core Support Structures: Stress Categories and Limits of Stress Intensity for Service Levels A and B (Normal and Upset) Conditions
3.9-24	Core Support Structures: Stress Categories and Limits of Stress Intensity for Service Level C (Emergency) Conditions
3.9-25	Maximum Pressure Differentials Across Reactor Vessel Internals During a Steam Line Break
3.9-26	Core Support Structure Design Loading Conditions and Combinations
3.9-27	Deformation Limit (for Reactor Internal Structures Only)
3.9-28	Primary Stress Limit (for Safety Class Reactor Internal Structures Only)
3.9-29	Buckling Stability Limit (for Safety Class Reactor Internal Structures Only)
3.9-30	Core Support Structures: Stress Categories and Limits of Stress Intensity for Service Level D (Fault) Conditions
3.9-31	Intentionally Left Blank
3.9-32	SRV Test Program
3.10-1	NSSS Essential Electrical Components and Instruments (Class 1E)
3.10-2	Seismic Qualification Test Summary: NSSS Safeguard Control Panels, Local Panels and Racks
3.10-3	Dynamic Qualification Test Summary: Non-NSSS Safety-Related Instruments and Electrical Equipment

LIST OF FIGURES

FIGURE	TITLE
3.3-1	Percent Probability of Exceeding Ordinate Value of Wind speed for Tornadoes Within 125 nm of Pottstown, PA
3.5-1	Resultant Load Curve on Structure Due to Impact of Design Aircraft
3.5-2	Reactor Enclosure Wall Section at Column Line D
3.5-3	Floor Plan, Diesel Generator, Unit 1
3.6-1	Typical Pipe Whip Restraint Details
3.6-2	Arrangement of Recirculation Loop Pipe Whip Restraints
3.6-3	Typical Recirculation System Pipe Whip Restraint
3.6-4	Recirculation System Isometric
3.6-5	Main Steam Piping Layout Outside Primary Containment
3.6-6	Main Steam Tunnel Elevation View
3.6-7	Main Steam Piping Restraints Inside Main Steam Tunnel
3.6-8	Main Steam Piping Isometric (Portion Inside Primary Containment)
3.6-9	Main Steam Piping Isometric (Portion Outside Primary Containment)
3.6-10	Rate of Coolant Loss for Main Steam Line Break Outside Primary Containment
3.6-11	Pressure-Temperature Transient Analysis Model for Main Steam Line Break in Main Steam Tunnel
3.6-12	Pressure-Temperature Transient Analysis Model for Main Steam Line Break in Turbine Enclosure
3.6-13	Feedwater Piping Restraints Inside Main Steam Tunnel
3.6-14	Feedwater Piping Restraints in Turbine Enclosure
3.6-15	Feedwater Piping Isometric (Portion Inside Primary Containment)
3.6-16	Feedwater Piping Isometric (Portion Outside Primary Containment)
3.6-17	RWCU Pump Suction Piping Isometric (Portion Inside Primary Containment)
3.6-18	RWCU Return Piping Isometric (Portion Inside Main Steam Tunnel)

LIST OF FIGURES (cont'd)

FIGURE	TITLE
3.6-19	Pressure-Temperature Transient Analysis Model for RWCU Line Breaks in RWCU Equipment Compartments
3.6-20	Reactor Vessel Drain Piping Isometric
3.6-21	HPCI Steam Supply Piping Isometric (Portion Inside Primary Containment)
3.6-22	HPCI Steam Supply Piping Isometric (Portion Outside Primary Containment)
3.6-23	Pressure-Temperature Transient Analysis Model for HPCI Steam Supply Line Break in HPCI Compartment
3.6-24	Pressure-Temperature Transient Analysis Model for HPCI Steam Supply Line Break in Isolation Valve Compartment
3.6-25	RCIC Steam Supply Piping Isometric (Portion Inside Primary Containment)
3.6-26	RCIC Steam Supply Piping Isometric (Portion Outside Primary Containment)
3.6-27	Pressure-Temperature Transient Analysis Model for RCIC Steam Supply Line Break in Pump Compartment
3.6-28	Main Steam Drainage Piping Isometric (Portion Inside Primary Containment)
3.6-29	Intentionally Left Blank
3.6-30	RPV Head Vent Piping Isometric
3.6-31	Standby Liquid Control Injection Piping Isometric
3.6-32	RHR Shutdown Cooling Piping Isometric
3.6-33	LPCI Injection Piping Isometric
3.6-34	Core Spray Injection Piping Isometric
3.6-35	Intentionally Left Blank
3.6-36	Typical Force-Deflection Curve for Recirculation System Pipe Whip Restraint
3.6-37	Break Locations and Restraints Analyzed for PDA Verification Program
3.6-38	Typical Pipe Break Analysis Models
3.6-39	RWCU Pump Suction Piping Isometric (Portion Inside RWCU Isolation Valve Compartment)

LIST OF FIGURES (cont'd)

FIGURE	TITLE
3.6-40	Intentionally Left Blank
3.6-41	Generic Presentation of Pipe
3.6-42	Representative of Pipe with Both Ends Built-in
3.6-43	Environmental Conditions and Compartment Dimensions for HPCI Steam Line Break
3.6-44	HPCI Steam Supply Line Break in HPCI Compartment Temperature Transient
3.6-45	HPCI Steam Supply Line Break in HPCI Compartment Pressure Transient
3.7-1	Design Response Spectra for Operating Basis Earthquake (Horizontal Component)
3.7-2	Design Response Spectra for Safe Shutdown Earthquake (Horizontal Component)
3.7-3	Synthetic Time History Normalized to 1g
3.7-4	Comparison of Time History Response Spectra and Design Response Spectra (0.5% Damping)
3.7-5	Comparison of Time History Response Spectra and Design Response Spectra (1% Damping) (Normalized to 1g)
3.7-6	Comparison of Time History Response Spectra and Design Response Spectra (2% Damping) (Normalized to 1g)
3.7-7	Comparison of Time History Response Spectra and Design Response Spectra (3% Damping) (Normalized to 1g)
3.7-8	Comparison of Time History Response Spectra and Design Response Spectra (5% Damping) (Normalized to 1g)
3.7-9	Comparison of Time History Response Spectra and Design Response Spectra (7% Damping) (Normalized to 1g)
3.7-10	Horizontal Seismic Model of Primary Containment
3.7-11	Vertical Seismic Model of Primary Containment
3.7-12	Horizontal Seismic Model of Primary Containment with Soil-Structure Interaction
3.7-13	Vertical Seismic Model of Primary Containment with Soil-Structure Interaction

LIST OF FIGURES (cont'd)

FIGURE	TITLE
3.7-14	Horizontal Seismic Model of Reactor Enclosure and Control Structure
3.7-15	Vertical Seismic Model of Reactor Enclosure and Control Structure
3.7-16	Horizontal Seismic Model of Reactor Enclosure and Control Structure with Soil-Structure Interaction
3.7-17	Vertical Seismic Model of Reactor Enclosure and Control Structure with Soil-Structure Interaction
3.7-18	Correlation of Vertical Seismic Model Mass Points to the Physical Structure
3.7-19	Seismic Model of Reactor Pressure Vessel and Internals
3.7-20	Containment Horizontal Mode Shapes - Uncracked Condition
3.7-21	Containment Horizontal Mode Shapes - Cracked Condition
3.7-22	Containment Vertical Mode Shapes - Uncracked Condition
3.7-23	Containment Vertical Mode Shapes - Cracked Condition
3.7-24	Reactor Enclosure and Control Structure N-S Mode Shapes
3.7-25	Reactor Enclosure and Control Structure E-W Mode Shapes
3.7-26	Reactor Enclosure and Control Structure Vertical Mode Shapes (Mode 1)
3.7-27	Reactor Enclosure and Control Structure Vertical Mode Shapes (Mode 7)
3.7-28	Reactor Enclosures and Control Structure Vertical Mode Shapes (Mode 14)
3.7-29	Reactor Enclosure and Control Structure Vertical Model Shapes (Mode 22)
3.7-30	Reactor Enclosure and Control Structure Vertical Mode Shapes (Mode 39)
3.7-31	Response Spectrum at RPV Pedestal Horizontal OBE (Damping = 0.005) - Uncracked Condition
3.7-32	Response Spectrum at RPV Pedestal Horizontal SSE (Damping = 0.005) - Uncracked Condition
3.7-33	Response Spectrum at RPV Pedestal Vertical OBE (Damping = 0.005) - Uncracked Condition
3.7-34	Response Spectrum at RPV Pedestal Vertical SSE (Damping = 0.005) - Uncracked Condition

LIST OF FIGURES (cont'd)

FIGURE	TITLE
3.7-35	Response Spectrum at Refueling Area E-W OBE (Damping = 0.005)
3.7-36	Response Spectrum at Refueling Area E-W SSE (Damping = 0.005)
3.7-37	Response Spectrum at Refueling Area N-S OBE (Damping = 0.005)
3.7-38	Response Spectrum at Refueling Area N-S SSE (Damping = 0.005)
3.7-39	Response Spectrum at Refueling Area Vertical OBE (Damping = 0.005)
3.7-40	Response Spectrum at Refueling Area Vertical SSE (Damping = 0.005)
3.7-41	Response Spectrum at Refueling Area N-S SSE (Damping = 0.005) Soil-Structure Interaction
3.7-42	Response Spectrum at Refueling Area Vertical SSE (Damping = 0.005) Soil-Structure Interaction
3.7-43	Earthquake Response Spectra
3.7-44	Postseismic Event Plant Procedures
3.7-45	Damping versus ZPA for Raceway System
3.7-46	Comparison of 3-Component SRSS to 2-Component ABS
3.7-47	Relative Conservatism of the Two-Component Absolute and Three-Component SRSS Techniques
3.7-48	Spray Pond Pumphouse 3-D Stick Model (E-W Direction)
3.7-49	Diesel Generator Enclosure 3-D Stick Model (E-W Direction)
3.7-50	Reactor Enclosure 3-D Stick Model (E-W Direction)
3.8-1	Primary Containment Elevation View
3.8-2	Primary Containment Plan View at el 203'-5"
3.8-3	Primary Containment Plan View at el 253'-0"
3.8-4	Primary Containment Plan View at el 272'-9"
3.8-5	Primary Containment Plan View at el 277'-6"

LIST OF FIGURES (cont'd)

FIGURE	TITLE
3.8-6	Primary Containment Plan View at el 286'-1"
3.8-7	Primary Containment Plan View at el 295'-11"
3.8-8	Primary Containment Plan View at el 303'-6"
3.8-9	Drywell Head Connection to Containment Wall
3.8-10	Diaphragm Slab Connection to Containment Wall
3.8-11	Base Foundation Slab Reinforcement
3.8-12	Base Foundation Slab Liner Plate and Anchorages
3.8-13	Reactor Pedestal Base Liner Anchorage
3.8-14	Suppression Chamber Column Base Liner Anchorage
3.8-15	Suppression Chamber Wall Reinforcement
3.8-16	Drywell Wall Reinforcement
3.8-17	Suppression Chamber Wall Liner Plate and Anchorages
3.8-18	Drywell Wall Liner Plate and Anchorages
3.8-19	Suppression Chamber Wall Reinforcement Detail at Typical Penetration
3.8-20	Drywell Wall Reinforcement Detail at Typical Penetration
3.8-21	Pipe Penetration Details
3.8-22	Electrical Penetration Details
3.8-23	Reinforcement Detail at Equipment Hatches
3.8-24	Beam Seat Embedment
3.8-25	Pipe Whip Restraint Embedment
3.8-26	Seismic Truss Support (Embedment)
3.8-27	Containment Wall Analytical Model for Axisymmetric Loads
3.8-28	Drywell Wall Analytical Model for Nonaxisymmetric Postulated Pipe Rupture Loads

LIST OF FIGURES (cont'd)

FIGURE	TITLE
3.8-29	Base Foundation Slab Analytical Model
3.8-30	Equipment Hatch Analytical Model
3.8-31	Drywell Head
3.8-32	Equipment Hatch
3.8-33	Equipment Hatch with Personnel Lock
3.8-34	Control Rod Drive Removal Hatch
3.8-35	Analytical Model of Drywell Head Assembly
3.8-36	Diaphragm Slab Reinforcement
3.8-37	Diaphragm Slab Liner Plate and Anchorages
3.8-38	Reactor Vessel and Reactor Shield Wall Base Connections
3.8-39	Reactor Pedestal Reinforcement above Diaphragm Slab
3.8-40	Reactor Pedestal Reinforcement below Diaphragm Slab
3.8-41	Reactor Shield Wall
3.8-42	Suppression Chamber Columns
3.8-43	Seismic Truss
3.8-44	Diaphragm Slab Analytical Model
3.8-45	Analytical Model for Suppression Chamber Columns and Lower Reactor Pedestal
3.8-46	Analytical Model for Upper Reactor Pedestal
3.8-47	Reactor Shield Wall Analytical Model for "FINEL" and "ASHSD" Programs
3.8-48	Reactor Shield Wall Analytical Model for "EASE" Program
3.8-49	Suppression Chamber Column Analytical Model for "ASHSD" Program
3.8-50	Suppression Chamber Column Seismic Model
3.8-51	Suppression Chamber Column Analytical Model for "CE668" Program

LIST OF FIGURES (cont'd)

FIGURE	TITLE
3.8-52	Seismic Truss Analytical Model for "STRESS" Program
3.8-53	Reactor Enclosure, Fuel Pool Girder
3.8-54	Reactor Enclosure Upper Frame and Crane Runway Details
3.8-55	Spray Pond Excavation Plan View
3.8-56	Spray Pond Excavation and Grading Sections and Details
3.8-57	Spray Pond Roads, Pavings, and Finished Gradings
3.8-58	Safety-Related Structures and Yard Piping
3.8-59	Radwaste Enclosure Foundation Details
3.8-60	Reactor Enclosure and Control Structures-Foundation Details
3.8-61	Diesel Generator Enclosure Foundation Details
3.8-62	Spray Pond Pump Structure-Foundation Details
3.8-63	Turbine Enclosure Foundation Details
3.8-64	Miscellaneous Structures-Foundation Details
3.8-65	Thin-Shell Cylinder Model (ASHSD Program, Sample Problem a)
3.8-66	Axisymmetric Solid Cylinder Model (ASHSD Program, Sample Problem a)
3.8-67	Cylinder Model (ASHSD Program, Sample Problem b)
3.8-68	Finite-Element Model (ASHSD Program, Sample Problem b)
3.8-69	Comparison of Computer Results and Theoretical Solution (ASHSD Program, Sample Problem b)
3.8-70	Cylinder Model (ASHSD Program, Sample Problem c)
3.8-71	Finite-Element Model (ASHSD Program, Sample Problem c)
3.8-72	Comparison of Computer Results and Theoretical Solution (ASHSD Program, Sample Problem c)
3.8-73	Reinforced Concrete Beam (CECAP Program)

LIST OF FIGURES (cont'd)

FIGURE	TITLE
3.8-74	Concrete Beam Model (CECAP Program, Sample Problem a)
3.8-75	Beam Cross-Section and Thermal-Stress Distribution (CECAP Program, Sample Problem a)
3.8-76	Stress Diagram (CECAP Program, Sample Problem a)
3.8-77	Concrete Beam Model (CECAP Program, Sample Problem b)
3.8-78	Beam Cross-Section, Stress Block, and Transformed Section (CECAP Program, Sample Problem b)
3.8-79	Concrete Beam Model (CECAP Program, Sample Problem c)
3.8-80	Beam Cross-Section and Stress Block (CECAP Program, Sample Problem c)
3.8-81	Plate Geometry, Loading, and Finite-Element Mesh (CE668 Program, Sample Problem a)
3.8-82	Plate Geometry, Loading, and Finite-Element Mesh (CE668 Program, Sample Problem b)
3.8-83	Welding Neck Flange Detail (E0119 Program, Sample Problem a)
3.8-84	Slip-on Flange Detail (E0119 Program, Sample Problem b)
3.8-85	Geometry of Ellipsoidal and Torispherical Heads (E0781 Program, Sample Problem a)
3.8-86	Analytical Model with Boundary Conditions (E0781 Program, Sample Problem a)
3.8-87	Plots of Hoop Force (θN) and Longitudinal Moment (Mϕ) (E0781 Program, Sample Problem a)
3.8-88	Plot of Stress in the Hoop (θ) Direction on the Inside Surface (θ = 0°) (E0781 Program, Sample Problem a)
3.8-89	Plot of Stress in the Hoop (θ) Direction on the Outside Surface (θ = 0°) (E0781 Program, Sample Problem a)
3.8-90	Plot of Stress in the Longitudinal Direction (ϕ) on the Inside Surface (ϕ = 0°) (E0781 Program, Sample Problem a)
3.8-91	Plot of Stress in the Longitudinal Direction (ϕ) on the Outside Surface (ϕ = 0°) (E0781 Program, Sample Problem a)

LIST OF FIGURES (cont'd)

FIGURE	TITLE
3.8-92	Plot of Membrane Stress ($\theta = 0°$) (E0781 Program, Sample Problem a)
3.8-93	Thickness Variation in Experimental Head No. 1 (E0781 Program, Sample Problem a)
3.8-94	Thickness Variation in Cylinder No. 1 (E0781 Program, Sample Problem a)
3.8-95	Geometry of Cylindrical Water Tank (E0781 Program, Sample Problem b)
3.8-96	Experimental Beam Geometry (FINEL Program, Sample Problem a)
3.8-97	Finite-Element Mesh Used in Reference 3.8-14 (FINEL Program, Sample Problem a)
3.8-98	Finite-Element Mesh Used in Program Verification (FINEL Program, Sample Problem a)
3.8-99	Regions of Cracking from Reference 3.8-14 and FINEL Analysis (FINEL Program, Sample Problem a)
3.8-100	Load-Deflection Curves from Reference 3.8-13, Reference 3.8-14, and FINEL Analysis (FINEL Program, Sample Program a)
3.8-101	Finite-Element Model for Hollow Cylinder with Distributed Pressure Loading (FINEL Program, Sample Problem b)
3.8-102	Finite-Element Model for Hollow Cylinder with Linear Temperature Gradient (FINEL Program, Sample Problem c)
3.8-103	Temperature Gradient Through-Wall of Hollow Cylinder (FINEL Program, Sample Problem c)
3.8-104	Temperature Conditions and Arrangement of Square Plate (ME620 Program, Sample Problem a)
3.8-105	Finite-Element Model of Square Plate (ME620 Program, Sample Problem a)
3.8-106	Comparison of Temperature Transients from ME620 and Reference 3.8-19 (ME620 Program, Sample Problem a)
3.8-107	Size and Temperature Conditions of Solid Steel Sphere (ME620 Program, Sample Problem b)
3.8-108	Finite-Element Model of Solid Steel Sphere (ME620 Program, Sample Problem b)

LIST OF FIGURES (cont'd)

FIGURE	TITLE
3.9-1	Transient Temperature Response of a Small Pipe
3.9-2	Transient Pressure Differentials Following a Steam Line Break
3.9-3	Typical Relief Valve Transient
3.9-4	Reactor Vessel Cutaway
3.9-5	Reactor Internals Flow Paths
3.9-6	Fuel Support Pieces
3.9.7	Jet Pump
3.9-8	Pressure Nodes Used for Depressurization Analysis
3.9-9	Jurisdictional Boundary Between Pipe Supports and Supporting Structure for Supports not Furnished with NSSS
3.9-10	Jurisdictional Boundary Between Pipe Supports and Supporting Structure for Supports Furnished with Control Rod Drive System and TIP System
3.10-1	Typical Bench Board
3.10-2	Instrument Rack
3.10-3	Typical Local Rack
3.10-4	NEMA Type 12 Enclosure (Instruments Mounted Inside on Internal Membrane Mounted on Standoffs Attached to Back)