

**PBAPS UFSAR**

SECTION 3.0 - REACTOR

TABLE OF CONTENTS

<u>SECTION</u>	<u>TITLE</u>
3.1	<u>SUMMARY DESCRIPTION</u>
3.2	<u>FUEL MECHANICAL DESIGN</u>
3.2.1	Power Generation Objective
3.2.2	Power Generation Design Basis
3.2.3	Safety Design Basis
3.2.4	Description
3.2.5	References
3.3	<u>REACTOR VESSEL INTERNALS MECHANICAL DESIGN</u>
3.3.1	Power Generation Objective
3.3.2	Power Generation Design Basis
3.3.3	Safety Design Basis
3.3.4	Description
3.3.4.1	Core Structure
3.3.4.1.1	Core Shroud and Shroud Support
3.3.4.1.2	Shroud Head and Steam Separator Assembly
3.3.4.1.3	Core Support (Core Plate)
3.3.4.1.4	Top Guide
3.3.4.2	Fuel Support Pieces
3.3.4.3	Control Rod Guide Tubes
3.3.4.4	Jet Pump Assemblies
3.3.4.5	Steam Dryers
3.3.4.6	Feedwater Spargers
3.3.4.7	Core Spray Lines
3.3.4.8	Vessel Head Cooling Spray Nozzle
3.3.4.9	Differential Pressure and Standby Liquid Control Line
3.3.4.10	In-Core Flux Monitor Guide Tubes
3.3.4.11	Surveillance Sample Holders
3.3.5	Safety Evaluation
3.3.5.1	Evaluation Methods
3.3.5.1.1	Specific Events to be Evaluated
3.3.5.1.2	Pressure Differentials During Rapid Depressurization
3.3.5.2	Recirculation Line Break
3.3.5.2.1	Jet Pump Joints and Access Hole Cover Joints
3.3.5.3	Steam Line Break Accident
3.3.5.3.1	Core Support
3.3.5.3.2	Guide Tubes
3.3.5.3.3	Fuel Channels
3.3.5.4	Thermal Shock
3.3.5.5	Earthquake

**PBAPS UFSAR**

TABLE OF CONTENTS (cont'd)

<u>SECTION</u>	<u>TITLE</u>
3.3.5.6	Blowdown Hydrodynamic Forces
3.3.5.7	Replacement Steam Dryer
3.3.5.8	Conclusions
3.3.6	Inspection and Testing
3.4	<u>REACTIVITY CONTROL MECHANICAL DESIGN</u>
3.4.1	Safety Objective
3.4.2	Safety Design Basis
3.4.3	Power Generation Objective
3.4.4	Power Generation Design Basis
3.4.5	Description
3.4.5.1	Reactivity Control Devices
3.4.5.1.1	Control Rods
3.4.5.1.2	Control Rod Velocity Limiter
3.4.5.2	Control Rod Drive Mechanisms
3.4.5.2.1	Components
3.4.5.2.2	Materials of Construction
3.4.5.3	Control Rod Drive Hydraulic System
3.4.5.3.1	Control Rod Drive Hydraulic Supply and Discharge Subsystems
3.4.5.3.2	Hydraulic Control Units
3.4.5.4	Control Rod Drive System Operation
3.4.6	Safety Evaluation
3.4.6.1	Evaluation of Control Rods
3.4.6.2	Evaluation of Control Rod Velocity Limiter
3.4.6.3	Evaluation of Scram Time
3.4.6.4	Analysis of Malfunctions Relating to Rod Withdrawal
3.4.6.5	Scram Reliability
3.4.6.6	Control Rod Support and Operation
3.4.7	Inspection and Testing
3.4.7.1	Development Tests
3.4.7.2	Factory Quality Control Tests
3.4.7.3	Operational Tests
3.4.8	Longer Life Control Rod Assembly
3.4.9	Marathon Control Rod Assembly
3.4.10	Westinghouse Atom Control Rod Assembly
3.4.11	GEH Ultra Control Rod Assembly
3.5	<u>CONTROL ROD DRIVE HOUSING SUPPORTS</u>
3.5.1	Safety Objective
3.5.2	Safety Design Basis
3.5.3	Description
3.5.4	Safety Evaluation
3.5.5	Inspection and Testing

**PBAPS UFSAR**

TABLE OF CONTENTS (cont'd)

<u>SECTION</u>	<u>TITLE</u>
3.6	<u>NUCLEAR DESIGN</u>
3.6.1	Power Generation Objective
3.6.2	Plant Performance Design Basis
3.6.3	Safety Design Bases
3.6.4	Nuclear Requirements
3.6.4.1	Control Rods
3.6.4.2	Reactor Manual Control System
3.6.4.3	Standby Liquid Control System
3.6.5	Fuel Nuclear Characteristics
3.6.5.1	Nuclear Design Description
3.6.5.1.1	Fuel Nuclear Properties
3.6.5.2	Power Distributions
3.6.5.2.1	Local Power Distribution
3.6.5.2.2	Radial Power Distribution
3.6.5.2.3	Axial Power Distribution
3.6.5.2.4	Power Distribution Measurements
3.6.5.2.5	Power Distribution Accuracy
3.6.5.3	Analytical Methods
3.6.5.4	Reactivity Control
3.6.5.4.1	Shutdown Reactivity
3.6.5.4.2	Reactivity Variations
3.6.5.5	Refueling Cycle
3.6.5.5.1	Criticality of the Reactor During Refueling
3.6.5.5.2	Criticality of Fuel Assemblies
3.6.5.6	Control Rod Patterns and Reactivity Worths
3.6.5.6.1	Rod Worth Minimizer System Range
3.6.5.6.2	Operating Range
3.6.5.6.3	Scram Reactivity
3.6.5.7	Reactivity Coefficients
3.6.5.8	Stability
3.6.5.8.1	Xenon Transients
3.6.5.8.2	Thermal-Hydraulic Stability
3.6.6	Changes to the Original GE-BWR/4 Nuclear Design
3.6.6.1	Control Cell Core
3.6.7	Nuclear Evaluations
3.6.8	Verification and Testing
3.7	<u>THERMAL AND HYDRAULIC DESIGN</u>
3.7.1	Power Generation Objective
3.7.2	Power Generation Design Basis
3.7.3	Safety Design Basis
3.7.4	Thermal and Hydraulic Design Limits
3.7.4.1	Steady-State Limits
3.7.4.2	Transient Limits

**PBAPS UFSAR**

TABLE OF CONTENTS (cont'd)

<u>SECTION</u>	<u>TITLE</u>
3.7.4.3	Summary of Design Limits
3.7.5	Thermal and Hydraulic Characteristics
3.7.5.1	Application of Thermal-Hydraulic Limits to Core Design
3.7.5.2	Description of Thermal-Hydraulic Design of the Reactor Core
3.7.5.2.1	Critical Power Ratio
3.7.5.2.2	Average Planar Linear Heat Generation Rate
3.7.5.2.3	Core Coolant Flow Distribution and Orificing Pattern
3.7.5.2.4	Core Pressure Drop and Hydraulic Loads
3.7.5.2.5	Correlation and Physical Data
3.7.5.2.6	Thermal Effects of Operational Transients
3.7.5.2.7	Uncertainties in Estimates
3.7.5.2.8	Flux Tilt Considerations
3.7.5.3	Analytical Methods
3.7.5.3.1	Reactor Limits Determination
3.7.5.3.2	Steady-State Hydraulic Models
3.7.5.4	Performance Range for Normal Operations
3.7.5.5	Flow Control
3.7.5.6	Core Power Distribution
3.7.6	Thermal and Hydraulic Evaluation
3.7.6.1	Design Minimum Critical Heat Flux Ratio Limit
3.7.6.2	Design Minimum Critical Power Ratio
3.7.6.2.1	Critical Power
3.7.6.2.2	Core Hydraulics
3.7.6.2.3	Influence of Power Distribution
3.7.6.2.4	Core Thermal Response
3.7.6.2.5	Analytical Methods
3.7.6.2.6	Thermal-Hydraulic Stability Analysis
3.7.6.3	Fuel Damage Analysis
3.7.7	Changes to the Original Thermal-Hydraulic BWR/4 Design
3.7.7.1	Modifications to Eliminate Significant In-Core Vibration
3.7.8	Verification and Testing
3.8	<u>STANDBY LIQUID CONTROL SYSTEM</u>
3.8.1	Safety Objective
3.8.2	Safety Design Basis
3.8.3	Description
3.8.4	Safety Evaluation
3.8.5	Inspection and Testing

**PBAPS UFSAR**

SECTION 3.0 - REACTOR

LIST OF TABLES

<u>TABLE</u>	<u>TITLE</u>
3.3.1	Reactor Vessel Internals Design Data
3.6.1	Deleted
3.6.2	Deleted
3.6.3	Deleted
3.6.4	Deleted
3.6.5	Deleted
3.6.6	Deleted

**PBAPS UFSAR**

LIST OF FIGURES (cont'd)

FIGURE

TITLE

SECTION 3.0 - REACTOR

LIST OF FIGURES

FIGURE

TITLE

3.3.1	Reactor Vessel Internals
3.3.2	Reactor Vessel Internal Flow - Schematic
3.3.3	Steam Separator
3.3.4	Fuel Support Pieces
3.3.5	Jet Pump
3.3.6	Deleted
3.3.7	Location of Tabulated Pressure Differentials
3.3.8	Unit 3 Transient Pressure Differentials Following a Steam Line Break at 110 Percent Power
3.3.8A	Unit 2 Transient Pressure Differentials Following a Steam Line Break
3.3.9	Thermal Shock Transient Analysis Zones
3.3.10	Materials Behavior Graph - Cycles Versus Stress for Stainless Steel
3.3.11	Analytical Model of the Reactor Vessel Internals
3.3.12	$\mu(\tau)$ for Various Amounts of Viscous Damping
3.4.1	Deleted
3.4.1.A	Control Rod - Isometric - Duralife 160
3.4.1.B	Control Rod - Isometric - Duralife 190, 230
3.4.1.C	Control Rod - Marathon
3.4.2	Control Rod to Control Rod Drive Coupling - Isometric

**PBAPS UFSAR**

LIST OF FIGURES (cont'd)

<u>FIGURE</u>	<u>TITLE</u>
3.4.3	Control Rod Velocity Limiter - Isometric
3.4.4	Control Rod Drive, Simplified Component Illustration
3.4.5	Control Rod Drive, Schematic Diagram
3.4.6	Control Rod Drive Hydraulic Control System Simplified Component Illustration
3.4.7	Deleted
3.4.8	Deleted
3.4.9	Control Rod Drive Cutaway Illustration
3.4.10	Control Rod Drive Hydraulic System, Process Diagram
3.4.11	Control Rod Hydraulic Control Unit - Isometric
3.5.1	Control Rod Drive Housing Support - Isometric
3.6.1	Control Cell Locations for PBAPS Units 2 and 3
3.6.2	Scram Reactivity and CRD Specifications, BOC5 to EOC5-1,000 MWd/t Unit 2
3.6.3	Scram Reactivity and CRD Specifications, EOC5-1,000 MWd/t to EOC5 Unit 2
3.6.4	Scram Reactivity and CRD Specifications Unit 3
3.7.1	Operating Power Flow Map
3.7.1A	Deleted
3.8.1	Deleted
3.8.2	Deleted
3.8.3	Deleted
3.8.4	Boron Requirements of the Standby Liquid Control System
3.8.5	Figure Deleted