

STPEGS UFSAR

TABLE OF CONTENTS

CHAPTER 4

REACTOR

<u>Section</u>	<u>Title</u>	<u>Page</u>
4.1	SUMMARY DESCRIPTION	4.1-1
4.2	FUEL SYSTEM DESIGN	4.2-1
4.2.1	Design Bases	4.2-2
4.2.2	Design Description	4.2-8
4.2.3	Design Evaluation	4.2-20
4.2.4	Testing and Inspection Plan	4.2-35
4.3	NUCLEAR DESIGN	4.3-1
4.3.1	Design Bases	4.3-1
4.3.2	Description	4.3-6
4.3.3	Analytical Methods	4.3-36
4.4	THERMAL AND HYDRAULIC DESIGN	4.4-1
4.4.1	Design Bases	4.4-1
4.4.2	Description	4.4-5
4.4.3	Description of the Thermal and Hydraulic Design of the Reactor Coolant System	4.4-21
4.4.4	Evaluation	4.4-23
4.4.5	Testing and Verification	4.4-35
4.4.6	Instrumentation Requirements	4.4-35
4.5	REACTOR MATERIALS	4.5-1
4.5.1	Control Rod System Structural Materials	4.5-1
4.5.2	Reactor Internals Materials	4.5-2
4.6	FUNCTIONAL DESIGN OF REACTIVITY CONTROL SYSTEMS	4.6-1
4.6.1	Information for Control Rod Drive System	4.6-1
4.6.2	Evaluation of the Control Rod Drive System	4.6-1
4.6.3	Testing and Verification of the Control Rod Drive System	4.6-1
4.6.4	Information for Combined Performance of Reactivity Systems	4.6-1
4.6.5	Evaluation of Combined Performance	4.6-2

STPEGS UFSAR

LIST OF TABLES

CHAPTER 4

<u>Table</u>	<u>Title</u>	<u>Page</u>
4.1-1	Reactor Design Table	4.1-5
4.1-2	Analytical Techniques in Core Design	4.1-9
4.1-3	Design Loading Conditions for Reactor Core Components	4.1-11
4.2-1	Fuel Assembly Component Stresses	4.2-43
4.3-1	Reactor Core Description	4.3-45
4.3-2	Nuclear Design Parameters (First Cycle)	4.3-48
4.3-3	Reactivity Requirements for Rod Cluster Control Assemblies	4.3-51
4.3-4	Comparison of Reactivity Requirements	4.3-52
4.3-5	Expected Reactivity Parameter Range	4.3-53
4.3-6	Benchmark Critical Experiments	4.3-54
4.3-7	Axial Stability Index Pressurized Water Reactor Core with a 12-Foot Height	4.3-55
4.3-8	Typical Neutron Flux Levels (n/cm ² -sec) at Full Power	4.3-56
4.3-9	Comparison of Measured and Calculated Doppler Defects	4.3-57
4.3-10	Saxton Core II Isotopics Rod MY, Axial Zone 6	4.3-58
4.3-11	Critical Boron Concentrations, HZP, BOL	4.3-59
4.3-12	Comparison of Measured and Calculated Rod Worth	4.3-60
4.3-13	Comparison of Measured and Calculated Moderator Coefficients at HZP, BOL	4.3-61
4.4-1	Thermal and Hydraulic Comparison Table (Historical)	4.4-47
4.4-4	Comparison of THINC-IV and THINC-I Predictions with Data from Representative Westinghouse Two and Three Loop Reactors	4.4-50

STPEGS UFSAR

LIST OF FIGURES (Continued)

CHAPTER 4

<u>Figure Number</u>	<u>Title</u>
4.2-1	Fuel Assembly Cross Section 17x17
4.2-2	Fuel Assembly Outline 17x17 XL (Conceptual)
4.2-2a	Upgraded Fuel Assembly Outline 17x17 XL (Conceptual)
4.2-2B	Fuel Assembly Outline 17x17 XL - Vantage 5H (Typical - All Dimensions Ref.)
4.2.-2C	Vantage + / RFA Fuel Assembly
4.2-3	Fuel Rod Schematic
4.2-4	Fuel Assembly Plan View
4.2-5	Fuel Assembly Elevation View
4.2-5A	Fuel Assembly Plan View of Mid Grid to Guide Thimble Joint-Vantage 5H/Vantage +/- RFA
4.2-5B	Fuel Assembly Elevation View of Mid Grid to Guide Thimble Joint- Vantage 5H/Vantage +/-RFA
4.2-6	Standard Top Nozzle and Grid Attachment
4.2-6a	Upgraded Top Nozzle and Guide Thimble Interface
4.2-7	Guide Thimble to Bottom Nozzle Joint
4.2-7A	Vantage + Guide Thimble to Bottom Nozzle Joint
4.2-7B	RFA Guide Thimble to Bottom Nozzle Joint
4.2-8	Rod Cluster Control and Drive Rod Assembly with Interfacing Components
4.2-9	Rod Cluster Control Assembly Outline
4.2-10	Hafnium or Silver-Indium-Cadmium Absorber Rod
4.2-11	Burnable Absorber Assembly
4.2-11a	Updated Burnable Absorber Assembly
4.2-12	Burnable Absorber Rod - Cross Section

STPEGS UFSAR

LIST OF FIGURES (Continued)

CHAPTER 4

<u>Figure Number</u>	<u>Title</u>
4.2-12a	Updated Burnable Absorber Rod - Cross Section
4.2-13	Primary Source Assembly
4.2-14	Secondary Source Assembly
4.2-15	Thimble Plug Assembly
4.3-1	Fuel Loading Arrangement
4.3-2	Production and Consumption of Higher Isotopes
4.3-3	Boron Concentration Versus First Cycle Burnup with and without Burnable Poison Rods Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-4	Burnable Poison Rod Arrangement Within an Assembly Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-4A	Typical IFBA Rod Arrangements Within an Assembly
4.3-5	Burnable Poison Loading Pattern Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-6	Normalized Power Density Distribution Near Beginning of Life, Unrodded Core, Hot Full Power, No Xenon Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-7	Normalized Power Density Distribution Near Beginning of Life, Unrodded Core, Hot Full Power, Equilibrium Xenon Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-8	Normalized Power Density Distribution Near Beginning of Life, Group D 40% Inserted, Hot Full Power, Equilibrium Xenon Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)

STPEGS UFSAR

LIST OF FIGURES (Continued)

CHAPTER 4

<u>Figure Number</u>	<u>Title</u>
4.3-9	Normalized Power Density Distribution Near Middle of Life, Unrodded Core, Hot Full Power, Equilibrium Xenon Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-10	Normalized Power Density Distribution Near End of Life, Unrodded Core, Hot Full Power, Equilibrium Xenon Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-11	Normalized Power Density Distribution Near End of Life, Hot Full Power, Equilibrium Xenon, Group D 40% Inserted Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-12	Rodwise Power Distribution in a Typical Assembly Near Beginning of Life, Hot Full Power, Equilibrium Xenon, Unrodded Core
4.3-13	Rodwise Power Distribution in a Typical Assembly Near End of Life, Hot Full Power, Equilibrium Xenon, Unrodded Core
4.3-14	Typical Axial Power Shapes Occurring at Start of Life
4.3-15	Typical Axial Power Shapes Occurring at Middle of Life
4.3-16	Typical Axial Power Shapes Occurring at End of Life
4.3-17	Comparison of Assembly Axial Power Distribution with Core Average Axial Distribution D Bank Slightly Inserted
4.3-18	Not Used
4.3-19	Not Used
4.3-20	Not Used
4.3-21	Maximum F_{Qx} Relative Power Versus Axial Height During Normal Operation

STPEGS UFSAR

LIST OF FIGURES (Continued)

CHAPTER 4

<u>Figure Number</u>	<u>Title</u>
4.3-22	Peak Linear Power During Control Rod Malfunction Overpower Transients Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-23	Peak Linear Power During Boration/Dilution Overpower Transients Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-24	Comparison Between Calculated and Measured Relative Fuel Assembly Power Distribution
4.3-25	Comparison of Calculated and Measured Axial Shape
4.3-26	Measured Values of F_Q for Full Power Rod Configurations
4.3-27	Doppler Temperature Coefficient at BOL and EOL Cycle 1 Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-28	Doppler Only Power Coefficient - BOL, EOL Cycle 1 Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-29	Doppler Only Power Defect - BOL, EOL Cycle 1 Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-30	Moderator Temperature Coefficient - BOL, Cycle 1, No Rods Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-31	Moderator Temperature Coefficient - EOL, Cycle 1 Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)

STPEGS UFSAR

LIST OF FIGURES (Continued)

CHAPTER 4

<u>Figure Number</u>	<u>Title</u>
4.3-32	Moderator Temperature Coefficient as a Function of Boron Concentration - BOL, Cycle 1, No Rods Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-33	Hot Full Power Moderator Temperature Coefficient During Cycle 1 for the Critical Boron Concentration Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-34	Total Power Coefficient - BOL, EOL, Cycle 1 Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-35	Total Power Defect - BOL, EOL Cycle 1 Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-36	Rod Cluster Control Assembly Pattern
4.3-37	Accidental Simultaneous Withdrawal of Two Control Banks Moving in the Same Plant (Typical)
4.3-38	Design - Trip Curve
4.3-39	Normalized Rod Worth Versus Percent Insertion - All Rods But One Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.3-40	Axial Offset Versus Time PWR Core with a 12-Ft. Height and 121 Assemblies
4.3-41	XY Xenon Test Thermocouple Response Quadrant Tilt Difference Versus Time
4.3-42	Calculated and Measured Doppler Defect and Coefficients at BOL Two- Loop Plant, 121 Assemblies, 12-Foot Core

STPEGS UFSAR

LIST OF FIGURES (Continued)

CHAPTER 4

<u>Figure Number</u>	<u>Title</u>
4.3-43	Comparison of Calculated and Measured Boron Concentration for 2-Loop Plant, 121 Assemblies, 12-Foot Core
4.3-44	Comparison of Calculated and Measured C_B in 2-Loop Plant, 121 Assemblies, 12-Foot Core
4.3-45	Comparison of Calculated and Measured C_B in 3-Loop Plant, 157 Assemblies, 12-Foot Core
4.4-1	Comparison of "R" Grid Data for Typical Cell [Reference (42)]
4.4-4	TDC Versus Reynolds Number of 26" Grid Spacing
4.4-5	Normalized Radial Flow and Enthalpy Distribution at Elevation of 1/3 Core Height Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.4-6	Normalized Radial Flow and Enthalpy Distribution at Elevation of 2/3 of Core Height Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.4-7	Normalized Radial Flow and Enthalpy Distribution at Core Exit Elevation Unit 1 (Sheet 1 of 2) Unit 2 (Sheet 2 of 2)
4.4-8	Void Fraction Versus Thermodynamic Quality $H-H_{SAT}/H_9-H_{SAT}$
4.4-9	Thermal Conductivity of UO_2 (Data Corrected to 95% Theoretical Density)

STPEGS UFSAR

LIST OF FIGURES (Continued)

CHAPTER 4

<u>Figure Number</u>	<u>Title</u>
4.4-10	100% Power Shapes Evaluated at Conditions Representative of Loss of Flow, All Shapes Evaluated with $F \frac{N}{\Delta H} = 1.52$
4.4-11	PWR Natural Circulation Test
4.4-12	Comparison of Representative W 2-Loop Reactor Incore Thermocouple Measurements with THINC-IV Predictions
4.4-13	Comparison of Representative W 3-Loop Reactor Incore Thermocouple Measurements with THINC-IV Predictions
4.4-14	Hanford Subchannel Temperature Data Comparison with THINC-IV
4.4-15	Hanford Subcritical Temperature Data Comparison with THINC-IV
4.4-20	Distribution of Incore Instrumentation
4.4-21	Reactor Coolant System Temperature Percent Power Map