TABLE OF CONTENTS

Section	Title	Page
CHAPTER 5	REACTOR COOLANT SYSTEM AND CONNECTED SYSTEMS	5.1-1
5.1	Summary Description	5.1-1
5.1.1	Design Bases	5.1-1
5.1.2	Design Description	5.1-2
5.1.3	System Components	5.1-4
5.1.3.1	Reactor Vessel	5.1-4
5.1.3.2	AP1000 Steam Generator	5.1-4
5.1.3.3	Reactor Coolant Pumps	5.1-5
5.1.3.4	Primary Coolant Piping	5.1-6
5.1.3.5	Pressurizer	5.1-6
5.1.3.6	Pressurizer Safety Valves	5.1-6
5.1.3.7	Reactor Coolant System Automatic Depressurization Valves	5.1-6
5.1.4	System Performance Characteristics	5.1-7
5.1.4.1	Best-Estimate Flow	5.1-7
5.1.4.2	Minimum Measured Flow	5.1-7
5.1.4.3	Thermal Design Flow	5.1-8
5.1.4.4	Mechanical Design Flow	5.1-8
5.1.5	Combined License Information	5.1-8
5.2	Integrity of Reactor Coolant Pressure Boundary	5.2-1
5.2.1	Compliance with Codes and Code Cases	5.2-1
5.2.1.1	Compliance with 10 CFR 50.55a	5.2-1
5.2.1.2	Applicable Code Cases	5.2-3
5.2.1.3	Alternate Classification	5.2-4
5.2.2	Overpressure Protection	5.2-5
5.2.2.1	Design Bases	5.2-5
5.2.2.2	Design Evaluation	5.2-7
5.2.2.3	Piping and Instrumentation Diagrams	5.2-7
5.2.2.4	Equipment and Component Description	5.2-8
5.2.2.5	Mounting of Pressure Relief Devices	5.2-8
5.2.2.6	Applicable Codes and Classification	5.2-8
5.2.2.7	Material Specifications	5.2-8
5.2.2.8	Process Instrumentation	5.2-9
5.2.2.9	System Reliability	5.2-9
5.2.2.10	Testing and Inspection	5.2-9
5.2.3	Reactor Coolant Pressure Boundary Materials	5.2-9
5.2.3.1	Materials Specifications	5.2-9
5.2.3.2	Compatibility with Reactor Coolant	5.2-10
5.2.3.3	Fabrication and Processing of Ferritic Materials	5.2-13
5.2.3.4	Fabrication and Processing of Austenitic Stainless Steel	5.2-14
5.2.3.5	Threaded Fastener Lubricants	5.2-19

TABLE OF CONTENTS (Cont.)

Section	Title	Page
5.2.4	Inservice Inspection and Testing of Class 1 Components	5.2-19
5.2.4.1	System Boundary Subject to Inspection	5.2-20
5.2.4.2	Arrangement and Inspectability	5.2-20
5.2.4.3	Examination Techniques and Procedures	5.2-21
5.2.4.4	Inspection Intervals	5.2-21
5.2.4.5	Examination Categories and Requirements	5.2-21
5.2.4.6	Evaluation of Examination Results	5.2-22
5.2.4.7	System Leakage and Hydrostatic Pressure Tests	5.2-22
5.2.5	Detection of Leakage Through Reactor Coolant Pressure Boundary	5.2-22
5.2.5.1	Collection and Monitoring of Identified Leakage	5.2-23
5.2.5.2	Intersystem Leakage Detection	5.2-24
5.2.5.3	Collection and Monitoring of Unidentified Leakage	5.2-25
5.2.5.4	Safety Evaluation	5.2-29
5.2.5.5	Tests and Inspections	5.2-29
5.2.5.6	Instrumentation Applications	5.2-29
5.2.5.7	Technical Specification	5.2-30
5.2.6	Combined License Information Items	5.2-31
5.2.6.1	ASME Code and Addenda	5.2-31
5.2.6.2	Plant-Specific Inspection Program	5.2-31
5.2.6.3	Response to Unidentified Reactor Coolant System Leakage Inside Containment	5.2-31
5.2.7	References	5.2-32
5.3	Reactor Vessel	5.3-1
5.3.1	Reactor Vessel Design	5.3-1
5.3.1.1	Safety Design Bases	5.3-1
5.3.1.2	Safety Description	5.3-1
5.3.1.3	System Safety Evaluation	5.3-3
5.3.1.4	Inservice Inspection/Inservice Testing	5.3-3
5.3.2	Reactor Vessel Materials	5.3-3
5.3.2.1	Material Specifications	5.3-3
5.3.2.2	Special Processes Used for Manufacturing and Fabrication	5.3-4
5.3.2.3	Special Methods for Nondestructive Examination	5.3-4
5.3.2.4	Special Controls for Ferritic and Austenitic Stainless Steels	5.3-6
5.3.2.5	Fracture Toughness	5.3-6
5.3.2.6	Material Surveillance	5.3-6
5.3.2.7	Reactor Vessel Fasteners	5.3-13
5.3.3	Pressure-Temperature Limits	5.3-13
5.3.3.1	Limit Curves	5.3-13
5.3.4	Reactor Vessel Integrity	5.3-14
5.3.4.1	Design	5.3-14
5.3.4.2	Materials of Construction	5.3-16

TABLE OF CONTENTS (Cont.)

Section	Title	Page
	5.3.4.3 Fabrication Methods	5.3-17
	5.3.4.4 Inspection Requirements	5.3-17
	5.3.4.5 Shipment and Installation	5.3-17
	5.3.4.6 Operating Conditions	5.3-17
	5.3.4.7 Inservice Surveillance	5.3-18
	5.3.5 Reactor Vessel Insulation	5.3-20
	5.3.5.1 Reactor Vessel Insulation Design Bases	5.3-20
	5.3.5.2 Description of Insulation	5.3-21
	5.3.5.3 Description of External Vessel Cooling Flooded Compartments	5.3-22
	5.3.5.4 Determination of Forces on Insulation and Support System	5.3-22
	5.3.5.5 Design Evaluation	5.3-23
	5.3.6 Combined License Information	5.3-23
	5.3.6.1 Pressure-Temperature Limit Curves	5.3-23
	5.3.6.2 Reactor Vessel Materials Surveillance Program	5.3-23
	5.3.6.3 Surveillance Capsule Lead Factor and Azimuthal Location Confirmation	5.3-23
	5.3.6.4 Reactor Vessel Materials Properties Verification	5.3-24
	5.3.6.5 Reactor Vessel Insulation	5.3-24
	5.3.6.6 Inservice Inspection of Reactor Vessel Head Weld Buildup	5.3-24
	5.3.7 References	5.3-25
5.4	Component and Subsystem Design	5.4-1
	5.4.1 Reactor Coolant Pump Assembly	5.4-1
	5.4.1.1 Design Bases	5.4-1
	5.4.1.2 Pump Assembly Description	5.4-1
	5.4.1.3 Design Evaluation	5.4-3
	5.4.1.4 Tests and Inspections	5.4-9
	5.4.2 Steam Generators	5.4-10
	5.4.2.1 Design Bases	5.4-10
	5.4.2.2 Design Description	5.4-11
	5.4.2.3 Design Evaluation	5.4-13
	5.4.2.4 Steam Generator Materials	5.4-16
	5.4.2.5 Steam Generator Inservice Inspection	5.4-20
	5.4.2.6 Quality Assurance	5.4-21
	5.4.3 Reactor Coolant System Piping	5.4-21
	5.4.3.1 Design Bases	5.4-21
	5.4.3.2 Design Description	5.4-22
	5.4.3.3 Design Evaluation	5.4-24
	5.4.3.4 Material Corrosion/Erosion Evaluation	5.4-25
	5.4.3.5 Test and Inspections	5.4-25

TABLE OF CONTENTS (Cont.)

Section	Title	Page
5.4.4	Main Steam Line Flow Restriction	5.4-26
5.4.4.1	Design Bases	5.4-26
5.4.4.2	Design Description	5.4-27
5.4.4.3	Design Evaluation	5.4-27
5.4.4.4	Inspections	5.4-27
5.4.5	Pressurizer	5.4-27
5.4.5.1	Design Bases	5.4-27
5.4.5.2	Design Description	5.4-29
5.4.5.3	Design Evaluation	5.4-31
5.4.5.4	Tests and Inspections	5.4-34
5.4.6	Automatic Depressurization System Valves	5.4-34
5.4.6.1	Design Bases	5.4-34
5.4.6.2	Design Description	5.4-35
5.4.6.3	Design Verification	5.4-35
5.4.6.4	Inspection and Testing Requirements	5.4-36
5.4.7	Normal Residual Heat Removal System	5.4-36
5.4.7.1	Design Bases	5.4-37
5.4.7.2	System Description	5.4-40
5.4.7.3	Component Description	5.4-44
5.4.7.4	System Operation and Performance	5.4-46
5.4.7.5	Design Evaluation	5.4-48
5.4.7.6	Inspection and Testing Requirements	5.4-49
5.4.7.7	Instrumentation Requirements	5.4-50
5.4.8	Valves	5.4-50
5.4.8.1	Design Bases	5.4-51
5.4.8.2	Design Description	5.4-54
5.4.8.3	Design Evaluation	5.4-55
5.4.8.4	Tests and Inspections	5.4-55
5.4.8.5	Preoperational Testing	5.4-56
5.4.9	Reactor Coolant System Pressure Relief Devices	5.4-59
5.4.9.1	Design Bases	5.4-59
5.4.9.2	Design Description	5.4-60
5.4.9.3	Design Evaluation	5.4-60
5.4.9.4	Tests and Inspections	5.4-61
5.4.10	Component Supports	5.4-62
5.4.10.1	Design Bases	5.4-62
5.4.10.2	Design Description	5.4-62
5.4.10.3	Design Evaluation	5.4-64
5.4.10.4	Tests and Inspections	5.4-65
5.4.11	Pressurizer Relief Discharge	5.4-65
5.4.11.1	Design Bases	5.4-65
5.4.11.2	System Description	5.4-66
5.4.11.3	Safety Evaluation	5.4-66

TABLE OF CONTENTS (Cont.)

Section	Title	Page
5.4.11.4	Instrumentation Requirements	5.4-66
5.4.11.5	Inspection and Testing Requirements	5.4-67
5.4.12	Reactor Coolant System High Point Vents	5.4-67
5.4.12.1	Design Bases	5.4-68
5.4.12.2	System Description	5.4-69
5.4.12.3	Safety Evaluation	5.4-69
5.4.12.4	Inspection and Testing Requirements	5.4-70
5.4.12.5	Instrumentation Requirements	5.4-70
5.4.13	Core Makeup Tank	5.4-70
5.4.13.1	Design Bases	5.4-71
5.4.13.2	Design Description	5.4-71
5.4.13.3	Design Evaluation	5.4-72
5.4.13.4	Material Corrosion/Erosion Evaluation	5.4-72
5.4.13.5	Test and Inspections	5.4-72
5.4.14	Passive Residual Heat Removal Heat Exchanger	5.4-73
5.4.14.1	Design Bases	5.4-73
5.4.14.2	Design Description	5.4-73
5.4.14.3	Design Evaluation	5.4-74
5.4.14.4	Material Corrosion/Erosion Evaluation	5.4-75
5.4.14.5	Testing and Inspections	5.4-75
5.4.15	Combined License Information	5.4-75
5.4.16	References	5.4-76

LIST OF TABLES

Table No.	Title	Page
5.1-1	Principal System Pressures, Temperatures, and Flow Rates	5.1-9
5.1-2	Nominal System Design and Operating Parameters	5.1-10
5.1-3	Thermal-Hydraulic Parameters	5.1-11
5.2-1	Reactor Coolant Pressure Boundary Materials Specifications (Sheets 1 – 5)	5.2-33
5.2-2	Reactor Coolant Water Chemistry Specifications	5.2-39
5.2-3	ASME Code Cases	5.2-40
5.3-1	Maximum Limits for Elements of the Reactor Vessel	5.3-26
5.3-2	Reactor Vessel Quality Assurance Program	5.3-27
5.3-3	End-of-Life RT_{NDT} and Upper Shelf Energy Projections	5.3-29
5.3-4	Reactor Vessel Material Surveillance Program	5.3-30
5.3-5	Reactor Vessel Design Parameters	5.3-31
5.4-1	Reactor Coolant Pump Design Parameters	5.4-77
5.4-2	Not Used	
5.4-3	Reactor Coolant Pump Quality Assurance Program	5.4-79
5.4-4	Steam Generator Design Requirements	5.4-80
5.4-5	Steam Generator Design Parameters (Nominal Values)	5.4-81
5.4-6	Steam Generator Quality Assurance Program	5.4-82
5.4-7	Reactor Coolant System Piping Design	5.4-83
5.4-8	Reactor Coolant System Piping Quality Assurance Program	5.4-84
5.4-9	Pressurizer Design Data	5.4-85
5.4-10	Pressurizer Heater Group Parameters	5.4-86
5.4-11	Reactor Coolant System Design Pressure Settings	5.4-87
5.4-12	Pressurizer Quality Assurance Program	5.4-88
5.4-13	Design Bases for Normal Residual Heat Removal System Operation	5.4-89
5.4-14	Normal Residual Heat Removal System Component Data	5.4-90
5.4-15	Reactor Coolant System Valve Design Parameters	5.4-91
5.4-16	Reactor Coolant System Motor-Operated Valves Design Opening and Closing Pressures	5.4-92
5.4-17	Pressurizer Safety Valves – Design Parameters	5.4-93
5.4-18	Reactor Vessel Head Vent System Design Parameters	5.4-94

LIST OF FIGURES

Figure No.	Title	Page
5.1-1	Reactor Coolant System Schematic Flow Diagram	5.1-12
5.1-2	Reactor Coolant Loops – Isometric View	5.1-13
5.1-3	Reactor Coolant System – Loop Layout	5.1-15
5.1-4	Reactor Coolant System – Elevation	5.1-17
5.1-5	Reactor Coolant System Piping and Instrumentation Diagram (Sheets 1 – 3)	5.1-19
5.2-1	Leak Detection Approach	5.2-41
5.3-1	Reactor Vessel	5.3-32
5.3-2	AP1000 Reactor Coolant System Heatup Limitations (Heatup Rate Up to 50 and 100°F/hour) Representative for the First 54 EFPY (Without Margins for Instrumentation Errors)	5.3-33
5.3-3	AP1000 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 50 and 100°F/hour) Representative for the First 54 EFPY (Without Margins for Instrumentation Errors)	5.3-34
5.3-4	AP1000 Reactor Vessel Surveillance Capsules Locations	5.3-35
5.3-5	Reactor Vessel Key Dimensions Plan View	5.3-36
5.3-6	Reactor Vessel Key Dimensions, Side View	5.3-37
5.3-7	Schematic of Reactor Vessel Insulation	5.3-38
5.3-8	RCS Flooded Compartments During Ex-Vessel Cooling	5.3-39
5.3-9	Door Between RCDT Room and Reactor Cavity Compartment	5.3-40
5.4-1	Reactor Coolant Pump	5.4-95
5.4-2	Steam Generator	5.4-96
5.4-3	Support Plate Geometry (Trifoil Holes)	5.4-97
5.4-4	Surge Line	5.4-98
5.4-5	Pressurizer	5.4-99
5.4-6	Normal Residual Heat Removal System	5.4-100
5.4-7	Normal Residual Heat Removal System Piping and Instrument Diagram	5.4-101
5.4-8	Reactor Vessel Head Vent System	5.4-103