

SECTION 6

ENGINEERED SAFETY FEATURES

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
6.1	CRITERIA	6.1-2
6.1.1	Engineered Safety Features Criteria	6.1-3
6.1.1.1	Engineered Safety Features Basis for Design	6.1-3
6.1.1.2	Reliability and Testability of Engineered Safety Features	6.1-4
6.1.1.3	Protection Against Dynamic Effects and Missiles	6.1-5
6.1.1.4	Engineered Safety Features Performance Capability	6.1-6
6.1.1.5	Engineered Safety Features Components' Capability	6.1-9
6.1.1.6	Accident Aggravation Prevention	6.1-9
6.1.1.7	Sharing of Systems	6.1-10
6.1.2	Related Criteria	6.1-11
6.2	CONTAINMENT SYSTEMS	6.2-1
6.2.1	Containment Function Design	6.2-1
6.2.1.1	Design Basis	6.2-1
6.2.1.2	Containment Structural Acceptance Test	6.2-4
6.2.1.2.1	General Description	6.2-4
6.2.1.2.2	Test Measurements and Instrumentation	6.2-5
6.2.1.2.3	Acceptance Criteria	6.2-8
6.2.1.3	Containment Overall Integrated Leakage Rate Tests	6.2-9
6.2.1.3.1	Preoperational Test	6.2-9
6.2.1.3.2	Periodic Tests	6.2-10
6.2.1.4	Penetration Leakage Rate Tests	6.2-10
6.2.1.4.1	Preoperational Tests	6.2-10
6.2.1.4.2	Periodic Tests	6.2-11

TABLE OF CONTENTS (Cont)

<u>Section</u>	<u>Title</u>	<u>Page</u>
6.2.2	Containment Heat Removal Systems	6.2-11
6.2.2.1	Containment Spray System	6.2-12
6.2.2.1.1	Design Bases	6.2-12
6.2.2.1.2	System Design	6.2-14
6.2.2.1.3	Design Evaluation	6.2-22
6.2.2.1.4	Tests and Inspections	6.2-26
6.2.2.2	Containment Fan Cooling System	6.2-28
6.2.2.2.1	Design Basis	6.2-28
6.2.2.2.2	System Description	6.2-31
6.2.2.2.3	Design Evaluation	6.2-39
6.2.2.2.4	Tests and Inspection	6.2-42
6.2.3	Containment Atmosphere Iodine Removal	6.2-43
6.2.3.1	Introduction	6.2-43
6.2.3.2	Iodine Removal Model	6.2-44
6.2.3.3	Experimental Verification of the Iodine Removal Model	6.2-51
6.2.3.4	Iodine Removal Evaluation	6.2-52
6.2.3.4.1	Injection Phase Operation	6.2-52
6.2.3.4.2	Recirculation Phase	6.2-53
6.2.3.4.3	Re-Evolution of Iodine	6.2-53
6.2.4	Containment Isolation System	6.2-54
6.2.4.1	Design Bases	6.2-54
6.2.4.2	System Description	6.2-55
6.2.4.3	Design Evaluation	6.2-62
6.2.4.4	Tests and Inspections	6.2-65
6.2.5	Combustible Gas Control	6.2-68
6.2.5.1	Hydrogen Production	6.2-68
6.2.5.1.1	Methods of Analysis	6.2-68
6.2.5.1.2	Zirconium-Water Reaction	6.2-69
6.2.5.1.3	Corrosion of Plant Materials	6.2-69
6.2.5.1.4	Radiolysis	6.2-71
6.2.5.1.5	Coatings	6.2-76
6.2.5.1.6	Chemical and Volume Control System	6.2-77

TABLE OF CONTENTS (Cont)

<u>Section</u>	<u>Title</u>	<u>Page</u>
6.2.5.1.7	Results	6.2-77
6.2.5.2	Hydrogen Control	6.2-77
6.2.5.2.1	Hydrogen Recombiner Description	6.2-78
6.2.5.2.2	Recombiner Test Program	6.2-78
6.2.5.2.3	Recombiner Inservice Testing	6.2-78
6.2.5.2.4	Hydrogen Purge	6.2-78
6.2.5.3	Hydrogen Monitoring	6.2-78
6.2.6	References for Section 6.2	6.2-80
6.3	EMERGENCY CORE COOLING SYSTEM	6.3-1
6.3.1	Design Bases	6.3-1
6.3.1.1	Range of Coolant Ruptures and Leaks	6.3-1
6.3.1.2	Fission Product Decay Heat	6.3-2
6.3.1.3	Reactivity Required for Cold Shutdown	6.3-2
6.3.1.4	Capability to Meet Functional Requirements	6.3-3
6.3.2	System Design	6.3-4
6.3.2.1	Schematic Piping and Instrumentation Diagrams	6.3-4
6.3.2.2	Equipment and Component Description	6.3-10
6.3.2.3	Applicable Codes and Classifications	6.3-33
6.3.2.4	Materials' Specification and Compatibility	6.3-33
6.3.2.5	Design Pressures and Temperatures	6.3-33a
6.3.2.6	Coolant Quantity	6.3-34
6.3.2.7	Pump Characteristics	6.3-37
6.3.2.8	Heat Exchanger Characteristics	6.3-37
6.3.2.9	Emergency Core Cooling System Flow Diagrams	6.3-37
6.3.2.10	Relief Valves	6.3-38
6.3.2.11	System Reliability	6.3-38
6.3.2.12	Protection Provisions	6.3-44
6.3.2.13	Provisions for Performance Testing	6.3-45
6.3.2.14	Pump Net Positive Suction Head	6.3-45
6.3.2.15	Control of Motor-Operated Isolation Valves	6.3-45
6.3.2.16	Motor-Operated Valves and Controls	6.3-46
6.3.2.17	Manual Actions	6.3-48
6.3.2.18	Process Instrumentation	6.3-48
6.3.2.19	Materials	6.3-48

TABLE OF CONTENTS (Cont)

<u>Section</u>	<u>Title</u>	<u>Page</u>
6.3.3	Design Evaluation	6.3-48
6.3.3.1	Evaluation Model	6.3-48
6.3.3.2	Small Break Analysis	6.3-49
6.3.3.3	Steam Line Rupture Analysis	6.3-49
6.3.3.4	Fuel Rod Perforations	6.3-49
6.3.3.5	Effects of Core Cooling System Operation on the Core	6.3-49
6.3.3.6	Use of Dual Function Components	6.3-49
6.3.3.7	Lag Times	6.3-52
6.3.3.8	Thermal Shock Considerations	6.3-53
6.3.3.9	Limits on System Parameters	6.3-54
6.3.4	Tests and Inspections	6.3-54
6.3.4.1	Component Testing	6.3-54
6.3.4.2	System Testing	6.3-56
6.3.4.3	Operational Sequence Testing	6.3-57
6.3.4.4	Conformance With Regulatory Guide 1.79	6.3-58
6.3.5	Instrumentation Application	6.3-60
6.3.5.1	Temperature Indication	6.3-60
6.3.5.2	Pressure Indication	6.3-61
6.3.5.3	Flow Indication	6.3-62
6.3.5.4	Level Indication	6.3-63
6.3.5.5	Valve Position Indication	6.3-63
6.3.6	References for Section 6.3	6.3-64
6.4	HABITABILITY SYSTEMS	6.4-1
6.4.1	Design Bases	6.4-1
6.4.2	System Design	6.4-1a
6.4.2.1	Control Room Envelope	6.4-1a
6.4.2.2	Ventilation System Design	6.4-1a
6.4.2.3	Leak Tightness	6.4-1b
6.4.3	System Operational Procedures	6.4-1c
6.4.4	Design Evaluation	6.4-1c
6.4.4.1	Normal Operation	6.4-1c
6.4.4.2	Radiological Protection	6.4-1c
6.4.4.3	Toxic and Chemical Gas Protection	6.4-1d
6.4.4.4	Smoke and Fire Protection	6.4-4
6.4.4.5	Conclusion	6.4-4
6.4.5	Testing and Inspection	6.4-4
6.4.6	References for Section 6.4	6.4-4

LIST OF TABLES

<u>Table</u>	<u>Title</u>
6.2-1	Containment Spray System - Code Requirements
6.2-2	Containment Spray Pump Design Parameters
6.2-3	Spray Additive Tank Design Parameters
6.4-4	Single Failure Analysis - Containment Spray System
6.2-5	Shared Functions Evaluation
6.2-6	Net Positive Suction Heads for Containment Spray
6.2-7	Single Failure Analysis - Containment Fan Cooling System
6.2-8	Shared Function Evaluation
6.2-9	Spray Evaluation Parameters
6.2-10	Containment Isolation - Major Piping Penetrations
6.2-11	Intentionally Left Blank
6.2-12	Deleted
6.2-13	Deleted

LIST OF TABLES (Cont)

<u>Table</u>	<u>Title</u>
6.2-14	Post-Accident Containment Temperature Transient Used in the Calculation of Aluminum Corrosion
6.2-15	Input Parameters and Aluminum Inventory Parameters Used to Determine Hydrogen Generation - Inventory of Aluminum in Containment (Nuclear Steam Supply System)
6.2-16	Core Fission Product Energy After 830 Full Power Days
6.2-17	Fission Product Decay Deposition in Sump Solution
6.3-1	ECCS Code Requirements
6.3-2	Accumulator Design Parameters
6.3-3	Boron Injection Tank Design Parameters
6.3-4	Refueling Water Storage Tank Design Parameters
6.3-5	Design Parameters - ECCS Pumps
6.3-6	Sequence of Changeover Operation Injection to Recirculation
6.3-7	4-Loop Pump Parameters
6.3-8	Changeover Depletion Analysis
6.3-9	Single Active Failure Analysis - Emergency Core Cooling System
6.3-10	Accumulator Inleakage

LIST OF TABLES (Cont)

<u>Table</u>	<u>Title</u>
6.3-11	Single Passive Failure Analysis - Emergency Core Cooling System Recirculation Phase
6.3-12	Recirculation Loop Leakage Sources
6.3-13	Net Positive Suction Heads for Post-accident Operational Pumps
6.3-14	Materials Employed for Emergency Core Cooling System Components
6.4-1	Deleted
6.4-2	Deleted
6.4-3	Control Area Ventilation System Parameters

LIST OF FIGURES

Figure	Title
6.2-1	Containment Instrumentation
6.2-2	Large Penetration Instrumentation (Equipment and Personnel Hatches)
6.2-3	Location of Strain Sensitive Coatings on the Containment
6.2-4A	Deleted: Refer to Plant Drawing 205235
6.2-4B	Deleted: Refer to Plant Drawing 205335
6.2-5	Deleted: Refer to VTD 121398
6.2-6	Deleted: Refer to Plant Drawing 207466
6.2-7	Deleted: Refer to Plant Drawing 207467
6.2-8	Deleted: Refer to Plant Drawing 223112
6.2-9	Deleted: Refer to Plant Drawing 223114
6.2-10	Deleted: Refer to Plant Drawing 223123
6.2-11	Deleted: Refer to VTD 142864
6.2-12	Deleted: Refer to VTD 142850
6.2-13	Deleted: Refer to Plant Drawing 224351
6.2-14	Minimum Sump pH vs Time

LIST OF FIGURES

<u>Figure</u>	<u>Title</u>
6.2-15	Minimum Sump Partition Coefficient vs Time (Iodine Reaction not Included)
6.2-16	Containment Isolation Piping Classes
6.2-17	Containment Isolation - Pressurizer Relief Tank Connections
6.2-18	Containment Isolation - Dead Weight Calibrator
6.2-19	Containment Isolation - Relief Lines to Pressurizer Relief Tank
6.2-20	Containment Isolation - Letdown and Charging Lines
6.2-21	Containment Isolation - Seal Water Supply and Return for R.C. Pumps
6.2-22	Containment Isolation - Residual Heat Removal Connections
6.2-23	Containment Isolation - Component Cooling for Excess Letdown HX
6.2-24	Containment Isolation - Component Cooling for Reactor Coolant Pumps
6.2-25	Containment Isolation - Reactor Coolant Drain Tank Connections
6.2-26	Containment Isolation - Reactor Coolant Drain Tank Pumps
6.2-27	Containment Isolation - Accumulator Nitrogen Supply

LIST OF FIGURES (Cont)

<u>Figure</u>	<u>Title</u>
6.2-28	Containment Isolation - Safety Injection Test Line
6.2-29	Containment Isolation - RHR Safety Injection Connections
6.2-30	Containment Isolation - Safety Injection Pump Connections
6.2-31	Containment Isolation - Charging Pump Connections
6.2-32	Containment Isolation - Safety Injection Recirculation From Sump
6.2-33	Containment Isolation - Containment Spray System
6.2-34	Containment Isolation - Reactor Coolant, Steam Generator, Pressurizer, Accumulator Sampling
6.2-35	Containment Isolation - Containment Pressure Instrumentation
6.2-36	Containment Isolation - Containment Air Sampler
6.2-37~	Containment Isolation - Containment Pressure Relief and Purge
6.2-38	Containment Isolation - Service Air, Instrument Air and Domestic Water
6.2-39	Containment Isolation - Containment Fan Cooling Water
6.2-40	Containment Isolation - Main Steam, Feedwater and Blowdown (11 Stm Gen)

LIST OF FIGURES (Cont)

<u>Figure</u>	<u>Title</u>
6.2-41	Containment Isolation - Main Steam, Feedwater and Blowdown (12 Stm Gen)
6.2-42	Containment Isolation - Main Steam, Feedwater and Blowdown (13 Stm Gen)
6.2-43	Containment Isolation - Main Steam, Feedwater and Blowdown (14 Stm Gen)
6.2-44	Containment Isolation - Containment Sump Discharge, Fuel Transfer Tube
6.2-45	Containment Isolation - Refueling Canal Supply and Discharge, Fire Water Supply
6.2-45A	Containment Isolation Post - LOCA Atmospheric Sample
6.2-45B	Containment Isolation Post - LOCA RCS Sample
6.2-45C	Containment Isolation Fill Line for Containment Pressure Instruments
6.2-45D	Containment Isolation Containment Pressure Test Instrumentation
6.2-45E	Containment Isolation Containment Airlock Test Instrumentation
6.2-46	Containment Isolation Legend
6.2-47	Aluminum Corrosion in DBA Environment
6.2-48	Zinc Corrosion in DBA Environment
6.2-49	Results of Westinghouse Capsule Irradiation Tests
6.2-50	Hydrogen Production Rate - Westinghouse Model
6.2-51	Hydrogen Production Rate - AEC Model
6.2-52	Total Hydrogen Accumulated from All Sources Westinghouse Model
6.2-53	Total Hydrogen Accumulated from All Sources AEC Model
6.2-54	Hydrogen Generated by Radiolysis
6.2-55	Hydrogen Generated from Metal Corrosion (Aluminum and Zinc)

LIST OF FIGURES (Cont)

<u>Figure</u>	<u>Title</u>
6.2-56	Deleted
6.2-57	Deleted
6.2-58	Deleted
6.3-1A	Deleted: Refer to Plant Drawing 205234
6.3-1B	Deleted: Refer to Plant Drawing 205334
6.3-2	Deleted: Refer to Plant Drawing 208915
6.3-3	Containment Sump Pit
6.3-4	Pump Head Characteristic Curve - RHR Pump