

**PBAPS UFSAR**

SECTION 14 - PLANT SAFETY ANALYSIS

TABLE OF CONTENTS

<u>SECTION</u>	<u>TITLE</u>
14.0	PLANT SAFETY ANALYSIS
14.0.1	Analytical Objective
14.0.2	Frequency Classification
14.1	<u>UNACCEPTABLE SAFETY RESULTS FOR INCIDENTS OF MODERATE FREQUENCY - ANTICIPATED (EXPECTED) OPERATIONAL TRANSIENTS</u>
14.2	<u>UNACCEPTABLE SAFETY RESULTS FOR INFREQUENT INCIDENTS - ABNORMAL (UNEXPECTED) OPERATIONAL TRANSIENTS</u>
14.3	<u>UNACCEPTABLE SAFETY RESULTS FOR LIMITING FAULTS - DESIGN BASIS ACCIDENTS</u>
14.4	<u>APPROACH TO SAFETY ANALYSIS</u>
14.4.1	General
14.4.2	Analytical Categories
14.4.3	Accidents
14.4.4	Barrier Damage Evaluations
14.4.4.1	Fuel Damage
14.4.4.2	Nuclear System Process Barrier Damage
14.4.4.3	Containment Damage
14.4.5	Licensing Basis Versus Emergency Procedure Guidelines
14.5	<u>ANALYSES OF ABNORMAL OPERATIONAL TRANSIENTS</u>
14.5.1	Events Resulting in a Nuclear System Pressure Increase
14.5.1.1	Electrical Load Rejection (Turbine Control Valve Fast Closure) with Bypass Failure
14.5.1.2	Turbine Trip (Turbine Stop Valve Closure)
14.5.1.2.1	Turbine Trip from High Power with Bypass
14.5.1.2.2	Turbine Trip from High Power without Bypass
14.5.1.2.3	Turbine Trip from Lower Power without Bypass
14.5.1.3	Main Steam Line Isolation Valve Closure
14.5.1.3.1	Closure of All Main Steam Line Isolation Valves
14.5.1.3.2	Closure of One Main Steam Line Isolation Valve
14.5.2	Events Resulting in a Reactor Vessel Water Temperature Decrease
14.5.2.1	Inadvertent Pump Start (HPCIS)
14.5.2.2	Feedwater Controller Failure - Maximum Demand
14.5.2.3	Loss of Feedwater Heating

**PBAPS UFSAR**

TABLE OF CONTENTS (cont'd)

<u>SECTION</u>	<u>TITLE</u>
14.5.2.4	Shutdown Cooling (RHRS) Malfunction - Decreasing Temperature
14.5.3	Events Resulting in a Positive Reactivity Insertion
14.5.3.1	Continuous Rod Withdrawal During Power Range Operation
14.5.3.2	Continuous Rod Withdrawal During Reactor Startup
14.5.3.3	Control Rod Removal Error During Refueling
14.5.3.4	Fuel Assembly Insertion Error During Refueling
14.5.3.5	Misoriented Bundle Event
14.5.4	Events Resulting in a Reactor Vessel Coolant Inventory Decrease
14.5.4.1	Pressure Regulator Failure
14.5.4.2	Inadvertent Opening of a Relief Valve or Safety Valve
14.5.4.3	Loss of Feedwater Flow
14.5.4.4	Loss of Auxiliary Power
14.5.5	Events Resulting in a Core Coolant Flow Decrease
14.5.5.1	Recirculation Flow Control Failure - Decreasing Flow
14.5.5.2	Trip of One Recirculation Pump
14.5.5.3	Trip of Two Adjustable Speed Drives (ASDs)
14.5.5.4	Recirculation Pump Seizure
14.5.6	Events Resulting in a Core Coolant Flow Increase
14.5.6.1	Recirculation Manual Control Station Failure - Increasing Flow
14.5.6.2	Startup of Idle Recirculation Pump
14.6	<u>ANALYSIS OF DESIGN BASIS ACCIDENTS</u>
14.6.1	Introduction
14.6.2	Control Rod Drop Accident
14.6.2.1	Initial Conditions
14.6.2.2	Excursion Analysis Assumptions
14.6.2.3	Fuel Damage
14.6.2.4	Fission Product Release From Fuel
14.6.2.5	Fission Product Transport
14.6.2.6	Fission Product Release to Environs
14.6.2.7	Radiological Effects
14.6.2.8	Elimination of Main Steamline Scram and Primary Containment High Radiation
14.6.3	Loss of Coolant Accident
14.6.3.1	Initial Conditions and Assumptions
14.6.3.2	Nuclear System Depressurization and Core Heatup
14.6.3.3	Primary Containment Response
14.6.3.3.1	Initial Conditions and Assumptions

**PBAPS UFSAR**

TABLE OF CONTENTS (cont'd)

<u>SECTION</u>	<u>TITLE</u>
14.6.3.3.2	Containment Response
14.6.3.3.3	Metal-Water Reaction Effects on the Primary Containment
14.6.3.4	Fission Products Released to Primary Containment
14.6.3.5	Fission Product Release to Secondary Containment
14.6.3.6	Fission Product Release to Environs
14.6.3.7	Radiological Effects
14.6.4	Refueling Accident
14.6.4.1	Accident Scenario Assumptions
14.6.4.2	Fuel Damage
14.6.4.3	Fission Product Release From Fuel
14.6.4.4	Fission Product Release to Secondary Containment
14.6.4.5	Fission Product Release to Environs
14.6.4.6	Radiological Effects
14.6.5	Main Steam Line Break Accident
14.6.5.1	Nuclear System Transient Effects
14.6.5.1.1	Assumptions
14.6.5.1.2	Sequence Events
14.6.5.1.3	Coolant Loss and Reactor Vessel Water Level
14.6.5.2	Radioactive Material Release
14.6.5.2.1	Assumptions
14.6.5.2.2	Fission Product Release from Break
14.6.5.2.3	Steam Cloud Movement
14.6.5.3	Radiological Effects
14.7	<u>CONCLUSIONS</u>
14.8	<u>ANALYTICAL METHODS</u>
14.8.1	Nuclear Excursion Analysis
14.8.1.1	Introduction
14.8.1.2	Description
14.8.2	Reactor Vessel Depressurization Analysis
14.8.2.1	Introduction
14.8.2.2	Theoretical Development
14.8.2.2.1	Mass Balance
14.8.2.2.2	Mass Rate of Change in Vessel
14.8.2.2.3	Rate of Change of Energy in Vessel
14.8.2.2.4	Flashing Rate in Vessel
14.8.2.2.5	Vessel Depressurization Rate
14.8.2.2.6	Mass Flow Rates
14.8.2.3	Numerical Solution
14.8.3	Reactor Core Heatup Analysis
14.8.3.1	Introduction

**PBAPS UFSAR**

TABLE OF CONTENTS (cont'd)

<u>SECTION</u>	<u>TITLE</u>
14.8.3.2	Theoretical Development
14.8.3.2.1	Heat Sources
14.8.3.2.2	Conduction Heat Transfer
14.8.3.2.3	Convection Heat Transfer
14.8.3.2.4	Radiation
14.8.3.3	Method of Solution
14.8.4	Containment Response Analysis
14.8.4.1	Short-Term Containment Response
14.8.4.1.1	Introduction
14.8.4.1.2	Theoretical Development
14.8.4.1.3	Solution
14.8.4.2	Long-Term Containment Pressure Response
14.8.5	Analytical Methods for Calculating Radiological Effects
14.8.5.1	Introduction
14.8.5.2	Meteorological Diffusion Evaluation Methods
14.8.5.2.1	General
14.8.5.2.2	Height of Release
14.8.5.2.3	Diffusion Conditions
14.8.5.2.4	Applied Meteorology
14.8.5.2.5	Cloud Dispersion Calculations
14.8.5.2.6	Cloud Depletion and Group Deposition
14.8.5.2.7	Air Concentration Calculation
14.8.5.3	Radiological Effects Calculation
14.8.5.3.1	Passing Cloud Dose
14.8.5.3.2	Inhalation Dose
14.9	<u>EVALUATIONS USING AEC METHOD</u>
14.9.1	Evaluation of Plant Systems Using TID-14844 Source Terms
14.9.1.1	Source Term Assumptions
14.9.1.2	Standby Gas Treatment System
14.9.1.3	Core Standby Cooling System Components
14.9.1.4	Electrical Penetrations
14.9.1.5	Control Room
14.9.1.6	Conclusion
14.9.2	Current Licensing Basis Evaluations Using the Alternative Source Term (RG 1.183)
14.9.2.1	Loss-of-Coolant Accident (LOCA)
14.9.2.2	Refueling Accident
14.9.2.3	Main Steam Line Break Accident (MSLB)
14.9.2.4	Control Rod Drop Accident (CRDA)
14.9.2.5	Conclusion

**PBAPS UFSAR**

TABLE OF CONTENTS (cont'd)

<u>SECTION</u>	<u>TITLE</u>
14.10	ANALYSIS OF CONTAINMENT RESPONSE
14.10.1	Methodology
14.10.2	Short-Term Containment Pressure Response
14.10.3	Drywell and Suppression Pool Temperature
14.10.4	Long-Term Bulk Suppression Pool Temperature Response - Design Basis Accidents
14.10.4.1	Suppression Pool Temperature Response - DBLOCA
14.10.4.2	Suppression Pool Temperature Response - Small Steam Break LOCA
14.10.4.3	Suppression Pool Temperature Response - Non- Accident Unit
14.10.4.4	Suppression Pool Temperature Response - Loss of RHR Normal Shutdown Cooling Function Event
14.10.5	Long-Term Bulk Suppression Pool Temperature Response - Special Events
14.10.5.1	Station Blackout
14.10.5.2	Appendix R Fire Safe Shutdown
14.10.5.3	Anticipated Transient Without Scram (ATWS)

**PBAPS UFSAR**

SECTION 14.0 - PLANT SAFETY ANALYSIS

LIST OF TABLES

<u>TABLE</u>	<u>TITLE</u>
14.4.1	Plant Safety Analysis Results of Operational Transients
14.4.2	Plant Safety Analysis Results of Design Basis Accidents
14.5.1	Deleted
14.5.2	Continuous Rod Withdrawal Sequence of Events
14.6.1	Control Rod Drop Accident, Fission Product Release Rate to Environs
14.6.2	Control Rod Drop Accident
14.6.3	Primary Containment Response Summary
14.6.4	Loss-of-Coolant Accident, Primary Containment Airborne Fission Product Inventory
14.6.5	Loss-of-Coolant Accident, Secondary Containment Airborne Fission Product Inventory
14.6.6	Loss-of-Coolant Accident, Fission Product Release Rate to Environs
14.6.7	Loss-of-Coolant Accident
14.6.8	Refueling Accident, Secondary Containment Airborne Fission Product Inventory
14.6.9	Refueling Accident, Fission Product Release Rate to Environs
14.6.10	Refueling Accident
14.6.11	Steam Line Break Accident
14.8.1	Calculated Air Concentration for 0-Meter Release Height

**PBAPS UFSAR**

LIST OF TABLES (cont'd)

<u>TABLE</u>	<u>TITLE</u>
14.8.2	Calculated Air Concentration for 30-Meter Release Height
14.8.3	Calculated Air Concentration for 152-Meter Release Height
14.9.1	Activity, Mass Loading, and Heat Loading at Various Locations for TID Release Assumptions
14.9.2	Standby Gas Treatment System Performance
14.9.3	Doses for Various Equipment or Locations Based on TID-14844 Fission Product Release Assumptions
14.9.4	Gamma Ray Energy Spectrum of Fission Products in the Secondary Containment
14.9.5	Biological Dose Rate at the Center of the Control Room Floor Following a Loss-of-Coolant Accident
14.9.6	Integrated Dose in the Control Room
14.9.7	Design Basis Accident Radiological Doses
14.9.8	Sensitivity of Doses to Variation of Assumptions, Loss-of-Coolant Accident
14.9.9	AST Radionuclide and Magnitude
14.9.10	Parameters And Assumptions Used In Post-LOCA Radiological Consequence Analysis
14.9.11	Parameters And Assumptions Used In Fuel Handling Accident Radiological Consequence Analysis
14.9.12	Parameters And Assumptions Used In Control Rod Drop Accident Radiological Consequence Analysis
14.10.1	DBA Containment Response Key Analysis Input Values
14.10.2	Containment Response Results Dual-Unit Interaction
14.10.3	Special Event Containment Response Key Analysis Input Values

**PBAPS UFSAR**

SECTION 14.0 - PLANT SAFETY ANALYSIS

LIST OF FIGURES

<u>FIGURE</u>	<u>TITLE</u>
14.4.1	Plant Safety Analysis Method for Identifying and Evaluating Abnormal Operational Transients
14.4.2	Plant Safety Analysis Method for Identifying and Evaluating Accidents
14.5.1A	Transient Results - Electrical Load Rejection Without Bypass (Unit 3)
14.5.1AA	Peach Bottom Response to LRNBP (Unit 2)
14.5.1B	Deleted
14.5.1BB	Peach Bottom Response to TTNBP (Unit 2)
14.5.2	Deleted
14.5.3	Transient Results - Closure of All Main Steam Isolation Valves (Unit 3)
14.5.3A	Deleted
14.5.3B	Deleted
14.5.4	Deleted
14.5.4A	Deleted
14.5.5	Transient Results - Feedwater Controller Failure, Maximum Demand
14.5.6	Deleted
14.5.7A	Deleted
14.5.7B	Deleted



**PBAPS UFSAR**

LIST OF FIGURES (cont'd)

<u>FIGURE</u>	<u>TITLE</u>
14.5.8	Transient Results - Pressure Regulator Failure - Open
14.5.9	Transient Results - Inadvertent Opening of a Relief Valve or Safety Valve (Unit 3)
14.5.10	Transient Results - Loss of FW Flow (Unit 2)
14.5.11A	Deleted
14.5.11B	Deleted
14.5.11C	Deleted
14.5.12a	Deleted
14.5.12b	Deleted
14.5.13	Deleted
14.5.14	Transient Results - Single Recirculation Flow Controller Failure - Increasing Flow
14.5.15	Transient Results - Startup of Idle Recirculation Pump
14.5.16	Deleted
14.5.17	Deleted
14.5.18	Deleted
14.5.19	Deleted
14.6.1	Maximum Rod Worth Versus Moderator Density
14.6.2	Control Rod Worth As a Function of Core Power
14.6.3	Rod Drop Accident (Cold, Critical) Peak Fuel Enthalpy
14.6.4	Rod Drop Accident (Hot, Critical) Peak Fuel Enthalpy

**PBAPS UFSAR**

LIST OF FIGURES (cont'd)

<u>FIGURE</u>	<u>TITLE</u>
14.6.5	Rod Drop Accident (Power Range) Peak Fuel Enthalpy
14.6.6	LOCA - Humboldt Primary Containment Pressure Response
14.6.7	LOCA - Bodega Bay Primary Containment Pressure Response
14.6.8	LOCA - Bodega Bay Primary Containment Pressure Response
14.6.9	LOCA - Comparison of Calculated and Measured Peak Drywell Pressure for Bodega Bay and Humboldt Tests
14.6.10	LOCA - Primary Containment Pressure Response
14.6.10A	Pressure Response as a Function of Time at 3696 MWt and 100% Core Flow
14.6.10B	Long Term Containment Pressure Response - Normal ECCS Flow
14.6.10C	Drywell Pressure Response - Small Steam Line Break (1.0 sqft)
14.6.11	LOCA - Drywell Temperature Response
14.6.11A	Temperature Response as a Function of Time at 3696 MWt and 100% Core Flow
14.6.11B	Long Term Drywell Airspace Temperature Response - Normal ECCS Flow
14.6.11C	Drywell Airspace Temperature Response - Small Steam Line Break (0.25 sqft)
14.6.12	LOCA - Suppression Pool Temperature Response
14.6.12A	Long Term Suppression Pool Temperature Response - Normal ECCS Flows
14.6.13	Primary Containment Leak Rate
14.6.14	Primary Containment Capability Index for Metal-Water Reaction

**PBAPS UFSAR**

LIST OF FIGURES (cont'd)

<u>FIGURE</u>	<u>TITLE</u>
14.6.15	Main Steam Line Break Accident - Break Location
14.6.16	Main Steam Line Break Accident - Mass of Coolant Through Break
14.6.17	Main Steam Line Break Accident - Normalized Core Inlet Flow
14.6.18	Main Steam Line Break Accident - Minimum Critical Heat Flux Ratio
14.8.1	Fuel Rod and Fuel Bundle Details
14.10.1	Design Case Short-Term RSLB DBLOCA Containment Pressure Response - Design Case
14.10.2	Design Case Short-Term RSLB DBLOCA Containment Temperature Response - Design Case
14.10.3	Bonding Case Short-Term RSLB DBLOCA Containment Pressure Response - Bounding Case
14.10.4	Bounding Case Short-Term RSLB DBLOCA Containment Temperature Response - Bounding Case
14.10.5	Reference Case Short-Term RSLB DBLOCA Containment Pressure Response - Reference Case
14.10.6	Reference Case Short-Term RSLB DBLOCA Containment Temperature Response - Reference Case
14.10.7	Long-Term Small Steam Break LOCA Drywell Temperature Response
14.10.8	SP and WW Temperature Response to RSLB DBLOCA (CIC)
14.10.8A	SP and WW Airspace Temperature Response to RSLB DBLOCA Dual-Unit Interaction (CIC)
14.10.9	DW and WW Airspace Temperature Response to DBLOCA (CIC)
14.10.9A	DW and WW Airspace Temperature Response to DBLOCA Dual-Unit Interaction (CIC)

**PBAPS UFSAR**

LIST OF FIGURES (cont'd)

<u>FIGURE</u>	<u>TITLE</u>
14.10.10	Long-Term Small Break LOCA Suppression Pool Temperature Response
14.10.10A	Long-Term Small Break LOCA Suppression Pool Temperature Response Dual-Unit Interaction
14.10.11	SP Temperature Response of Non-Accident Unit During Safe Shutdown
14.10.12	SP Temperature Response to Loss of Normal RHR Shutdown Cooling Event (CIC)
14.10.12A	SP Temperature Response to Loss of Normal RHR Shutdown Cooling Event Dual-Unit Interaction (CIC)
14.10.13	Deleted
14.10.14	Deleted