

CHAPTER 15—TRANSIENT AND ACCIDENT ANALYSES TABLE OF CONTENTS

15.0	TRANSIENT AND ACCIDENT ANALYSES.....	15.0-1
	15.0.0.1	Classification of Transients and Accidents..... 15.0-1
	15.0.0.2	Accident Analysis Acceptance Criteria..... 15.0-2
	15.0.0.3	Plant Characteristics Considered in the Safety Analysis..... 15.0-2
	15.0.1	Radiological Consequence Analysis 15.0-16
	15.0.2	Computer Codes Used in Analysis..... 15.0-16
	15.0.2.1	PRISM..... 15.0-16
	15.0.2.2	NEMO-K..... 15.0-16
	15.0.2.3	LYNXT..... 15.0-16
	15.0.2.4	S-RELAP5..... 15.0-17
	15.0.2.5	ORIGEN 15.0-17
	15.0.3	Radiological Consequences of Design Basis Accidents 15.0-17
	15.0.3.1	Introduction 15.0-17
	15.0.3.2	Event Categorization..... 15.0-18
	15.0.3.3	Analytical Assumptions 15.0-19
	15.0.3.4	Receptor Variables..... 15.0-20
	15.0.3.5	Small Line Carrying Primary Coolant Break Outside of the Reactor Building Accident..... 15.0-23
	15.0.3.6	Steam Generator Tube Rupture Accident..... 15.0-25
	15.0.3.7	Main Steam Line Break Outside of Reactor Building Accident..... 15.0-27
	15.0.3.8	Locked Rotor Accident..... 15.0-30
	15.0.3.9	Rod Ejection Accident..... 15.0-32
	15.0.3.10	Fuel Handling Accident 15.0-35
	15.0.3.11	Loss of Coolant Accident 15.0-36
	15.0.3.12	Postaccident Reactor Building Water Chemistry Control 15.0-40
	15.0.3.13	Control Room Radiological Habitability..... 15.0-42

15.0.4	Plant Cooldown	15.0-42
15.0.4.1	Post Chapter 15 Events Cooldown	15.0-42
15.0.5	Compliance with Section C.I.15, “Transient and Accident Analyses,” of Regulatory Guide 1.206	15.0-42
15.0.6	References	15.0-42
15.1	Increase in Heat Removal by the Secondary System	15.1-1
15.1.1	Decrease in Feedwater Temperature	15.1-1
15.1.1.1	Identification of Causes and Event Description	15.1-1
15.1.1.2	Methods of Analysis and Assumptions	15.1-1
15.1.1.3	Results	15.1-3
15.1.1.4	Radiological Consequences	15.1-3
15.1.1.5	Conclusions	15.1-4
15.1.1.6	SRP Acceptance Criteria	15.1-4
15.1.2	Increase in Feedwater Flow	15.1-6
15.1.2.1	Identification of Causes and Event Description	15.1-6
15.1.2.2	Methods of Analysis and Assumptions	15.1-6
15.1.2.3	Results	15.1-8
15.1.2.4	Radiological Consequences	15.1-8
15.1.2.5	Conclusions	15.1-9
15.1.2.6	SRP Acceptance Criteria	15.1-9
15.1.3	Increase in Steam Flow	15.1-11
15.1.3.1	Identification of Causes and Event Description	15.1-11
15.1.3.2	Methods of Analysis and Assumptions	15.1-11
15.1.3.3	Results	15.1-12
15.1.3.4	Radiological Consequences	15.1-13
15.1.3.5	Conclusions	15.1-13
15.1.3.6	SRP Acceptance Criteria	15.1-13
15.1.4	Inadvertent Opening of a Steam Generator Relief or Safety Valve	15.1-15
15.1.4.1	Identification of Causes and Event Description	15.1-15
15.1.4.2	Methods of Analysis and Assumptions	15.1-16

15.1.4.3	Results	15.1-17
15.1.4.4	Radiological Consequences.....	15.1-19
15.1.4.5	Conclusions.....	15.1-19
15.1.4.6	SRP Acceptance Criteria	15.1-20
15.1.5	Steam System Piping Failures Inside and Outside of Containment (PWR)	15.1-21
15.1.5.1	Identification of Causes and Event Description	15.1-21
15.1.5.2	Methods of Analysis and Assumptions	15.1-22
15.1.5.3	Results	15.1-23
15.1.5.4	Radiological Consequences.....	15.1-24
15.1.5.5	Conclusions.....	15.1-25
15.1.5.6	SRP Acceptance Criteria	15.1-25
15.1.6	References	15.1-26
15.2	Decrease in Heat Removal by the Secondary System	15.2-1
15.2.1	Loss of External Load.....	15.2-1
15.2.1.1	Identification of Causes and Event Description	15.2-1
15.2.1.2	Method of Analysis and Assumptions	15.2-2
15.2.1.3	Conclusions.....	15.2-2
15.2.2	Turbine Trip	15.2-3
15.2.2.1	Identification of Causes and Event Description	15.2-3
15.2.2.2	Method of Analysis and Assumptions	15.2-3
15.2.2.3	Results	15.2-4
15.2.2.4	Radiological Consequences.....	15.2-4
15.2.2.5	Conclusions.....	15.2-5
15.2.2.6	SRP Acceptance Criteria	15.2-5
15.2.3	Loss of Condenser Vacuum	15.2-8
15.2.3.1	Radiological Consequences.....	15.2-8
15.2.4	Inadvertent Main Steam Isolation Valve Closure	15.2-8
15.2.4.1	Identification of Causes and Event Description	15.2-8
15.2.4.2	Method of Analysis and Assumptions	15.2-9

15.2.4.3	Results	15.2-10
15.2.4.4	Radiological Consequences.....	15.2-11
15.2.4.5	Conclusions.....	15.2-11
15.2.4.6	SRP Acceptance Criteria	15.2-12
15.2.5	Steam Pressure Regulator Failure	15.2-14
15.2.6	Loss of Non-Emergency AC Power to the Station Auxiliaries	15.2-15
15.2.7	Loss of Normal Feedwater Flow.....	15.2-16
15.2.7.1	Identification of Causes and Event Description	15.2-16
15.2.7.2	Method of Analysis and Assumptions	15.2-17
15.2.7.3	Results	15.2-19
15.2.7.4	Radiological Consequences.....	15.2-19
15.2.7.5	Conclusions.....	15.2-19
15.2.7.6	SRP Acceptance Criteria	15.2-20
15.2.8	Feedwater Line Breaks Inside and Outside Containment.....	15.2-22
15.2.8.1	Identification of Causes and Event Description	15.2-22
15.2.8.2	Method of Analysis and Assumptions	15.2-24
15.2.8.3	Results	15.2-25
15.2.8.4	Radiological Consequences.....	15.2-28
15.2.8.5	Conclusions.....	15.2-28
15.2.8.6	SRP Acceptance Criteria	15.2-28
15.2.9	References	15.2-30
15.3	Decrease in Reactor Coolant System Flow Rate	15.3-1
15.3.1	Partial Loss of Forced Reactor Coolant Flow.....	15.3-1
15.3.1.1	Identification of Causes and Event Description	15.3-1
15.3.1.2	Method of Analysis and Assumptions	15.3-2
15.3.1.3	Results	15.3-3
15.3.1.4	Radiological Consequences.....	15.3-4
15.3.1.5	Conclusions.....	15.3-4
15.3.1.6	SRP Acceptance Criteria	15.3-4

15.3.2	Complete Loss of Forced Reactor Coolant Flow	15.3-6
15.3.2.1	Identification of Causes and Event Description	15.3-6
15.3.2.2	Method of Analysis and Assumptions	15.3-6
15.3.2.3	Results	15.3-7
15.3.2.4	Radiological Consequences.....	15.3-7
15.3.2.5	Conclusions.....	15.3-7
15.3.2.6	SRP Acceptance Criteria	15.3-8
15.3.3	Reactor Coolant Pump Rotor Seizure	15.3-10
15.3.3.1	Identification of Causes and Event Description	15.3-10
15.3.3.2	Method of Analysis and Assumptions	15.3-10
15.3.3.3	Results	15.3-11
15.3.3.4	Radiological Consequences.....	15.3-11
15.3.3.5	Conclusions.....	15.3-11
15.3.3.6	SRP Acceptance Criteria	15.3-11
15.3.4	Reactor Coolant Pump Shaft Break	15.3-14
15.3.4.1	Identification of Causes and Event Description	15.3-14
15.3.4.2	Method of Analysis and Assumptions	15.3-14
15.3.5	References	15.3-14
15.4	Reactivity and Power Distribution Anomalies.....	15.4-1
15.4.1	Uncontrolled Control Rod Assembly Withdrawal from a Subcritical or Low-Power Startup Condition	15.4-1
15.4.1.1	Identification of Causes and Event Description	15.4-1
15.4.1.2	Method of Analysis and Assumptions	15.4-4
15.4.1.3	Results	15.4-5
15.4.1.4	Radiological Conclusions	15.4-5
15.4.1.5	Conclusions.....	15.4-5
15.4.1.6	SRP Acceptance Criteria	15.4-5
15.4.2	Uncontrolled Control Rod Assembly Withdrawal at Power	15.4-6
15.4.2.1	Identification of Causes and Event Description	15.4-6

15.4.2.2	Method of Analysis and Assumptions	15.4-8
15.4.2.3	Results	15.4-9
15.4.2.4	Radiological Consequences.....	15.4-9
15.4.2.5	Conclusions.....	15.4-10
15.4.2.6	SRP Acceptance Criteria	15.4-10
15.4.3	Control Rod Misoperation (System Malfunction or Operator Error)	15.4-10
15.4.3.1	Dropped RCCA or RCCA Sub-Bank	15.4-11
15.4.3.2	Statically Misaligned RCCA	15.4-14
15.4.3.3	Single RCCA Withdrawal	15.4-14
15.4.3.4	SRP Acceptance Criteria	15.4-15
15.4.4	Startup of an Inactive Reactor Coolant Pump at an Incorrect Temperature.....	15.4-16
15.4.4.1	Identification of Causes and Event Description	15.4-16
15.4.4.2	Method of Analysis and Assumptions	15.4-17
15.4.4.3	Results	15.4-18
15.4.4.4	Radiological Consequences.....	15.4-19
15.4.4.5	Conclusions.....	15.4-19
15.4.4.6	SRP Acceptance Criteria	15.4-19
15.4.5	Flow Controller Malfunction Causing an Increase in BWR Core Flow Rate	15.4-20
15.4.6	Chemical and Volume Control System Malfunction that Results in a Decrease in the Boron Concentration in the Reactor Coolant	15.4-20
15.4.6.1	Identification of Causes and Accident Description	15.4-20
15.4.6.2	Method of Analysis.....	15.4-24
15.4.6.3	Results	15.4-27
15.4.6.4	Radiological Conclusions	15.4-28
15.4.6.5	Conclusions.....	15.4-28
15.4.6.6	SRP Acceptance Criteria	15.4-28
15.4.7	Inadvertent Loading and Operation of a Fuel Assembly in an Improper Position.....	15.4-31
15.4.7.1	Identification of Causes and Accident Description	15.4-31

15.4.7.2	Method of Analysis and Assumptions	15.4-31
15.4.7.3	Results	15.4-32
15.4.7.4	Conclusions.....	15.4-33
15.4.7.5	SRP Acceptance Criteria	15.4-33
15.4.8	Spectrum of Rod Ejection Accidents in a PWR.....	15.4-34
15.4.8.1	Identification of Causes and Accident Description	15.4-34
15.4.8.2	Method of Analysis and Assumptions	15.4-35
15.4.8.3	Results	15.4-37
15.4.8.4	Radiological Consequences.....	15.4-39
15.4.8.5	Conclusions.....	15.4-39
15.4.8.6	SRP Acceptance Criteria	15.4-39
15.4.9	Spectrum of Rod Drop Accidents (BWR)	15.4-40
15.4.10	References.....	15.4-40
15.5	Increase in Reactor Coolant Inventory	15.5-1
15.5.1	Inadvertent Operation of ECCS or EBS	15.5-1
15.5.1.1	Identification of Causes and Event Description	15.5-1
15.5.1.2	Method of Analysis and Assumptions	15.5-2
15.5.1.3	Results	15.5-4
15.5.1.4	Radiological Consequences.....	15.5-4
15.5.1.5	Conclusions.....	15.5-4
15.5.1.6	SRP Acceptance Criteria	15.5-5
15.5.2	Chemical and Volume Control System Malfunction that Increases Reactor Coolant Inventory	15.5-6
15.5.2.1	Identification of Causes and Event Description	15.5-6
15.5.2.2	Method of Analysis and Assumptions	15.5-7
15.5.2.3	Results	15.5-9
15.5.2.4	Radiological Consequences.....	15.5-9
15.5.2.5	Conclusions.....	15.5-9
15.5.2.6	SRP Acceptance Criteria	15.5-10
15.5.3	References	15.5-11
15.6	Decrease in Reactor Coolant Inventory Events	15.6-1

15.6.1	Inadvertent Opening of a Pressurizer Safety Relief Valve	15.6-1
15.6.1.1	Identification of Causes and Event Description	15.6-1
15.6.1.2	Method of Analysis and Assumptions	15.6-3
15.6.1.3	Results	15.6-5
15.6.1.4	Radiological Consequences.....	15.6-6
15.6.1.5	Conclusions.....	15.6-6
15.6.1.6	SRP Acceptance Criteria	15.6-6
15.6.2	Radiological Consequences of the Failure of Small Lines Carrying Primary Coolant Outside Containment.....	15.6-7
15.6.3	Steam Generator Tube Failure (PWR).....	15.6-7
15.6.3.1	Identification of Causes and Accident Description	15.6-7
15.6.3.2	Method of Analysis and Assumptions	15.6-10
15.6.3.3	Results	15.6-13
15.6.3.4	Radiological Consequences.....	15.6-17
15.6.3.5	Conclusions.....	15.6-17
15.6.3.6	SRP Acceptance Criteria	15.6-18
15.6.4	Radiological Consequences of Main Steam Line Failure Outside Containment (BWR).....	15.6-18
15.6.5	Loss of Coolant Accidents Resulting from Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary	15.6-18
15.6.5.1	Large Break Loss of Coolant Accident.....	15.6-19
15.6.5.2	Small Break Loss of Coolant Accident.....	15.6-26
15.6.5.3	Coolable Core Geometry	15.6-37
15.6.5.4	Long-Term Core Cooling.....	15.6-39
15.6.6	References	15.6-43
15.7	Radioactive Release from a Subsystem or Component.....	15.7-1
15.7.1	Radioactive Gas Waste System Leak or Failure	15.7-1
15.7.2	Radioactive Liquid Waste System Leak or Failure	15.7-1
15.7.3	Postulated Radioactive Releases due to Liquid-Containing Tank Failures	15.7-1
15.7.4	Radiological Consequences of Fuel Handling Accidents	15.7-1
15.7.5	Spent Fuel Cask Drop Accidents	15.7-1



15.8	Anticipated Transients Without Scram	15.8-1
15.8.1	General Background	15.8-1
15.8.1.1	U.S. EPR Design Features	15.8-1
15.8.1.2	Protection System	15.8-2
15.8.1.3	Diverse Actuation System	15.8-2
15.8.1.4	Emergency Feedwater System	15.8-3
15.8.1.5	Extra Borating System	15.8-3
15.8.1.6	Mechanical Blockage of Rod Cluster Control Assemblies	15.8-3
15.8.2	Anticipated Transients Without Scram	15.8-4
15.8.2.1	Loss of Feedwater	15.8-4
15.8.2.2	Loss of Electrical Load	15.8-4
15.8.2.3	Turbine Trip	15.8-5
15.8.2.4	Loss of Condenser Vacuum	15.8-5
15.8.2.5	Loss of Offsite Power	15.8-6
15.8.2.6	Closure of Main Steam Line Isolation Valves	15.8-6
15.8.2.7	Rod Cluster Control Assembly Events	15.8-7
15.8.3	Conclusion	15.8-8
15.8.4	References	15.8-9
15.9	Boiling Water Reactor Stability	15.9-1
15.10	Spent Fuel Pool Criticality and Boron Dilution Analysis	15.10-1