

TABLE OF CONTENTS

1	INTRODUCTION AND GENERAL DESCRIPTION OF THE PLANTN	1-1
1.1	Introduction	1-1
1.1.1	Metrication.....	1-3
1.1.2	Proprietary Information.....	1-3
1.1.3	Applicants Referencing the NuScale Design.....	1-3
1.1.4	Additional Information.....	1-4
1.2	General Design Description	1-4
1.2.1	Scope of the NuScale Small Modular Reactor Design	1-4
1.2.2	Summary of the NuScale Small Modular Reactor Design.....	1-5
1.2.3	Engineered Safety Features and Emergency Systems	1-9
1.2.4	Instrumentation, Controls, and Electrical Systems.....	1-10
1.2.5	Steam Power Conversion System.....	1-11
1.2.6	Fuel Handling and Storage Systems.....	1-11
1.2.7	Plant Cooling Water Systems.....	1-11
1.2.8	Radioactive Waste Management System.....	1-12
1.3	General Arrangement of Major Structures and Equipment	1-12
1.4	Description of Site, Plant, and Facility.....	1-14
1.4.1	Site Description	1-14
1.4.2	General Plant Description	1-14
1.4.3	Facility Description	1-15
1.4.4	Multimodule Design Considerations	1-16
1.5	Comparison with Other Facilities.....	1-16
1.5.1	Nuclear Power Plants to Be Operated on Multiunit Sites	1-17
1.6	Identification of Agents and Contractors	1-17
1.7	Requirements for Additional Technical Information.....	1-17
1.7.1	NuScale Testing Programs.....	1-17
1.8	Material Referenced.....	1-21
1.9	Drawings and Other Detailed Information.....	1-24
1.10	Interfaces with Standard Designs	1-25
1.11	Conformance with Regulatory Criteria	1-38
1.12	Summary of Open Items	1-39
1.13	Summary of Confirmatory Items	1-39

1.14	Index of Exemptions	1-39
1.15	Requests for Additional Information.....	1-42
1.16	Conclusion.....	1-42
2	SITE CHARACTERISTICS AND SITE PARAMETERS	2-1
2.0	Site Characteristics and Site Parameters	2-1
2.0.1	Introduction	2-1
2.0.2	Summary of Application.....	2-1
2.0.3	Regulatory Basis.....	2-2
2.0.4	Technical Evaluation	2-2
2.0.5	Combined License Information Items	2-3
2.0.6	Conclusion	2-3
2.1	Geography and Demography	2-3
2.1.1	Site Location and Description.....	2-3
2.1.2	Exclusion Area Authority and Control.....	2-6
2.1.3	Population Distribution.....	2-9
2.2	Nearby Industrial, Transportation, and Military Facilities	2-11
2.2.1	Identification of Potential Hazards in Site Vicinity.....	2-11
2.2.2	Evaluation of Potential Accidents.....	2-14
2.3	Meteorology	2-17
2.3.1	Regional Climatology.....	2-17
2.3.2	Local Meteorology	2-34
2.3.3	Onsite Meteorological Measurements Programs.....	2-36
2.3.4	Short-Term Atmospheric Dispersion Estimates for Accident Releases.....	2-38
2.3.5	Long-Term Atmospheric Dispersion Estimates for Routine Releases.....	2-43
2.4	Hydrologic Engineering	2-46
2.4.0	Regulatory Basis	2-47
2.4.1	Hydrologic Description.....	2-49
2.4.2	Floods.....	2-51
2.4.3	Probable Maximum Flood on Streams and Rivers.....	2-53
2.4.4	Potential Dam Failures	2-55
2.4.5	Probable Maximum Surge and Seiche Flooding	2-56
2.4.6	Probable Maximum Tsunami Hazards	2-58
2.4.7	Ice Effects	2-59
2.4.8	Cooling Water Canals and Reservoirs	2-60
2.4.9	Channel Diversions	2-61
2.4.10	Flood Protection Requirements.....	2-62
2.4.11	Low Water Considerations	2-63
2.4.12	Ground Water.....	2-64

2.4.13	Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters	2-65
2.4.14	Technical Specifications and Emergency Operation Requirements	2-67
2.5	Geology, Seismology, and Seismic Information.....	2-68
2.5.1	Basic Geologic and Seismic Information	2-68
2.5.2	Vibratory Ground Motion	2-69
2.5.3	Surface Deformation.....	2-73
2.5.4	Stability of Subsurface Materials and Foundations	2-74
2.5.5	Stability of Slopes.....	2-79

3	DESIGN OF STRUCTURES, SYSTEMS, COMPONENTS AND EQUIPMENT	3-1
3.1	Conformance with the U.S. Nuclear Regulatory Commission General Design Criteria	3-1
3.2	Classification of Structures, Systems, and Components	3-3
3.2.1	Seismic Classification	3-3
3.2.2	System Quality Group Classification	3-9
3.3	Wind and Tornado Loading	3-11
3.3.1	Wind Loadings	3-12
3.4	Water Level (Flood) Design	3-16
3.4.1	Internal Flood Protection for Onsite Equipment Failure	3-16
3.4.2	Flood Protection from External Sources	3-19
3.5	Missile Protection	3-22
3.5.1	Missile Selection and Description	3-22
3.5.2	Structures, Systems, and Components to be Protected from Externally Generated Missiles	3-39
3.5.3	Barrier Design Procedures	3-41
3.6	Protection against Dynamic Effects Associated with the Postulated Rupture of Piping	3-45
3.6.1	Plant Design for Protection against Postulated Piping Failures in Fluid Systems Outside Containment	3-45
3.6.2	Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping	3-54
3.6.3	Leak-before-Break Evaluation Procedures	3-71
3.7	Seismic Design	3-72
3.7.1	Seismic Design Parameters	3-72
3.7.2	Seismic System Analysis	3-80
3.7.3	Seismic Subsystem Analysis	3-98
3.7.4	Seismic Instrumentation	3-105
3.8	Design of Category I Structures	3-108
3.8.1	Concrete Containment	3-108
3.8.2	Steel Containment	3-108
3.8.3	Concrete and Steel Internal Structures of Steel Containments	3-123
3.8.4	Seismic Category I Structures	3-123
3.8.5	Foundations	3-138
3.9	Mechanical Systems and Components	3-151
3.9.1	Special Topics for Mechanical Components	3-151
3.9.2	Dynamic Testing and Analysis of Systems, Structures, and Components	3-156

3.9.3	ASME BPV Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures	3-192
3.9.4	Control Rod Drive Systems	3-198
3.9.5	Reactor Pressure Vessel Internals	3-204
3.9.6	Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints.....	3-216
3.10	Seismic and Dynamic Qualification of Mechanical and Electrical Equipment	3-241
3.10.1	Introduction	3-241
3.10.2	Summary of Application	3-241
3.10.3	Regulatory Basis.....	3-241
3.10.4	Technical Evaluation.....	3-242
3.10.5	Combined License Information Items	3-250
3.10.6	Conclusion.....	3-250
3.11	Environmental Qualification of Mechanical and Electrical Equipment	3-251
3.11.1	Introduction	3-251
3.11.2	Summary of Application	3-251
3.11.3	Regulatory Basis.....	3-252
3.11.4	Technical Evaluation.....	3-255
3.11.5	Combined License Information Items	3-268
3.11.6	Conclusion.....	3-269
3.12	ASME BPV Code Class 1, 2, and 3 Piping Systems and Associated Support Design.....	3-269
3.12.1	Introduction	3-269
3.12.2	Summary of Application	3-270
3.12.3	Regulatory Basis.....	3-270
3.12.4	Technical Evaluation.....	3-272
3.12.5	Combined License Information Items	3-293
3.12.6	Conclusion.....	3-293
3.13	Threaded Fasteners—ASME BPV Code Class 1, 2, and 3	3-294
3.13.1	Introduction	3-294
3.13.2	Summary of Application	3-294
3.13.3	Regulatory Basis.....	3-296
3.13.4	Technical Evaluation.....	3-297
3.13.5	Combined License Information Items	3-305
3.13.6	Conclusion.....	3-305
4	REACTOR	4-1
4.1	Summary Description	4-1
4.2	Fuel System Design.....	4-1

4.2.1	Introduction	4-1
4.2.2	Summary of Application	4-1
4.2.3	Regulatory Basis	4-3
4.2.4	Technical Evaluation.....	4-4
4.2.5	Combined License Information Items.....	4-17
4.2.6	Conclusion	4-17
4.3	Nuclear Design	4-18
4.3.1	Introduction	4-18
4.3.2	Summary of Application	4-18
4.3.3	Regulatory Basis	4-21
4.3.4	Technical Evaluation.....	4-22
4.3.5	Combined License Information Items.....	4-33
4.3.6	Conclusion	4-33
4.4	Thermal-Hydraulic Design.....	4-34
4.4.1	Introduction	4-34
4.4.2	Summary of Application	4-35
4.4.3	Regulatory Basis	4-36
4.4.4	Technical Evaluation.....	4-37
4.4.5	Combined License Information Items.....	4-42
4.4.6	Conclusion	4-42
4.5	Reactor Materials	4-43
4.5.1	Control Rod Drive Structural Materials.....	4-43
4.5.2	Reactor Internal Core and Support Structure Materials.....	4-48
4.6	Functional Design of Control Rod Drive System.....	4-51
4.6.1	Introduction	4-51
4.6.2	Summary of Application	4-52
4.6.3	Regulatory Basis	4-52
4.6.4	Technical Evaluation.....	4-53
4.6.5	Combined License Information Items.....	4-57
4.6.6	Conclusion	4-57
5	REACTOR COOLANT SYSTEM AND CONNECTING SYSTEMS	5-1
5.1	Introduction	5-1
5.2	Integrity of Reactor Coolant Boundary	5-1
5.2.1	Compliance with Codes and Code Cases	5-1
5.2.2	Overpressure Protection	5-8
5.2.3	Reactor Coolant Pressure Boundary Materials.....	5-13
5.2.4	Inservice Inspection and Testing of the Reactor Coolant Pressure Boundary	5-23

5.2.5	Reactor Coolant Pressure Boundary Leakage Detection	5-29
5.3	Reactor Vessel	5-35
5.3.1	Reactor Vessel Materials	5-35
5.3.2	Pressure-Temperature Limits, Pressurized thermal Shock, and Charpy Upper-Shelf Energy Data and Analyses	5-45
5.3.3	Reactor Vessel Integrity	5-50
5.3.4	SDAA Part 7, Section 6 Exemption, Acceptance Criteria for Fracture Prevention Measures	5-52
5.3.5	SDAA Part 7, Section 15 Exemption, Fracture Toughness Requirements for Protection Against Thermal Shock.....	5-55
5.4	Reactor Coolant System Components and Subsystem Design	5-57
5.4.1	Steam Generators	5-57
5.4.2	Reactor Coolant System Piping	5-92
5.4.3	Decay Heat Removal System	5-93
5.4.4	Reactor Coolant System High-Point Vents	5-102
5.4.5	Pressurizer.....	5-109
6	ENGINEERED SAFETY FEATURES	6-1
6.1	Engineered Safety Feature Materials	6-1
6.1.1	Engineered Safety Feature Materials	6-1
6.1.2	Organic Materials	6-14
6.2	Containment Systems	6-14
6.2.1	Introduction	6-14
6.2.2	Containment Heat Removal.....	6-55
6.2.3	Secondary Containment Functional Design	6-72
6.2.4	Containment Isolation System.....	6-72
6.2.5	Combustible Gas Control in Containment	6-96
6.2.6	Containment Leakage Testing	6-105
6.2.7	Fracture Prevention of Containment Pressure Boundary.....	6-115
6.3	Emergency Core Cooling System.....	6-118
6.3.1	Introduction	6-118
6.3.2	Summary of Application	6-118
6.3.3	Regulatory Basis	6-119
6.3.4	Technical Evaluation.....	6-121
6.3.5	Combined License Information Items	6-134
6.3.6	Conclusion	6-134
6.4	Control Room Habitability	6-135
6.4.1	Introduction	6-135
6.4.2	Summary of Application	6-135
6.4.3	Regulatory Basis	6-137

6.4.4	Technical Evaluation.....	6-138
6.4.5	Combined License Information Items.....	6-146
6.4.6	Conclusion	6-146
6.5	Fission Product Removal and Control Systems.....	6-146
6.5.1	Engineered Safety Features Filter Systems	6-146
6.5.2	Containment Spray System	6-147
6.5.3	Fission Product Control Systems	6-147
6.5.4	Ice Condenser as a Fission Product Cleanup System.....	6-147
6.5.5	Pressure Suppression Pool as a Fission Product Cleanup System.....	6-147
6.6	Inservice Inspection and Testing of Class 2 and 3 Systems and Components.....	6-147
6.6.1	Introduction	6-147
6.6.2	Summary of Application	6-147
6.6.3	Regulatory Basis	6-148
6.6.4	Technical Evaluation.....	6-148
6.6.5	Conclusions.....	6-153
7	INSTRUMENTATION AND CONTROLS	7-1
7.0	Introduction and Review Process	7-2
7.0.1	Introduction	7-2
7.0.2	Summary of Application	7-2
7.0.3	Regulatory Basis	7-4
7.0.4	Technical Evaluation.....	7-6
7.0.5	Combined License Information Item.....	7-16
7.0.6	Conclusions.....	7-16
7.1	Instrumentation and Controls—Fundamental Design Principles	7-16
7.1.1	Safety System Design-Basis	7-17
7.1.2	Independence	7-24
7.1.3	Predictability and Repeatability	7-44
7.1.4	Diversity and Defense in Depth	7-49
7.1.5	Disposition of Application-Specific Action Items in the Topical Report Safety Evaluation “Design of Highly Integrated Protection Platform”	7-67
7.1.6	Not Used.....	7-85
7.1.7	Hazard Analysis	7-85
7.2	Instrumentation and Controls—System Characteristics	7-88
7.2.1	Quality.....	7-88
7.2.2	Equipment Qualification	7-101
7.2.3	Reliability, Integrity, and Completion of Protective Action	7-105
7.2.4	Operating and Maintenance Bypasses	7-112
7.2.5	Interlocks	7-116
7.2.6	Derivation of System Inputs.....	7-118
7.2.7	Setpoints.....	7-121
7.2.8	Auxiliary Features	7-131

7.2.9	Control of Access, Identification, and Repair	7-135
7.2.10	Interaction between Sense and Command Features and Other Systems	7-142
7.2.11	Multi-unit Stations	7-144
7.2.12	Automatic and Manual Control	7-147
7.2.13	Displays and Monitoring	7-150
7.2.14	Human Factors Considerations	7-158
7.2.15	Capability for Test and Calibration	7-160
8	ELECTRIC POWER	8-1
8.1	Electric Power—Introduction	8-1
8.1.1	Introduction	8-2
8.1.2	Technical Evaluation of Exemption Request	8-2
8.1.3	Evaluation of the Exemption Criteria of 10 CFR 50.12	8-6
8.1.4	Conclusion	8-8
8.2	Offsite Power System	8-8
8.2.1	Introduction	8-8
8.2.2	Summary of Application	8-8
8.2.3	Regulatory Basis	8-9
8.2.4	Technical Evaluation	8-11
8.2.5	Combined License Information Items	8-17
8.2.6	Conclusion	8-17
8.3	Onsite Power Systems	8-18
8.3.1	Alternating Current Power Systems	8-18
8.3.2	Direct Current Power Systems	8-29
8.4	Station Blackout	8-43
8.4.1	Introduction	8-43
8.4.2	Summary of Application	8-43
8.4.3	Regulatory Basis	8-43
8.4.4	Technical Evaluation	8-44
8.4.5	Combined License Information Items	8-46
8.4.6	Conclusion	8-46
9	AUXILIARY SYSTEMS	9-1
9.1	Fuel Storage and Handling	9-1
9.1.1	Criticality Safety of Fresh and Spent Fuel Storage Handling	9-1
9.1.2	New and Spent Fuel Storage	9-4

9.1.3	Pool Cooling and Cleanup System	9-12
9.1.4	Light Load Handling System (Related to Refueling)	9-22
9.1.5	Overhead Heavy Load Handling Systems	9-27
9.2	Water Systems	9-39
9.2.1	Station Service Water System.....	9-39
9.2.2	Reactor Component Cooling Water System	9-40
9.2.3	Demineralized Water System	9-45
9.2.4	Potable and Sanitary Water Systems.....	9-48
9.2.5	Ultimate Heat Sink	9-51
9.2.6	Condensate Storage Facilities.....	9-59
9.2.7	Site Cooling Water System.....	9-62
9.2.8	Chilled Water Systems	9-67
9.2.9	Utility Water Systems.....	9-71
9.3	Process Auxiliaries	9-73
9.3.1	Compressed Air Systems	9-73
9.3.2	Process Sampling Systems	9-75
9.3.3	Equipment and Floor Drain Systems.....	9-87
9.3.4	Chemical and Volume Control System	9-90
9.3.5	Standby Liquid Control System (BWR)—Not Applicable.....	9-102
9.3.6	Containment Evacuation System and Containment Flooding and Drain System	9-102
9.3.7	Containment Flooding and Drain System	9-105
9.4	Air Conditioning, Heating, and Ventilation Systems	9-108
9.4.1	Control Room Area Ventilation System	9-108
9.4.2	Reactor Building and Spent Fuel Pool Area Ventilation System	9-114
9.4.3	Radioactive Waste Building Ventilation System	9-120
9.4.4	Turbine Building Ventilation System	9-123
9.5	Other Process Auxiliaries	9-125
9.5.1	Fire Protection Program	9-125
9.5.2	Communication Systems	9-143
9.5.3	Lighting Systems	9-149
9.5.4	Backup Diesel Generator Auxiliary Systems	9-154
10	STEAM AND POWER CONVERSION SYSTEM.....	10-1
10.1	Summary Description	10-2
10.2	Turbine Generator	10-2
10.2.1	Introduction	10-2
10.2.2	Summary of Application	10-2
10.2.3	Regulatory Basis	10-2
10.2.4	Technical Evaluation.....	10-3

10.2.5	Initial Test Program.....	10-4
10.2.6	Conclusion	10-4
10.3	Main Steam System.....	10-4
10.3.1	Main Steam System.....	10-4
10.3.2	Steam and Feedwater System Materials	10-10
10.4	Other Features of Steam and Power Conversion System	10-14
10.4.1	Air-Cooled Condensers	10-14
10.4.2	Condenser Air Removal System	10-17
10.4.3	Turbine Gland Sealing System.....	10-19
10.4.4	Turbine Bypass System	10-20
10.4.5	Condenser Polisher Skid and Resin Regeneration System.....	10-22
10.4.6	Condensate and Feedwater System	10-27
10.4.7	Auxiliary Boiler System.....	10-32
10.4.8	Feedwater Treatment System	10-34
11	RADIOACTIVE WASTE MANAGEMENT	11-1
11.1	Source Terms	11-1
11.1.1	Introduction	11-1
11.1.2	Summary of Application	11-2
11.1.3	Regulatory Basis	11-3
11.1.4	Technical Evaluation.....	11-4
11.1.5	Combined License Information Items	11-6
11.1.6	Conclusion.....	11-6
11.2	Liquid Waste Management System.....	11-7
11.2.1	Introduction	11-7
11.2.2	Summary of Application	11-7
11.2.3	Regulatory Basis	11-10
11.2.4	Technical Evaluation.....	11-12
11.2.5	Combined License Items.....	11-19
11.2.6	Conclusion.....	11-20
11.3	Gaseous Waste Management System.....	11-22
11.3.1	Introduction	11-22
11.3.2	Summary of Application	11-22
11.3.3	Regulatory Basis	11-24

11.3.4	Technical Evaluation.....	11-27
11.3.5	Combined License Items.....	11-32
11.3.6	Conclusion.....	11-33
11.4	Solid Waste Management System.....	11-35
11.4.1	Introduction	11-35
11.4.2	Summary of Application	11-35
11.4.3	Regulatory Basis	11-38
11.4.4	Technical Evaluation.....	11-40
11.4.5	Combined License Items.....	11-43
11.4.6	Conclusion.....	11-44
11.5	Process and Effluent Radiological Monitoring Instrumentation and Sampling System.....	11-45
11.5.1	Introduction	11-45
11.5.2	Summary of Application	11-45
11.5.3	Regulatory Basis	11-47
11.5.4	Technical Evaluation.....	11-49
11.5.5	Combined License Items.....	11-54
11.5.6	Conclusion.....	11-54
11.6	Instrumentation and Control Design Features for Process and Effluent Radiological Monitoring and Area Radiation and Airborne Radioactivity Monitoring.....	11-56
11.6.1	Introduction/Summary.....	11-56
11.6.2	Regulatory Basis	11-56
11.6.3	Technical Evaluation.....	11-56
11.6.4	Combined License Items.....	11-56
11.6.5	Conclusion.....	11-56
12	RADIATION PROTECTION	12-1
12.1	Ensuring that Occupational Radiation Exposures Are As Low As Is Reasonably Achievable.....	12-1
12.1.1	Introduction	12-1
12.1.2	Summary of Application	12-2
12.1.3	Regulatory Basis	12-2
12.1.4	Technical Evaluation.....	12-4
12.1.5	Combined License Information Items.....	12-5
12.1.6	Conclusion.....	12-5
12.2	Radiation Sources.....	12-5
12.2.1	Introduction	12-5
12.2.2	Summary of Application	12-6

12.2.3	Regulatory Basis	12-7
12.2.4	Technical Evaluation.....	12-9
12.2.5	Combined License Information Items.....	12-20
12.2.6	Conclusion.....	12-20
12.3	Radiation Protection Design Features.....	12-21
12.3.1	Introduction	12-21
12.3.2	Summary of Application	12-22
12.3.3	Regulatory Basis	12-23
12.3.4	Technical Evaluation.....	12-28
12.3.5	Combined License Information Items.....	12-44
12.3.6	Conclusion.....	12-45
12.4	Dose Assessment	12-46
12.5	Operational Radiation Protection Program.....	12-46
12.5.1	Introduction	12-46
12.5.2	Summary of Application	12-46
12.5.3	Regulatory Basis	12-46
12.5.4	Technical Evaluation.....	12-47
12.5.5	Combined License Information Items.....	12-47
12.5.6	Conclusion.....	12-48
13	CONDUCT OF OPERATIONS.....	13-1
13.1	Organizational Structure.....	13-1
13.1.1	Introduction	13-1
13.1.2	Summary of Application	13-1
13.1.3	Regulatory Basis.....	13-2
13.1.4	Technical Evaluation.....	13-3
13.1.5	Combined License Information Items	13-4
13.1.6	Conclusion.....	13-5
13.2	Training.....	13-5
13.2.1	Introduction	13-5
13.2.2	Summary of Application	13-5
13.2.3	Regulatory Basis.....	13-6
13.2.4	Technical Evaluation.....	13-8
13.2.5	Combined License Information Items	13-9
13.2.6	Conclusion.....	13-9
13.3	Emergency Planning.....	13-9
13.3.1	Introduction	13-10
13.3.2	Summary of Application	13-10

13.3.3	Regulatory Basis	13-12
13.3.4	Technical Evaluation.....	13-12
13.3.5	Combined License Information Items	13-19
13.3.6	Conclusion.....	13-20
13.4	Operational Programs	13-20
13.4.1	Introduction	13-20
13.4.2	Summary of Application	13-20
13.4.3	Regulatory Basis	13-20
13.4.4	Technical Evaluation.....	13-21
13.4.5	Combined License Information Items	13-21
13.4.6	Conclusion.....	13-22
13.5	Plant Procedures	13-22
13.5.1	Introduction	13-22
13.5.2	Summary of Application	13-22
13.5.3	Regulatory Basis	13-22
13.5.4	Technical Evaluation.....	13-24
13.5.5	Combined License Information Items	13-25
13.5.6	Conclusion.....	13-27
13.6	Physical Security	13-27
13.6.1	Introduction	13-27
13.6.2	Summary of Application	13-28
13.6.3	Regulatory Basis	13-29
13.6.4	Technical Evaluation	13-30
13.6.5	Combined License Information Items.....	13-42
13.6.6	Conclusion	13-44
13.7	Fitness for Duty	13-45
13.7.1	Conclusion	13-45
14	INITIAL TEST PROGRAM AND INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA	14-1
14.1	Introduction	14-1
14.2	Initial Test Program.....	14-1
14.2.1	Generic Guidelines for Initial Test Programs.....	14-1
14.3	Inspections, Tests, Analyses, and Acceptance Criteria	14-14
14.3.1	Selection Criteria for Standard Design Approval Application	14-15
14.3.2	Structural and Systems Engineering—Inspections, Tests, Analyses, and Acceptance Criteria	14-19
14.3.3	Piping Systems and Components—Inspections, Tests, Analyses, and	

Acceptance Criteria	14-24
14.3.4 Reactor Systems—Inspections, Tests, Analyses, and Acceptance Criteria	14-30
14.3.5 Instrumentation and Controls—Inspections, Tests, Analyses, and Acceptance Criteria.....	14-33
14.3.6 Electrical Systems—Inspections, Tests, Analyses, and Acceptance Criteria	14-35
14.3.7 Plant Systems—Inspections, Tests, Analyses, and Acceptance Criteria	14-37
14.3.8 Radiation Protection—Inspections, Tests, Analyses, and Acceptance Criteria	14-47
14.3.9 Human Factors Engineering—Inspections, Tests, Analyses, and Acceptance Criteria.....	14-53
14.3.10 Emergency Planning—Inspections, Tests, Analyses, and Acceptance Criteria	14-56
14.3.11 Containment Systems—Inspections, Tests, Analyses, and Acceptance Criteria	14-57
14.3.12 Physical Security Hardware—Inspections, Tests, Analyses, and Acceptance Criteria	14-60
14.3.13 External Flooding Protection—Inspections, Tests, Analyses, and Acceptance Criteria	14-70
15 TRANSIENT AND ACCIDENT ANALYSES.....	15-1
15.0 Transient and Accident Analysis	15-1
15.0.0 Classification and Key Assumptions	15-1
15.0.1 Radiological Consequence Analyses Using Alternative Source Terms	15-17
15.0.2 Review of Transient and Accident Analysis Methods	15-17
15.0.3 Radiological Consequences of Design-Basis Accidents	15-25
15.0.4 Safe, Stabilized Condition.....	15-39
15.0.5 Extended Passive Cooling for Decay and Residual Heat Removal	15-40
15.1 Increase in Heat Removal by the Secondary System.....	15-50
15.1.1 Decrease in Feedwater Temperature	15-50
15.1.2 Increase in Feedwater Flow	15-55
15.1.3 Increase in Steam Flow	15-59
15.1.4 Inadvertent Opening of a Steam Generator Relief or Safety Valve	15-63
15.1.5 Steam System Piping Failures Inside and Outside of Containment.....	15-64
15.1.6 Loss of Containment Vacuum and Containment Flooding	15-68
15.2 Decrease in Heat Removal by the Secondary System.....	15-74
15.2.1 Loss of External Load, Turbine Trip, and Loss of Condenser Vacuum.....	15-74
15.2.2 Turbine Trip.....	15-79
15.2.3 Loss of Condenser Vacuum	15-79

15.2.4	Closure of Main Steam Isolation Valve(s)	15-79
15.2.5	Steam Pressure Regulator Failure (Closed).....	15-82
15.2.6	Loss of Non-Emergency AC Power to the Station Auxiliaries	15-82
15.2.7	Loss of Normal Feedwater Flow	15-86
15.2.8	Feedwater System Pipe Breaks Inside and Outside Containment.....	15-89
15.2.9	Inadvertent Operation of Decay Heat Removal System	15-93
15.3	Decrease in Reactor Coolant System Flow Rate.....	15-96
15.4	Reactivity and Power Distribution Anomalies.....	15-96
15.4.1	Uncontrolled Control Rod Assembly Withdrawal from a Subcritical or Low Power Startup Condition	15-96
15.4.2	Uncontrolled Control Rod Assembly Withdrawal at Power	15-100
15.4.3	Control Rod Misoperation (System Malfunction or Operator Error).....	15-103
15.4.4	Startup of an Inactive Loop or Recirculation Loop at an Incorrect Temperature	15-109
15.4.5	Flow Controller Malfunction Causing an Increase in Core Flow Rate (Boiling Water Reactor).....	15-109
15.4.6	Inadvertent Decrease in Boron Concentration in the Reactor Coolant System.....	15-109
15.4.7	Inadvertent Loading and Operation of a Fuel Assembly in an Improper Position	15-115
15.4.8	Spectrum of Rod Ejection Accidents	15-119
15.4.9	Spectrum of Rod Drop Accidents.....	15-125
15.5	Increase in Reactor Coolant Inventory	15-125
15.5.1	Chemical and Volume Control System Malfunction	15-125
15.6	Decrease in Reactor Coolant Inventory	15-128
15.6.1	Inadvertent Opening of a Reactor Safety Valve.....	15-128
15.6.2	Failure of Small Lines Carrying Primary Coolant outside Containment.....	15-129
15.6.3	Steam Generator Tube Rupture (Thermal Hydraulic)	15-132
15.6.4	Main Steamline Failure outside Containment (BWR).....	15-137
15.6.5	Loss-of-Coolant Accidents Resulting from Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary.....	15-138
15.6.6	Inadvertent Operation of the Emergency Core Cooling System	15-158
15.7	Radioactive Release from a Subsystem or Component	15-164
15.7.1	Gaseous Waste Management System Leak or Failure	15-164
15.7.2	Liquid Waste Management System Leak or Failure	15-164
15.7.3	Postulated Radioactive Releases Due to Liquid-Containing Tank Failures.....	15-164

15.7.4	Fuel-Handling Accidents	15-164
15.7.5	Spent Fuel Cask and NuScale Power Module Drop Accidents	15-165
15.8	Anticipated Transients without Scram	15-165
15.8.1	Introduction	15-165
15.8.2	Summary of Application	15-166
15.8.3	Regulatory Basis	15-167
15.8.4	Technical Evaluation	15-167
15.8.5	Combined License Information Items	15-169
15.8.6	Conclusion	15-169
15.9	Stability	15-169
15.9.1	Introduction	15-169
15.9.2	Summary of Application	15-169
15.9.3	Regulatory Basis	15-170
15.9.4	Technical Evaluation	15-170
15.9.5	Combined License Information Items	15-176
15.9.6	Conclusion	15-176
15.10	Core Damage Event	15-177
16	TECHNICAL SPECIFICATIONS...	16-1
16.1	Introduction	16-2
16.2	Summary of Application	16-2
16.3	Regulatory Basis	16-4
16.4	Technical Evaluation	16-6
16.4.1	Application of Limiting Condition for Operation Selection Criteria	16-7
16.4.2	Use and Application (GTS Chapter 1), Definitions (Section 1.1), Logical Connectors (Section 1.2), Completion Times (Section 1.3), and Frequency (Section 1.4)	16-47
16.4.3	Safety Limits (GTS Chapter 2)	16-60
16.4.4	Limiting Condition for Operation and Surveillance Requirement Use and Applicability (GTS Chapter 3, Section 3.0)	16-62
16.4.5	Limiting Condition for Operation Statements (GTS Chapter 3, Sections 3.1 through 3.8)	16-71
16.4.6	Applicability Statements (GTS Chapter 3, Sections 3.1 through 3.8)	16-73
16.4.7	Action Requirements (GTS Chapter 3, Sections 3.1 through 3.8)	16-88
16.4.8	Surveillance Requirements (GTS Chapter 3, Sections 3.1 through 3.8) ..	16-108
16.4.9	Design Features (GTS Chapter 4, Sections 4.1 through 4.3)	16-125
16.4.10	Administrative Controls (GTS Chapter 5, Sections 5.1 through 5.7)	16-126
16.4.11	Technical Specification Task Force Traveler Disposition	16-130
16.4.12	SDAA Technical Issues Affecting GTS and Bases	16-149

16.5	Combined License Information Items	16-152
16.6	Conclusion.....	16-155
17	QUALITY ASSURANCE AND RELIABILITY ASSURANCE	17-1
17.0	Quality Assurance.....	17-1
17.1	Quality Assurance during the Design Phase	17-2
17.2	Quality Assurance during the Construction and Operation Phases	17-2
17.3	Quality Assurance Program Description	17-2
17.4	Reliability Assurance Program	17-2
	17.4.1 Introduction	17-2
	17.4.2 Summary of Application	17-2
	17.4.3 Regulatory Basis	17-3
	17.4.4 Technical Evaluation.....	17-3
	17.4.5 Combined License Information Items	17-8
	17.4.6 Conclusion.....	17-9
17.5	Quality Assurance Program Description—Design Certification, Early Site Permits, and New License Applicants	17-9
	17.5.1 Introduction	17-9
	17.5.2 Summary of Application	17-9
	17.5.3 Regulatory Basis	17-10
	17.5.4 Technical Evaluation.....	17-10
	17.5.5 Combined License Information Items	17-10
	17.5.6 Conclusion.....	17-11
17.6	Maintenance Rule	17-11
	17.6.1 Introduction	17-11
	17.6.2 Summary of Application	17-11
	17.6.3 Regulatory Basis	17-11
	17.6.4 Technical Evaluation.....	17-11
	17.6.5 Combined License Information Items	17-12
	17.6.6 Conclusion.....	17-12
18	HUMAN FACTORS ENGINEERING.....	18-1
18.0	Human Factors Engineering Program Management.....	18-4
	18.0.1 Introduction	18-4
	18.0.2 Summary of Application	18-4
	18.0.3 Regulatory Basis	18-7
	18.0.4 Technical Evaluation.....	18-9
	18.0.5 Combined License Information Items	18-11
	18.0.6 Conclusion.....	18-11

18.1	Operating Experience Review	18-12
18.1.1	Introduction	18-12
18.1.2	Summary of Application	18-12
18.1.3	Regulatory Basis	18-12
18.1.4	Technical Evaluation.....	18-13
18.1.5	Combined License Information Items.....	18-14
18.1.6	Conclusion.....	18-14
18.2	Functional Requirements Analysis and Function Allocation.....	18-14
18.2.1	Introduction	18-14
18.2.2	Summary of Application	18-15
18.2.3	Regulatory Basis	18-15
18.2.4	Technical Evaluation.....	18-16
18.2.5	Combined License Information Items.....	18-17
18.2.6	Conclusion.....	18-17
18.3	Task Analysis.....	18-17
18.3.1	Introduction	18-17
18.3.2	Summary of Application	18-18
18.3.3	Regulatory Basis	18-18
18.3.4	Technical Evaluation.....	18-19
18.3.5	Combined License Information Items.....	18-20
18.3.6	Conclusion.....	18-20
18.4	Staffing and Qualification	18-20
18.4.1	Introduction	18-20
18.4.2	Summary of Application	18-21
18.4.3	Regulatory Basis	18-21
18.4.4	Technical Evaluation.....	18-22
18.4.5	Combined License Information Items.....	18-28
18.4.6	Conclusion.....	18-28
18.5	Treatment of Important Human Actions	18-29
18.5.1	Introduction	18-29
18.5.2	Summary of Application	18-29
18.5.3	Regulatory Basis	18-29
18.5.4	Technical Evaluation.....	18-30
18.5.5	Combined License Information Items.....	18-31
18.5.6	Conclusion.....	18-31
18.6	Human-System Interface Design	18-31
18.6.1	Introduction	18-31
18.6.2	Summary of Application	18-31
18.6.3	Regulatory Basis	18-32

18.6.4	Technical Evaluation.....	18-33
18.6.5	Combined License Information Items.....	18-41
18.6.6	Conclusion.....	18-41
18.7	Procedure Development.....	18-42
18.8	Training Program Development	18-42
18.9	Verification and Validation.....	18-42
18.9.1	Introduction	18-42
18.9.2	Summary of Application	18-42
18.9.3	Regulatory Basis.....	18-42
18.9.4	Technical Evaluation	18-43
18.9.5	Combined License Information Items.....	18-51
18.9.6	Conclusion	18-51
18.10	Design Implementation.....	18-51
18.10.1	Introduction	18-51
18.10.2	Summary of Application	18-51
18.10.3	Regulatory Basis.....	18-52
18.10.4	Technical Evaluation	18-52
18.10.5	Combined License Information Items.....	18-55
18.10.6	Conclusion	18-55
18.11	Human Performance Monitoring	18-55
18.11.1	Introduction	18-55
18.11.2	Summary of Application	18-56
18.11.3	Regulatory Basis.....	18-56
18.11.4	Technical Evaluation	18-56
18.11.5	Combined License Information Items.....	18-56
18.11.6	Conclusion	18-57
19	PROBABILISTIC RISK ASSESSMENT AND SEVERE ACCIDENT EVALUATION.....	19-1
19.0	Probabilistic Risk Assessment.....	19-1
19.1.1	Introduction	19-1
19.1.2	Summary of Application	19-2
19.1.3	Regulatory Basis.....	19-3
19.1.4	Technical Evaluation.....	19-4
19.1.5	Combined License Information Items	19-48
19.1.6	Conclusion.....	19-49
19.1	Severe Accident Evaluation	19-50
19.2.1	Introduction	19-50
19.2.2	Summary of Application	19-50

19.2.3	Regulatory Basis	19-50
19.2.4	Technical Evaluation.....	19-51
19.2.5	Combined License Information Items	19-60
19.2.6	Conclusion.....	19-60
19.2	Regulatory Treatment of Nonsafety Systems for Passive Advanced Light Water Reactors.....	19-60
19.3.1	Introduction	19-60
19.3.2	Summary of Application.....	19-61
19.3.3	Regulatory Basis	19-61
19.3.4	Technical Evaluation.....	19-61
19.3.5	Combined License Information Items	19-66
19.3.6	Conclusion.....	19-66
19.3	Strategies and Guidance to Address Mitigation of Beyond-Design-Basis Events.....	19-66
19.4	Adequacy of Design Features and Functional Capabilities Identified and Described for Withstanding Aircraft Impacts	19-67
19.5.1	Introduction	19-67
19.5.2	Summary of Application.....	19-67
19.5.3	Regulatory Basis	19-67
19.5.4	Technical Evaluation.....	19-68
19.5.5	Combined License Information Items	19-78
19.5.6	Conclusion.....	19-78

APPENDICES

APPENDIX A CHRONOLOGY	A-1
APPENDIX B REFERENCE.....	B-1
APPENDIX C ACRONYMS.....	C-1
APPENDIX D PRINCIPAL CONTRIBUTORS.....	D-1
APPENDIX E INDEX OF RESPONSES TO NRC REQUESTS FOR ADDITIONAL INFORMATION AND AUDIT ITEMS	E-1
APPENDIX F REPORT BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS.....	F-1