

## **TABLE OF CONTENTS**

1.1	Introduction	1-1
1.1.1	Metrication	1-2
1.1.2	Proprietary Information	1-3
1.1.3	Combined License Applicants Referencing the APR1400 Design	1-3
1.1.4	Additional Information	1-3
1.2	General Design Description	1-4
1.2.1	Scope of the APR1400 Design	1-4
1.2.2	Summary of the APR1400 Design	1-4
1.2.3	Nuclear Steam Supply System Summary	1-9
1.2.4	Engineered Safety Features	1-11
1.2.5	Instrumentation and Control	1-15
1.2.6	Human-System Interface System	1-18
1.2.7	Electrical System	1-19
1.2.8	Steam and Power Conversion System	1-20
1.2.9	Heating, Ventilation, and Air Conditioning System	1-22
1.2.10	Fuel Handling and Storage	1-22
1.2.11	Cooling Water Systems	1-23
1.2.12	Auxiliary Systems	1-25
1.2.13	Radioactive Waste Management Systems	1-30
1.3	Comparison with Similar Facility Designs	1-32
1.4	Identification of Agents and Contractors	1-33

1.5	Performance of New Safety Features	1-34
1.6	Material Referenced	1-36
1.7	Drawings and Other Detailed Information	1-36
1.8	Interfaces with Standard Designs	1-36
1.9	Conformance with Regulatory Guidance	1-37
1.10	Index of Exemptions	1-39
1.11	Index of Tier 2* Information	1-39
1.12	COL Information Items	1-39
1.13	Requests for Additional Information	1-40
1.14	Conclusion	1-40
2	SITE CHARACTERISTICS	2-1
2.0	Site Characteristics	2-2
2.0.1	Introduction	2-2
2.0.2	Summary of Application	2-2
2.0.3	Regulatory Basis	2-3
2.0.4	Technical Evaluation	2-3
2.0.5	Combined License Information Items	2-4
2.0.6	Conclusion	2-4
2.1	Geography and Demography	2-4
2.1.1	Site Location and Description	2-4
2.1.2	Exclusion Area Authority and Control	2-6
2.1.3	Population Distribution	2-8

2.2	Nearby Industrial, Transportation, and Military Facilities	2-11
2.2.1	Location and Routes	2-11
2.2.2	Descriptions	2-11
2.2.3	Evaluation of Potential Accidents	2-13
2.4	Hydrologic Engineering	2-54
2.4.1	Hydrologic Description	2-54
2.4.2	Floods	2-56
2.4.3	Probable Maximum Flood on Streams and Rivers	2-57
2.4.4	Potential Dam Failures	2-59
2.4.5	Probable Maximum Surge and Seiche Flooding	2-60
2.4.6	Probable Maximum Tsunami Flooding	2-62
2.4.7	Ice Effects	2-63
2.4.8	Cooling Water Channels and Reservoirs	2-65
2.4.9	Channel Diversion	2-66
2.4.10	Flooding Protection Requirements	2-68
2.4.11	Low Water Considerations	2-70
2.4.12	Ground Water	2-71
2.4.13	Accidental Releases of Liquid Effluent in Ground and Surface Water	2-73
2.4.14	Technical Specification and Emergency Operation Requirements	2-74
2.5	Geology, Seismology, and Geotechnical Engineering	2-76
2.5.1	Introduction	2-76
2.5.2	Summary of Application	2-77

2.5.3	Regulatory Basis	2-81
2.5.4	Technical Evaluation	2-82
2.5.5	Combined License Information Items	2-92
2.5.6	Conclusion	2-94
3	DESIGN OF STRUCTURES, SYSTEMS, COMPONENTS, AND EQUIPMENT	3-1
3.1	Conformance with the NRC General Design Criteria	3-1
3.2	Classification of Structures, Systems, and Components	3-2
3.2.1	Seismic Classification	3-2
3.2.2	System Quality Group Classification	3-11
3.3	Wind and Tornado Loading	3-18
3.3.1	Wind Loadings	3-18
3.3.2	Tornado Loadings	3-23
3.4	Water Level (Flood) Design	3-29
3.4.1	Internal Flood Protection for Onsite Equipment Failures	3-29
3.4.2	Analysis Procedures	3-48
3.5	Missile Protection	3-55
3.5.1	Missile Selection and Description	3-55
3.5.2	Structures, Systems, and Components to be Protected from Externally-Generated Missiles	3-79
3.5.3	Barrier Design Procedures	3-85
3.6	Protection Against Dynamic Effects Associated with Postulated Rupture of Piping	3-91
3.6.1	Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside of Containment	3-91
3.6.2	Determination of Pipe Break Locations and Dynamic Effects Associated with the Postulated Rupture of Piping	3-97

3.6.3	Leak-Before-Break Evaluation Procedures	3-123
3.7	Seismic Design	3-140
3.7.1	Seismic Design Parameters	3-140
3.7.2	Seismic System Analysis	3-160
3.7.3	Seismic Subsystem Analysis	3-192
3.7.4	Seismic Instrumentation	3-203
3.8	Seismic Category I Structures	3-207
3.8.1	Concrete Containment	3-207
3.8.2	Steel Containment	3-229
3.8.3	Concrete and Steel Internal Structures of Steel or Concrete Containments	3-240
3.8.4	Other Seismic Category I Structures	3-255
3.8.5	Foundations	3-284
3.9	Mechanical Systems and Components	3-324
3.9.1	Special Topics for Mechanical Components	3-324
3.9.2	Dynamic Testing and Analysis of Systems, Components, and Equipment	3-333
3.9.3	ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures	3-355
3.9.4	Control Rod Drive System	3-367
3.9.5	Reactor Pressure Vessel Internals	3-374
3.9.6	Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints	3-410
3.10	Seismic and Dynamic Qualification of Mechanical and Electrical Equipment	3-427
3.10.1	Introduction	3-427
3.10.2	Summary of Application	3-428

3.10.3	Regulatory Basis	3-429
3.10.4	Technical Evaluation	3-429
3.10.5	Combined License Information Items	3-443
3.10.6	Conclusion	3-443
3.11	Environmental Qualification of Mechanical and Electrical Equipment	3-444
3.11.1	Introduction	3-444
3.11.2	Summary of Application	3-444
3.11.3	Regulatory Basis	3-446
3.11.4	Technical Evaluation	3-449
3.11.5	Combined License Information Items	3-483
3.11.6	Conclusion	3-484
3.12	ASME Code Class 1, 2, and 3 Piping Systems, Piping Components and their Associated Supports	3-485
3.12.1	Introduction	3-485
3.12.2	Summary of Application	3-485
3.12.3	Regulatory Basis	3-486
3.12.4	Technical Evaluation	3-487
3.12.5	Combined License Information Items	3-519
3.12.6	Conclusion	3-520
3.13	Threaded Fasteners for ASME Code Class 1, 2, and 3 Components	3-520
3.13.1	Introduction	3-520
3.13.2	Summary of Application	3-520
3.13.3	Regulatory Basis	3-521

3.13.4	Technical Evaluation	3-522
3.13.5	Combined License Information Items	3-523
3.13.6	Conclusion	3-523
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	4-10
4.2.6	Conclusions	4-10
4.3	Nuclear Design	4-10
4.3.1	Introduction	4-10
4.3.2	Summary of Application	4-11
4.3.3	Regulatory Basis	4-12
4.3.4	Technical Evaluation	4-14
4.3.5	Combined License Information Items	4-34
4.3.6	Conclusions	4-34
4.4	Thermal and Hydraulic Design	4-35
4.4.1	Introduction	4-35
4.4.2	Summary of Application	4-35

4.4.3	Regulatory Basis	4-39
4.4.4	Technical Evaluation	4-40
4.4.5	Combined License Information Items	4-50
4.4.6	Conclusions	4-50
4.5	Reactor Materials	4-50
4.5.1	Control Rod Drive System Structural Materials	4-50
4.5.2	Reactor Internals and Core Support Materials	4-63
4.6	Functional Design of Reactivity Control Systems	4-68
4.6.1	Introduction	4-68
4.6.2	Summary of Application	4-69
4.6.3	Regulatory Basis	4-70
4.6.4	Technical Evaluation	4-71
4.6.5	Combined License Information Items	4-75
4.6.6	Conclusions	4-75
5	REACTOR COOLANT SYSTEM AND RELATED SYSTEMS	5-1
5.0	Reactor Coolant System and Related Systems	5-1
5.1	Summary Description	5-1
5.1.1	Introduction	5-1
5.1.2	Summary of Application	5-1
5.1.3	Technical Evaluation	5-2
5.2	Integrity of the Reactor Coolant Pressure Boundary	5-2
5.2.1	Compliance with Codes and Code Cases	5-2



5.2.2	Overpressure Protection	5-13
5.2.3	Reactor Coolant Pressure Boundary Materials	5-29
5.2.4	Inservice Inspection and Testing of the RCPB	5-39
5.2.5	Reactor Coolant Pressure Boundary (RCPB) Leakage Detection	5-47
5.3	Reactor Vessel	5-56
5.3.1	Reactor Vessel Materials	5-57
5.3.2	Pressure-Temperature Limits, Pressurized Thermal Shock, and Charpy Upper-Shelf Energy (USE) Data and Analyses	5-65
5.3.3	Reactor Vessel Integrity	5-70
5.4	Component and Subsystem Design	5-73
5.4.1	Reactor Coolant Pumps	5-74
5.4.2	Steam Generators	5-94
5.4.3	Reactor Coolant Piping	5-110
5.4.7	Shutdown Cooling System	5-111
5.4.10	Pressurizer	5-119
5.4.11	Pressurizer Relief Tank	5-120
5.4.12	Reactor Coolant System High Point Vents	5-120
5.4.13	Main Steam Flow Restrictor	5-132
5.4.14	Safety and Relief Valves	5-132
5.4.15	Component Supports	5-133
5.A	Evaluation Of The APR400 Design and Intersystem Loss-Of-Coolant Accident Challenges	5-135
6	ENGINEERED SAFETY FEATURES	6-1
6.1	Engineered Safety Features Materials	6-1

6.1.1	Engineered Safety Features Materials	6-1
6.1.2	Protective Coatings Systems (Paints) Organic Materials	6-11
6.2	Containment Systems	6-16
6.2.1	Containment Functional Design	6-16
6.2.2	Containment Heat Removal Systems	6-77
6.2.4	Containment Isolation System	6-122
6.2.5	Combustible Gas Control in Containment	6-148
6.2.6	Containment Leakage Testing	6-157
6.2.7	Fracture Prevention of Containment Pressure Boundary	6-174
6.3	Emergency Core Cooling System/Safety Injection System	6-176
6.3.1	Introduction	6-176
6.3.2	Summary of Application	6-176
6.3.3	Regulatory Basis	6-177
6.3.4	Technical Evaluation	6-179
6.3.5	Combined License Information Items	6-194
6.3.6	Conclusion	6-195
6.4	Control Room Habitability System	6-195
6.4.1	Introduction	6-195
6.4.2	Summary of Application	6-196
6.4.3	Regulatory Basis	6-196
6.4.4	Technical Evaluation	6-197
6.4.5	Combined License Information Items	6-206

6.4.6	Conclusion	6-207
6.5	Fission Product Removal and Control Systems	6-207
6.5.1	ESF Atmosphere Cleanup Systems/ESF Filter Systems	6-208
6.5.2	Containment Spray System (CSS)	6-215
6.5.3	Fission Product Control Systems and Structures	6-219
6.6	Inservice Inspection and Testing of Class 2 and 3 Components	6-224
6.6.1	Introduction	6-224
6.6.2	Summary of Application	6-224
6.6.3	Regulatory Basis	6-225
6.6.4	Technical Evaluation	6-226
6.6.5	Combined License Information Items	6-230
6.6.6	Conclusion	6-231
7	INSTRUMENTATION AND CONTROLS	7-1
7.1	Instrumentation and Controls – Introduction	7-1
7.1.1	Introduction	7-1
7.1.2	Summary of Application	7-1
7.1.3	Regulatory Basis	7-2
7.1.4	Technical Evaluation	7-4
7.1.5	Combined License Information Items	7-129
7.1.6	Findings and Conclusions	7-129
7.2	Reactor Trip System	7-129
7.2.1	Introduction	7-129

7.2.2	Summary of Application	7-132
7.2.3	Regulatory Basis	7-132
7.2.4	Technical Evaluation	7-133
7.2.5	Combined License Information Items	7-166
7.2.6	Findings and Conclusions	7-166
7.3	Engineered Safety Features Systems	7-167
7.3.1	Introduction	7-167
7.3.2	Summary of Application	7-167
7.3.3	Regulatory Basis	7-168
7.3.4	Technical Evaluation	7-169
7.3.5	Combined License Information Items	7-192
7.3.6	Findings and Conclusions	7-192
7.4	Systems Required for Safe Shutdown	7-192
7.4.1	Introduction	7-192
7.4.2	Summary of Application	7-193
7.4.3	Regulatory Basis	7-194
7.4.4	Technical Evaluation	7-195
7.4.5	Combined License Information Items	7-204
7.4.6	Findings and Conclusions	7-204
7.5	Information Systems Important to Safety	7-204
7.5.1	Introduction	7-204
7.5.2	Summary of Application	7-204

7.5.3	Regulatory Basis	7-205
7.5.4	Technical Evaluation	7-207
7.5.5	Combined License Information Items	7-221
7.5.6	Findings and Conclusions	7-221
7.6	Interlock Systems Important to Safety	7-221
7.6.1	Introduction	7-221
7.6.2	Summary of Application	7-222
7.6.3	Regulatory Basis	7-224
7.6.4	Technical Evaluation	7-225
7.6.5	Combined License Information Items	7-234
7.6.6	Findings and Conclusions	7-235
7.7	Control Systems Not Required for Safety	7-235
7.7.1	Introduction	7-235
7.7.2	Summary of Application	7-235
7.7.3	Regulatory Basis	7-238
7.7.4	Technical Evaluation	7-240
7.7.5	Combined License Information Items	7-293
7.7.6	Findings and Conclusions	7-293
7.8	Diverse I&C Systems	7-294
7.8.1	Introduction	7-294
7.8.2	Summary of Application	7-294
7.8.3	Regulatory Basis	7-295

7.8.4	Technical Evaluation	7-296
7.8.5	Combined License Information Items	7-336
7.8.6	Findings and Conclusions	7-336
7.9	Data Communication Systems	7-337
7.9.1	Introduction	7-337
7.9.2	Summary of Application	7-337
7.9.3	Regulatory Basis	7-338
7.9.4	Technical Evaluation	7-339
7.9.5	Combined License Information Items	7-397
7.9.6	Findings and Conclusions	7-397
8	ELECTRIC POWER	8-1
8.1	Introduction	8-1
8.1.1	Introduction	8-1
8.1.2	Summary of Application	8-1
8.1.3	Regulatory Basis	8-1
8.1.4	Technical Evaluation	8-2
8.1.5	Combined License Information Items	8-10
8.1.6	Conclusion	8-10
8.2	Offsite Power System	8-10
8.2.1	Introduction	8-11
8.2.2	Summary of Application	8-11
8.2.3	Regulatory Basis	8-12

8.2.4	Technical Evaluation	8-14
8.2.5	Combined License Information Items	8-25
8.2.6	Conclusion	8-27
8.3	Onsite Power Systems	8-27
8.3.1	AC Power Systems	8-27
8.3.2	DC Power System	8-70
8.4	Station Blackout	8-92
8.4.1	Introduction	8-92
8.4.2	Summary of Application	8-92
8.4.3	Regulatory Basis	8-93
8.4.4	Technical Evaluation	8-94
8.4.5	Combined License Information Items	8-111
8.4.6	Conclusion	8-111
9	AUXILIARY SYSTEMS	9-1
9.1	Fuel Storage and Handling	9-1
9.1.1	Criticality Safety of Fresh and Spent Fuel Storage and Handling	9-1
9.1.2	New and Spent Fuel Storage	9-29
9.1.3	Spent Fuel Pool Cooling and Cleanup System	9-73
9.1.4	Light Load Handling System (Related to Refueling)	9-88
9.1.5	Overhead Heavy Load Handling System	9-99
9.2	Water Systems	9-112
9.2.1	Essential Service Water System	9-112

9.2.2	Component Cooling Water System	9-132
9.2.3	[Reserved]	9-147
9.2.4	Domestic Water and Sanitary Systems	9-147
9.2.5	Ultimate Heat Sink	9-152
9.2.6	Condensate Storage Facilities	9-160
9.2.7	Chilled Water System	9-166
9.2.8	Turbine Generator Building Closed Cooling Water System	9-177
9.2.9	Turbine Generator Building Open Cooling Water System	9-183
9.3	Process Auxiliaries	9-187
9.3.1	Compressed Air and Gas Systems	9-187
9.3.2	Process and Post-Accident Sampling Systems	9-194
9.3.3	Equipment and Floor Drainage System	9-199
9.3.4	Chemical and Volume Control System	9-210
9.4	Heating, Ventilation, and Air Conditioning Systems	9-229
9.4.1	Control Room HVAC System	9-229
9.4.2	Fuel Handling Area HVAC System	9-236
9.4.3	Auxiliary Building Clean Area and Compound Building HVAC System	9-247
9.4.4	Turbine Generator Building HVAC System	9-256
9.4.5	Engineered Safety Feature Ventilation System	9-259
9.4.6	Reactor Containment Building HVAC System and Purge System	9-273
9.4.7	Compound Building HVAC System	9-283
9.4.8	Design Features for Minimization of Contamination	9-283



9.5	Other Auxiliary Systems	9-287
9.5.1	Fire Protection Program	9-287
9.5.2	Communications Systems	9-309
9.5.3	Lighting Systems	9-334
9.5.4	Emergency Diesel Engine Fuel Oil System	9-344
9.5.5	Emergency Diesel Engine Cooling Water System	9-356
9.5.6	Emergency Diesel Engine Starting Air System	9-364
9.5.7	Emergency Diesel Engine Lubrication System	9-370
9.5.8	Emergency Diesel Engine Combustion Air Intake and Exhaust System	9-376
9.5.9	Gas Turbine Generator Facility	9-382
10	STEAM AND POWER CONVERSION SYSTEM	10-1
10.1	Summary Description	10-1
10.2	Turbine Generator	10-1
10.2.1	Turbine Generator Operation and Speed Control	10-1
10.2.2	[Not Used]	10-12
10.2.3	Turbine Rotor Integrity	10-12
10.3	Main Steam System	10-20
10.3.1	Design, Components, and Operation	10-20
10.3.2	[See Section 10.3.1.4 of This Report]	10-29
10.3.3	[See Section 10.3.1.4 of This Report]	10-29
10.3.4	[See Section 10.3.1.4 of This Report]	10-29
10.3.5	[See Section 10.3.1.4 of This Report]	10-29

10.3.6	Steam and Feedwater System Materials	10-29
10.4	Other Features of the Steam and Power Conversion System	10-38
10.4.1	Main Condensers	10-38
10.4.2	Condenser Vacuum System	10-45
10.4.3	Turbine Steam Seal System	10-49
10.4.4	Turbine Bypass System	10-53
10.4.5	Circulating Water System	10-57
10.4.6	Condensate Polishing System	10-65
10.4.7	Condensate and Feedwater System	10-68
10.4.8	Steam Generator Blowdown System	10-78
10.4.9	Auxiliary Feedwater System	10-87
10.4.10	Auxiliary Steam System	10-104
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	11-8
11.1.6	Conclusions	11-8
11.2	Liquid Waste Management System	11-8
11.2.1	Introduction	11-8

11.2.2	Summary of Application	11-8
11.2.3	Regulatory Basis	11-12
11.2.4	Technical Evaluation	11-15
11.2.5	Combined License Information Items	11-28
11.2.6	Conclusions	11-30
11.3	Gaseous Waste Management System	11-30
11.3.1	Introduction	11-30
11.3.2	Summary of Application	11-30
11.3.3	Regulatory Basis	11-34
11.3.4	Technical Evaluation	11-36
11.3.5	Combined License Information Items	11-47
11.3.6	Conclusions	11-48
11.4	Solid Waste Management System (SWMS)	11-49
11.4.1	Introduction	11-49
11.4.2	Summary of Application	11-50
11.4.3	Regulatory Basis	11-53
11.4.4	Technical Evaluation	11-55
11.4.5	Combined License Information Items	11-62
11.4.6	Conclusions	11-63
11.5	Process and Effluent Radiation Monitoring and Sampling System	11-65
11.5.1	Introduction	11-65
11.5.2	Summary of Application	11-65

11.5.3	Regulatory Basis	11-69
11.5.4	Technical Evaluation	11-71
11.5.5	Combined License Information Items	11-80
11.5.6	Conclusions	11-81
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	12-3
12.1.4	Technical Evaluation	12-4
12.1.5	Combined License Information Items	12-8
12.1.6	Conclusion	12-9
12.2	Radiation Sources	12-9
12.2.1	Introduction	12-9
12.2.2	Summary of Application	12-9
12.2.3	Regulatory Basis	12-12
12.2.4	Technical Evaluation	12-14
12.2.5	Combined License Information Items	12-46
12.2.6	Conclusion	12-47
12.3	Radiation Protection Design Features (including Dose Assessment)	12-47
12.3.1	Introduction	12-47
12.3.2	Summary of Application	12-48

12.3.3	Regulatory Basis	12-50
12.3.4	Technical Evaluation	12-53
12.3.5	Combined License Information Items	12-100
12.3.6	Conclusion	12-102
12.4	Dose Assessment and Minimization of Contamination	12-102
12.5	Operational RPP	12-102
12.5.1	Introduction	12-102
12.5.2	Summary of Application	12-102
12.5.3	Regulatory Basis	12-103
12.5.4	Technical Evaluation	12-103
12.5.5	Combined License Information Items	12-104
12.5.6	Conclusion	12-105
13	CONDUCT OF OPERATIONS	13-1
13.0	Conduct of Operations	13-3
13.1	Organizational Structure of the Applicant	13-3
13.1.1	Introduction	13-3
13.1.2	Summary of Application	13-3
13.1.3	Regulatory Basis	13-4
13.1.4	Technical Evaluation	13-5
13.1.5	Combined License Information Items	13-5
13.1.6	Conclusion	13-7
13.2	Training	13-7

13.2.1	Introduction	13-7
13.2.2	Summary of Application	13-8
13.2.3	Regulatory Basis	13-8
13.2.4	Technical Evaluation	13-9
13.2.5	Combined License Information Items	13-10
13.2.6	Conclusion	13-10
13.3	Emergency Planning	13-11
13.3.1	Introduction	13-11
13.3.2	Summary of Application	13-11
13.3.3	Regulatory Basis	13-15
13.3.4	Technical Evaluation	13-16
13.3.5	Combined License Information Items	13-25
13.3.6	Conclusion	13-25
13.4	Operational Program Implementation	13-25
13.4.1	Introduction	13-25
13.4.2	Summary of Application	13-26
13.4.3	Regulatory Basis	13-26
13.4.4	Technical Evaluation	13-26
13.4.5	Combined License Information Items	13-26
13.4.6	Conclusion	13-27
13.5	Plant Procedures	13-27
13.5.1	Introduction	13-27

13.5.2	Summary of Application	13-27
13.5.3	Regulatory Basis	13-27
13.5.4	Technical Evaluation	13-28
13.5.5	Combined License Information Items	13-34
13.5.6	Conclusion	13-35
13.6	Physical Security	13-36
13.6.1	Introduction	13-36
13.6.2	Summary of Application	13-36
13.6.3	Regulatory Basis	13-39
13.6.4	Technical Evaluation	13-40
13.6.5	Combined License Information Items	13-62
13.6.6	Conclusion	13-63
13.7	Fitness for Duty	13-64
14	VERIFICATION PROGRAMS	14-1
14.1	Specific Information to be Addressed for the Initial Plant Test Program	14-1
14.2	Initial Plant Test Program	14-2
14.2.1	Introduction	14-2
14.2.2	Summary of Application for DCD Section 14.2	14-3
14.2.3	Regulatory Basis for DCD Section 14.2	14-3
14.2.4	Technical Evaluation for DCD Tier 2 Subsections 14.2.1 through 14.2.12	14-4
14.2.5	DCD Tier 2 Subsection 14.2.13, Combined License Items	14-78
14.2.6	Conclusion	14-83

14.3	Inspections, Tests, Analyses and Acceptance Criteria	14-84
14.3.1	Selection Criteria and Methodology for FSAR Tier 1	14-84
14.3.2	Structural and Systems Engineering – Inspections, Tests, Analyses, and Acceptance Criteria	14-91
14.3.3	Piping Systems and Components – Inspections, Test, Analyses, and Acceptance Criteria	14-101
14.3.4	Reactor Systems – Inspections, Tests, Analyses, and Acceptance Criteria	14-110
14.3.5	Instrumentation and Controls– Inspections, Tests, Analyses, and Acceptance Criteria	14-117
14.3.6	Electrical Systems– Inspections, Tests, Analyses, and Acceptance Criteria	14-168
14.3.7	Plant Systems – Inspections, Tests, Analyses, and Acceptance Criteria	14-190
14.3.8	Radiation Protection– Inspections, Tests, Analyses, and Acceptance Criteria	14-197
14.3.9	Human Factors Engineering – Inspections, Tests, Analyses, and Acceptance Criteria	14-218
14.3.10	Emergency Planning– Inspections, Tests, Analyses, and Acceptance Criteria	14-230
14.3.11	Containment Systems – Inspections, Tests, Analyses, and Acceptance Criteria	14-230
14.3.12	Physical Security Hardware – Inspections, Tests, Analyses, and Acceptance Criteria	14-238
14.3.13	Design Reliability Assurance Program – Inspections, Tests, Analyses, and Acceptance Criteria	14-262
15	TRANSIENT AND ACCIDENT ANALYSES	15-1
15	Transient and Accident Analyses	15-1
15.0.0	General Information for Safety Analyses	15-1
15.0.1	Radiological Consequence Analyses Using Alternative Source Terms	15-11
15.0.2	Review of Transient and Accident Analysis Methods	15-11
15.0.3	Design Basis Accident Radiological Consequence Analyses for Advanced Light Water Reactors	15-38
15.1	Increase in Heat Removal by the Secondary System	15-72
15.1.1	Decrease in Feedwater Temperature	15-72



15.1.2	Increase in Feedwater Flow	15-75
15.1.3	Increase in Steam Flow	15-77
15.1.4	Inadvertent Opening of a Steam Generator Relief or Safety Valve	15-78
15.1.5	Steam System Piping Failure Inside and Outside Containment	15-84
15.2	Decrease in Heat Removal by the Secondary System	15-96
15.2.1	Loss of External Load, Turbine Trip, Loss of Condenser Vacuum, Inadvertent Main Steam Isolation Valve Closure, and Steam Pressure Regulator Failure	15-96
15.2.2	Turbine Trip	15-103
15.2.3	Loss of Condenser Vacuum	15-104
15.2.4	Closure of the Main Steam Isolation Valve	15-104
15.2.5	Steam Pressure Regulator Failure	15-104
15.2.6	Loss of Nonemergency AC Power to the Station Auxiliaries	15-104
15.2.7	Loss of Normal Feedwater Flow	15-107
15.2.8	Feedwater System Pipe Break Inside and Outside Containment	15-109
15.3	Decrease in Reactor Coolant System Flow Rate	15-115
15.3.1	Loss of Forced Reactor Coolant Flow	15-115
15.3.2	Flow Controller Malfunctions	15-120
15.3.3	Reactor Coolant Pump Rotor Seizure and Reactor Coolant Pump Shaft Break	15-120
15.4	Reactivity and Power Distribution Anomalies	15-124
15.4.1	Uncontrolled Control Element Assembly Withdrawal from a Subcritical or Low Power Startup Condition	15-124
15.4.2	Uncontrolled Control Element Assembly Withdrawal at Power	15-130
15.4.3	Control Element Assembly Misoperation (System Malfunction or Operator Error)	15-135

15.4.4	Startup of an Inactive Reactor Coolant Pump	15-141
15.4.5	Flow Controller Malfunction Causing an Increase in BWR Core Flow Rate	15-144
15.4.6	Inadvertent Decrease in Boron Concentration in the Reactor Coolant System	15-144
15.4.7	Inadvertent Loading and Operation of a Fuel Assembly in an Improper Position	15-150
15.4.8	Spectrum of Control Element Assembly Ejection Accidents	15-154
15.5	Increase in Reactor Coolant Inventory	15-168
15.5.1	Inadvertent Operation of the Emergency Core Cooling System that Increases the Reactor Coolant Inventory	15-168
15.5.2	Chemical and Volume Control System Malfunction that Increases the Reactor Coolant Inventory	15-171
15.6	Decrease in Reactor Coolant Inventory	15-177
15.6.1	Inadvertent Opening of a Pressurizer Pressure Relief Valve	15-177
15.6.2	Failure of Small Lines Carrying Primary Coolant Outside Containment	15-180
15.6.3	Steam Generator Tube Rupture	15-183
15.6.4	Radiological Consequences of Main Steam Line Failure Outside Containment (Boiling Water Reactor)	15-191
15.6.5	Loss-of-Coolant Accidents Resulting From Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary	15-191
15.7	Radioactive Material Release from a Subsystem or Component	15-229
15.7.1	Radioactive Gas Waste System Leak or Failure	15-229
15.7.2	Radioactive Liquid Waste System Leak or Failure	15-230
15.7.3	Postulated Radioactive Releases Due to Liquid-Containing Tank Failures	15-230
15.7.4	Fuel Handling Accident	15-230
15.7.5	Spent Fuel Cask Drop Accident	15-230

15.8	Anticipated Transients Without Scram	15-230
15.8.1	Introduction	15-230
15.8.2	Summary of Application	15-230
15.8.3	Regulatory Basis	15-233
15.8.4	Technical Evaluation	15-234
15.8.5	Combined License Information	15-237
15.8.6	Conclusion	15-237
15.8.7	References	15-237
16	TECHNICAL SPECIFICATIONS	16-1
16.1	Introduction	16-1
16.2	Summary of Application	16-1
16.3	Regulatory Basis	16-1
16.4	Technical Evaluation	16-3
16.4.1	Selection of Limiting Conditions for Operation	16-18
16.4.2	TS Chapter 1.0 Use and Application — Section 1.1 Definitions	16-25
16.4.3	TS Chapter 1.0 Use and Application — Section 1.2 Logical Connectors; Section 1.3 Completion Times; Section 1.4 Frequency	16-30
16.4.4	TS Chapter 2.0 Safety Limits — Section 2.1 Safety Limits; Section 2.2 Safety Limit Violations	16-31
16.4.5	TS Chapter 3.0 Limiting Conditions for Operation (LCOs) and Surveillance Requirements (SRs) — Section 3.0 LCO Applicability; Section 3.0 SR Applicability	16-33
16.4.6	TS Chapter 3.0 LCOs and SRs — Section 3.1 Reactivity Control Systems	16-37
16.4.7	TS Chapter 3.0 LCOs and SRs — Section 3.2 Power Distribution Limits	16-61
16.4.8	TS Chapter 3.0 LCOs and SRs — Section 3.3 Instrumentation	16-70
16.4.9	TS Chapter 3.0 LCOs and SRs — Section 3.4 Reactor Coolant System	16-188

16.4.10	TS Chapter 3.0 LCOs and SRs — Section 3.5 Emergency Core Cooling System (ECCS)	16-271
16.4.11	TS Chapter 3.0 LCOs and SRs — Section 3.6 Containment Systems	16-286
16.4.12	TS Chapter 3.0 LCOs and SRs — Section 3.7 Plant Systems	16-300
16.4.13	TS Chapter 3.0 LCOs and SRs — Section 3.8 Electrical Power Systems	16-359
16.4.14	TS Chapter 3.0 LCOs and SRs — Section 3.9 Refueling Operations	16-378
16.4.15	TS Chapter 4.0 Design Features	16-394
16.4.16	TS Chapter 5.0 Administrative Controls	16-397
16.5	Combined License Information Items	16-403
16.6	Conclusion	16-403
17	QUALITY ASSURANCE AND RELIABILITY ASSURANCE	17-1
17.0	Quality Assurance and Reliability Assurance	17-1
17.1	Quality Assurance during the Design Certification Phase	17-1
17.1.1	Introduction	17-1
17.1.2	Summary of Application	17-2
17.2	Quality Assurance during the Operations Phase	17-2
17.3	Quality Assurance Program Description	17-3
17.4	Reliability Assurance Program	17-3
17.4.1	Introduction	17-3
17.4.2	Summary of Application	17-4
17.4.3	Regulatory Basis	17-4
17.4.4	Technical Evaluation	17-5
17.4.5	Combined License Information Items	17-7

17.4.6	Conclusion	17-9
17.5	Quality Assurance Program Description - Design Certification	17-9
17.5.1	Introduction	17-9
17.5.2	Summary of Application	17-10
17.5.3	Regulatory Basis	17-10
17.5.4	Technical Evaluation	17-10
17.5.5	Conclusion	17-11
17.6	Maintenance Rule	17-12
17.6.1	Introduction	17-12
17.6.2	Summary of Application	17-12
17.6.3	Regulatory Basis	17-12
17.6.4	Technical Evaluation	17-13
17.6.5	Combined License Information Items	17-13
17.6.6	Conclusion	17-13
18	HUMAN FACTORS ENGINEERING	18-1
18.1	Human Factors Engineering Program Management	18-2
18.1.1	Introduction	18-2
18.1.2	Summary of Application	18-2
18.1.3	Regulatory Basis	18-3
18.1.4	Technical Evaluation	18-4
18.1.5	Combined License Items	18-20
18.1.6	Conclusion	18-20

18.2	Operating Experience Review	18-20
18.2.1	Introduction	18-20
18.2.2	Summary of Application	18-21
18.2.3	Regulatory Basis	18-21
18.2.4	Technical Evaluation	18-22
18.2.5	Combined License Items	18-29
18.2.6	Conclusion	18-29
18.3	Functional Requirements Analysis and Function Allocation	18-29
18.3.1	Introduction	18-29
18.3.2	Summary of Application	18-30
18.3.3	Regulatory Basis	18-30
18.3.4	Technical Evaluation	18-31
18.3.5	Combined License Items	18-37
18.3.6	Conclusion	18-37
18.4	Task Analysis	18-37
18.4.1	Introduction	18-37
18.4.2	Summary of Application	18-38
18.4.3	Regulatory Basis	18-38
18.4.4	Technical Evaluation	18-39
18.4.5	Combined License Items	18-50
18.4.6	Conclusion	18-51
18.5	Staffing and Qualifications	18-51

18.5.1	Introduction	18-51
18.5.2	Summary of Application	18-51
18.5.3	Regulatory Basis	18-52
18.5.4	Technical Evaluation	18-52
18.5.5	Combined License Items	18-57
18.5.6	Conclusion	18-57
18.6	Treatment of Important Human Actions	18-58
18.6.1	Introduction	18-58
18.6.2	Summary of Application	18-58
18.6.3	Regulatory Basis	18-59
18.6.4	Technical Evaluation	18-59
18.6.5	Combined License Items	18-66
18.6.6	Conclusion	18-66
18.7	Human System Interface Design	18-66
18.7.1	Introduction	18-66
18.7.2	Summary of Application	18-66
18.7.3	Regulatory Basis	18-68
18.7.4	Technical Evaluation	18-69
18.7.5	Combined License Items	18-121
18.7.6	Conclusion	18-121
18.8	Procedure Development	18-121
18.9	Training Program Development	18-122

18.10	Human Factors Verification and Validation	18-122
18.10.1	Introduction	18-122
18.10.2	Summary of Application	18-122
18.10.3	Regulatory Basis	18-123
18.10.4	Technical Evaluation	18-124
18.10.5	Combined License Items	18-168
18.10.6	Conclusion	18-168
18.11	Design Implementation	18-169
18.11.1	Introduction	18-169
18.11.2	Summary of Application	18-169
18.11.3	Regulatory Basis	18-169
18.11.4	Technical Evaluation	18-170
18.11.5	Combined License Items	18-172
18.11.6	Conclusion	18-172
18.12	Human Performance Monitoring	18-172
18.12.1	Introduction	18-172
18.12.2	Summary of Application	18-172
18.12.3	Regulatory Basis	18-173
18.12.4	Technical Evaluation	18-173
18.12.5	Combined License Items	18-173
18.12.6	Conclusion	18-173
19	PROBABILISTIC RISK ASSESSMENT AND SEVERE ACCIDENT EVALUATION	19-1



19.0.1	NRC Regulatory Requirements and Related Policies	19-1
19.0.2	Structure of the APR1400 DCD Chapter 19	19-5
19.0.3	Combined License Information	19-5
19.1	Probabilistic Risk Assessment	19-6
19.1.1	Uses and Applications of the PRA	19-7
19.1.2	Quality of PRA	19-10
19.1.3	Special Design/Operational Features	19-20
19.1.4	Safety Insights from the Internal Events PRA for Operations at Power	19-25
19.1.5	Safety Insights from the External Events PRA for Operations at Power	19-49
19.1.6	Safety Insights from the PRA for Other Modes of Operation	19-81
19.1.7	PRA Related Input to Other Programs and Processes	19-117
19.1.8	Conclusion and Finding	19-125
19.1.9	References	19-127
19.2.	Severe Accident Evaluation	19-133
19.2.1	Introduction	19-133
19.2.2	Severe Accident Prevention	19-133
19.2.3	Severe Accident Mitigation	19-139
19.2.4	Containment Performance Capability	19-175
19.2.5	Accident Management	19-183
19.2.6	Combined License Information	19-185
19.2.7	Conclusion and Finding	19-185
19.2.8	References	19-186

19.3	Beyond Design Basis External Event	19-191
19.3.1	Recommendations 4.1 and 4.2 - Station Blackout and Mitigation Strategies for Beyond Design Basis External Events	19-191
19.3.2	Reliable Spent Fuel Pool Instrumentation (Based on Recommendation 7.1)	19-240
19.4	Loss of Large Areas of the Plant Due to Explosions or Fire	19-247
19.4.1	Summary of Application	19-247
19.4.2	Regulatory Basis	19-247
19.4.3	Technical Evaluation	19-247
19.4.4	Combined License Information Items	19-257
19.4.5	Conclusion	19-259
19.5	Aircraft Impact Assessment	19-260
19.5.1	Introduction	19-260
19.5.2	Summary of Application	19-260
19.5.3	Regulatory Basis	19-263
19.5.4	Technical Evaluation	19-264
19.5.5	Combined License Items Identified in the DCD	19-277
19.5.6	Conclusions	19-278

## APPENDICES

Appendix A	Chronology	A-1
Appendix B	References	B-1
Appendix C	Acronyms	C-1
Appendix D	Principal Contributors	D-1
Appendix E	Index of NRC's Requests for Additional Information	E-1
Appendix F	Report by the Advisory Committee on Reactor Safeguards	F-1