

Clinch River Nuclear Site
Early Site Permit Application
Part 2
Site Safety Analysis Report
Revision 1

SSAR MASTER TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
CHAPTER 1	INTRODUCTION AND GENERAL DESCRIPTION OF THE PLANT	1.1-1
1.1	Introduction	1.1-1
1.2	General Site Description	1.2-1
1.2.1	Site Location	1.2-1
1.2.2	Site Development	1.2-1
1.3	Comparison With Other Facilities	1.3-1
1.4	Identification of Agents and Contractors	1.4-1
1.4.1	Applicant/Program Manager	1.4-1
1.4.2	Principal Contractors and Participants	1.4-1
1.4.2.1	BWX Technologies, Inc.	1.4-1
1.4.2.2	Generation mPower LLC	1.4-1
1.4.2.3	Bechtel Power Corporation	1.4-1
1.4.2.4	Other Contractors and Participants	1.4-1
1.5	Requirements for Additional Technical Information	1.5-1
1.6	Material Referenced	1.6-1
1.7	Drawings and Other Detailed Information	1.7-1
1.8	Interfaces with Standard Design	1.8-1
1.9	Conformance with Regulatory Criteria	1.9-1
1.10	Impact of Construction of New Nuclear Power Plant Units on Operating Units at Multi-Unit Sites	1.10-1
1.11	Overview of Reactor Types	1.11-1
1.11.1	BWXT mPower™	1.11-1
1.11.2	NuScale	1.11-1
1.11.3	SMR-160	1.11-1
1.11.4	Westinghouse SMR	1.11-2
1.11.5	Reference	1.11-2
CHAPTER 2	SITE CHARACTERISTICS	2.0-1
2.0	Plant Parameter Envelope	2.0-1
2.1	Geography and Demography	2.1-1
2.1.1	Site Location and Description	2.1-1
2.1.1.1	Specification of Location	2.1-1
2.1.1.2	Site Area Map	2.1-2
2.1.2	Exclusion Area Authority and Control	2.1-2
2.1.2.1	Authority	2.1-3
2.1.2.2	Control of Activities Unrelated to Plant Operation	2.1-3
2.1.2.3	Arrangements for Traffic Control	2.1-3
2.1.2.4	Abandonment or Relocation of Roads	2.1-3
2.1.3	Population Distribution	2.1-3
2.1.3.1	Population Within 10 Miles	2.1-4
2.1.3.2	Population Between 10 and 50 Miles	2.1-4
2.1.3.3	Transient Population	2.1-4
2.1.3.4	Low-Population Zone	2.1-6
2.1.3.5	Population Center	2.1-7
2.1.3.6	Population Density	2.1-7
2.1.4	References	2.1-8
2.2	Nearby Industrial, Transportation, and Military Facilities	2.2-1
2.2.1	Locations and Routes	2.2-1

SSAR MASTER TABLE OF CONTENTS (CONTINUED)

<u>Section</u>	<u>Title</u>	<u>Page</u>
2.2.2	Descriptions	2.2-3
2.2.2.1	Descriptions of Facilities	2.2-3
2.2.2.2	Description of Products and Materials	2.2-3
2.2.2.3	Description of Pipelines	2.2-6
2.2.2.4	Description of Waterways	2.2-7
2.2.2.5	Description of Highways	2.2-7
2.2.2.6	Description of Railroads	2.2-8
2.2.2.7	Description of Airports, Aircraft, and Airway Hazards	2.2-8
2.2.2.8	Projections of Industrial Growth	2.2-12
2.2.3	Evaluation of Potential Accidents	2.2-12
2.2.3.1	Determination of Potential Accidents	2.2-12
2.2.3.2	Effects of Design-Basis Events	2.2-27
2.2.4	References	2.2-27
2.3	Meteorology	2.3.1-1
2.3.1	Regional Climatology.....	2.3.1-1
2.3.1.1	General Climate	2.3.1-1
2.3.1.2	Regional Meteorological Conditions for Design and Operating Basis	2.3.1-2
2.3.1.3	Severe Weather	2.3.1-2
2.3.1.4	Design Basis Dry- and Wet-Bulb Temperatures	2.3.1-7
2.3.1.5	Meteorological Data for Evaluating Ultimate Heat Sink	2.3.1-7
2.3.1.6	Climate Changes	2.3.1-8
2.3.1.7	Regional Air Quality Conditions	2.3.1-8
2.3.1.8	References	2.3.1-9
2.3.2	Local Meteorology	2.3.2-1
2.3.2.1	Normal and Extreme Values of Meteorological Parameters	2.3.2-2
2.3.2.2	Potential Influence of the Plant and Its Facilities on Local Meteorology	2.3.2-5
2.3.2.3	Local Meteorological Conditions for Design and Operating Bases	2.3.2-5
2.3.2.4	References	2.3.2-6
2.3.3	Onsite Meteorological Measurements Program	2.3.3-1
2.3.3.1	Meteorological Measurements History	2.3.3-1
2.3.3.2	Primary Meteorological Facility	2.3.3-1
2.3.3.3	Operational Meteorological Program	2.3.3-4
2.3.3.4	References	2.3.3-4
2.3.4	Short-Term (Accident) Diffusion Estimates.....	2.3.4-1
2.3.4.1	Purpose and Background	2.3.4-1
2.3.4.2	Calculation Methodology and Assumptions	2.3.4-1
2.3.4.3	Summary of Results and Conclusions	2.3.4-4
2.3.4.4	References	2.3.4-4
2.3.5	Long-Term (Routine) Diffusion Estimates.....	2.3.5-1
2.3.5.1	Purpose and Background	2.3.5-1
2.3.5.2	Calculation Methodology and Assumptions	2.3.5-1

SSAR MASTER TABLE OF CONTENTS (CONTINUED)

<u>Section</u>	<u>Title</u>	<u>Page</u>
	2.3.5.3 Complex Terrain Modeling Analysis	2.3.5-2
	2.3.5.4 Summary of Results and Conclusions	2.3.5-4
	2.3.5.5 References	2.3.5-5
2.4.1	Hydrologic Description.....	2.4.1-1
	2.4.1.1 Site and Facilities	2.4.1-1
	2.4.1.2 Hydrosphere	2.4.1-1
	2.4.1.3 References	2.4.1-4
2.4.2	Floods.....	2.4.2-1
	2.4.2.1 Flood History	2.4.2-1
	2.4.2.2 Flood Design Considerations	2.4.2-1
	2.4.2.3 Effects of Local Intense Precipitation	2.4.2-3
	2.4.2.4 Site Drainage System	2.4.2-4
	2.4.2.5 References	2.4.2-5
2.4.3	Probable Maximum Flood (PMF) on Streams and Rivers	2.4.3-1
	2.4.3.1 Watershed Characteristics	2.4.3-1
	2.4.3.2 Probable Maximum Precipitation	2.4.3-1
	2.4.3.3 Precipitation Losses	2.4.3-4
	2.4.3.4 Runoff and Stream Course Models	2.4.3-4
	2.4.3.5 Probable Maximum Flood Flow	2.4.3-10
	2.4.3.6 Water Level Determinations	2.4.3-11
	2.4.3.7 Coincident Wind Wave Activity	2.4.3-11
	2.4.3.8 References	2.4.3-12
2.4.4	Potential Dam Failures	2.4.4-1
	2.4.4.1 Dam and Reservoir Description	2.4.4-1
	2.4.4.2 Dam Failure Permutations	2.4.4-1
	2.4.4.3 Unsteady Flow Analysis of Potential Dam Failures	2.4.4-8
	2.4.4.4 Water Level at CRN Site	2.4.4-8
	2.4.4.5 Coincident Wind Wave	2.4.4-8
	2.4.4.6 Erosion and Deposition Effects	2.4.4-9
	2.4.4.7 References	2.4.4-9
2.4.5	Probable Maximum Surge and Seiche Flooding	2.4.5-1
	2.4.5.1 References	2.4.5-1
2.4.6	Probable Maximum Tsunami Hazards.....	2.4.6-1
2.4.7	Ice Effects.....	2.4.7-1
	2.4.7.1 Historical Ice Accumulation	2.4.7-1
	2.4.7.2 High and Low Water Levels	2.4.7-2
	2.4.7.3 Ice Sheet Formation	2.4.7-3
	2.4.7.4 Ice-Induced Forces and Blockages	2.4.7-4
	2.4.7.5 Consideration of Other Site-Related Evaluation Criteria	2.4.7-4
	2.4.7.6 Consideration of Cold-Region Hydrology	2.4.7-4
	2.4.7.7 Conclusion	2.4.7-4
	2.4.7.8 References	2.4.7-4
2.4.8	Cooling Water Canals and Reservoirs.....	2.4.8-1
2.4.9	Channel Diversions	2.4.9-1
	2.4.9.1 Historical Channel Diversions	2.4.9-1
	2.4.9.2 Regional Topographic Evidence	2.4.9-2

SSAR MASTER TABLE OF CONTENTS (CONTINUED)

<u>Section</u>	<u>Title</u>	<u>Page</u>
	2.4.9.3 Ice Causes	2.4.9-2
	2.4.9.4 Flooding of Site Due to Channel Diversions	2.4.9-2
	2.4.9.5 Human-Induced Causes of Channel Diversions	2.4.9-3
	2.4.9.6 Alternative Water Sources	2.4.9-3
	2.4.9.7 Other Site-Related Evaluation Criteria	2.4.9-3
	2.4.9.8 Conclusions	2.4.9-4
	2.4.9.9 References	2.4.9-4
2.4.10	Flooding Protection Requirements	2.4.10-1
2.4.11	Low Water Considerations	2.4.11-1
	2.4.11.1 Low Flow in Rivers and Streams	2.4.11-1
	2.4.11.2 Low Water Resulting from Surges, Seiches, or Tsunamis	2.4.11-4
	2.4.11.3 Historical Low Water	2.4.11-5
	2.4.11.4 Future Controls	2.4.11-5
	2.4.11.5 Plant Requirements	2.4.11-5
	2.4.11.6 Heat Sink Dependability Requirement	2.4.11-5
	2.4.11.7 References	2.4.11-6
2.4.12	Groundwater	2.4.12-1
	2.4.12.1 Description and Onsite Use	2.4.12-1
	2.4.12.2 Groundwater Sources	2.4.12-12
	2.4.12.3 Subsurface Pathways	2.4.12-21
	2.4.12.4 Monitoring or Safeguard Requirements	2.4.12-23
	2.4.12.5 Site Characteristics for Subsurface Hydrostatic Loading	2.4.12-23
	2.4.12.6 Construction Dewatering	2.4.12-25
	2.4.12.7 References	2.4.12-25
2.4.12A	List of Water Systems in EPA's Safe Drinking Water Information System (SDWIS)	2.4.12A-1
2.4.12B	Aquifer Pumping Test Results.....	2.4.12B-2
	2.4.12B.1 Introduction	2.4.12B-2
	2.4.12B.2 APT Design	2.4.12B-2
	2.4.12B.3 Analysis Methodology	2.4.12B-4
	2.4.12B.4 Results and Discussion	2.4.12B-12
	2.4.12B.5 Conclusion	2.4.12B-13
	2.4.12B.6 References	2.4.12B-13
2.4.12C	Groundwater Flow Model for the Clinch River Nuclear Site ...	2.4.12C-2
	2.4.12C.1 Objective and Scope	2.4.12C-2
	2.4.12C.2 Regional Geology and Hydrogeology	2.4.12C-2
	2.4.12C.3 Site-Specific Information	2.4.12C-4
	2.4.12C.4 Conceptual Site Model and Assumptions	2.4.12C-9
	2.4.12C.5 Numerical Model	2.4.12C-13
	2.4.12C.6 Groundwater Model Calibration	2.4.12C-17
	2.4.12C.7 Post-Construction Modeling	2.4.12C-22
	2.4.12C.8 Conclusions	2.4.12C-24
	2.4.12C.9 References	2.4.12C-24
2.4.13	Accidental Releases of Liquid Effluents to Ground and Surface Waters	2.4.13-1

SSAR MASTER TABLE OF CONTENTS (CONTINUED)

<u>Section</u>	<u>Title</u>	<u>Page</u>
	2.4.13.1 Accident Source	2.4.13-1
	2.4.13.2 Receptors	2.4.13-2
	2.4.13.3 Primary Conceptual Model	2.4.13-2
	2.4.13.4 Alternate Conceptual Model	2.4.13-2
	2.4.13.5 Radionuclide Transport Analysis	2.4.13-3
	2.4.13.6 Radionuclide Concentration in the Reservoir	2.4.13-7
	2.4.13.7 Dose Evaluation	2.4.13-8
	2.4.13.8 References	2.4.13-9
2.4.14	Technical Specifications and Emergency Operation Requirements	2.4.14-1
2.5	Geology, Seismology, and Geotechnical Engineering	2.5.1-1
2.5.1	Geologic Characterization Information	2.5.1-1
	2.5.1.1 Regional Geology (within the 200-Mile Regional Radius)	2.5.1-1
	2.5.1.2 Local Geology	2.5.1-34
	2.5.1.3 References	2.5.1-99
2.5.2	Vibratory Ground Motion	2.5.2-1
	2.5.2.1 Seismicity	2.5.2-1
	2.5.2.2 Geologic and Tectonic Characteristics of the Site and Region	2.5.2-17
	2.5.2.3 Correlation of Seismicity with Seismic Sources	2.5.2-34
	2.5.2.4 Probabilistic Seismic Hazard Analysis and Controlling Earthquakes	2.5.2-38
	2.5.2.5 Seismic Wave Transmission Characteristics of the Site	2.5.2-43
	2.5.2.6 2D Sensitivity Analysis	2.5.2-66
	2.5.2.7 References	2.5.2-69
2.5.3	Surface Deformation.....	2.5.3-1
	2.5.3.1 Geological, Seismological, and Geophysical Investigations	2.5.3-2
	2.5.3.2 Geological Evidence, or Absence of Evidence, for Surface Deformation	2.5.3-4
	2.5.3.3 Correlation of Earthquakes with Capable Tectonic Sources	2.5.3-22
	2.5.3.4 Ages of Most Recent Deformation	2.5.3-23
	2.5.3.5 Relationship of Tectonic Structures in the Site Area to Regional Tectonic Sources	2.5.3-24
	2.5.3.6 Characterization of Capable Tectonic Sources	2.5.3-24
	2.5.3.7 Designation of Zones of Quaternary Deformation in the Site Region	2.5.3-25
	2.5.3.8 Potential for Tectonic or Non-Tectonic Deformation at the Site	2.5.3-26
	2.5.3.9 References	2.5.3-28
2.5.4	Stability of Subsurface Materials and Foundations	2.5.4-1
	2.5.4.1 Geologic Features	2.5.4-1
	2.5.4.2 Properties of Subsurface Materials	2.5.4-5
	2.5.4.3 Foundation Interfaces	2.5.4-16

SSAR MASTER TABLE OF CONTENTS (CONTINUED)

<u>Section</u>	<u>Title</u>	<u>Page</u>
2.5.4.4	Geophysical Surveys	2.5.4-20
2.5.4.5	Excavation and Backfill	2.5.4-25
2.5.4.6	Groundwater Conditions	2.5.4-28
2.5.4.7	Response of Soil and Rock to Dynamic Loading ..	2.5.4-30
2.5.4.8	Liquefaction Potential	2.5.4-33
2.5.4.9	Earthquake Design Basis	2.5.4-34
2.5.4.10	Static and Dynamic Stability	2.5.4-34
2.5.4.11	Design Criteria	2.5.4-42
2.5.4.12	Techniques to Improve Subsurface Conditions ...	2.5.4-42
2.5.4.13	Foundation Assessment Model	2.5.4-43
2.5.4.14	References	2.5.4-46
2.5.5	Stability of Slopes	2.5.5-1
2.5.5.1	Slope Characteristics	2.5.5-1
2.5.5.2	Design Criteria and Analyses	2.5.5-1
2.5.5.3	Results of the Investigation	2.5.5-2
2.5.5.4	Properties of Borrow Material	2.5.5-2
2.5.5.5	References	2.5.5-2
CHAPTER 3	DESIGN OF STRUCTURES, SYSTEMS, COMPONENTS, AND EQUIPMENT	3.5-1
	3.5.1.6 Aircraft Hazards	3.5-1
CHAPTER 11	RADIOACTIVE WASTE MANAGEMENT	11.2-1
11.2.3	Liquid Radioactive Releases	11.2-1
	11.2.3.1 Exposure Pathways	11.2-1
	11.2.3.2 Liquid Pathway Doses	11.2-2
11.2.4	References	11.2-3
11.3.3	Gaseous Radioactive Releases	11.3-1
	11.3.3.1 Exposure Pathways	11.3-1
	11.3.3.2 Gaseous Pathway Doses	11.3-2
11.3.4	References	11.3-2
CHAPTER 13	CONDUCT OF OPERATIONS	13.3-1
13.3	Emergency Preparedness	13.3-1
13.3.1	Physical Characteristics	13.3-5
	13.3.1.1 Site Description	13.3-5
	13.3.1.2 Area Population	13.3-5
13.3.2	Emergency Plan	13.3-6
13.3.3	Emergency Planning Zones	13.3-6
	13.3.3.1 Plume Exposure Pathway Emergency Planning Zone	13.3-6
	13.3.3.2 Ingestion Exposure Pathway	13.3-15
13.3.4	Evacuation Time Estimates	13.3-15
13.3.5	Contacts and Agreements	13.3-15
13.3.6	References	13.3-15
13.6	Physical Security	13.6-1
CHAPTER 15	ACCIDENT ANALYSIS	15-1
15.1	Accident Selection	15-1
15.2	Source Term	15-2
15.3	Evaluation Methodology and Conclusions	15-2

SSAR MASTER TABLE OF CONTENTS (CONTINUED)

<u>Section</u>	<u>Title</u>	<u>Page</u>
15.4	References.....	15-3
CHAPTER 17	QUALITY ASSURANCE	17.5-1
17.5	Quality Assurance Program Description – Design Certification, Early Site Permit and New License Applicants	17.5-1
17.5.1	Introduction	17.5-1
17.5.2	Summary	17.5-1
17.5.3	Regulatory Basis	17.5-1
17.5.4	Evaluation	17.5-2
17.5.4.1	Organization	17.5-2
17.5.4.2	Quality Assurance Program	17.5-2
17.5.4.3	Design Control and Verification	17.5-2
17.5.4.4	Procurement Document Control	17.5-3
17.5.4.5	Instructions, Procedures and Drawings	17.5-3
17.5.4.6	Document Control	17.5-3
17.5.4.7	Control of Purchased Material, Equipment, and Services	17.5-3
17.5.4.8	Identification and Control of Materials, Parts, and Components	17.5-3
17.5.4.9	Control of Special Processes	17.5-3
17.5.4.10	Inspection	17.5-4
17.5.4.11	Test Control	17.5-4
17.5.4.12	Control of Measuring and Test Equipment	17.5-4
17.5.4.13	Handling, Storage, and Shipping	17.5-4
17.5.4.14	Inspection, Test, and Operating Status	17.5-4
17.5.4.15	Nonconforming Materials, Parts, or Components	17.5-4
17.5.4.16	Corrective Action	17.5-4
17.5.4.17	Quality Assurance Records	17.5-5
17.5.4.18	Quality Assurance Audits	17.5-5
17.5.4.19	Nonsafety-Related SSC Quality Controls	17.5-5
17.5.4.20	Quality Assurance Program Commitments	17.5-5