Safety Evaluation Report for an Early Site Permit (ESP) at the Exelon Generation Company, LLC (EGC) ESP Site

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

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NUREG-1844

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ABSTRACT

This safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's technical review of the site safety analysis report (SSAR) and emergency planning information in the early site permit (ESP) application submitted by Exelon Generation Company, LLC (EGC or the applicant), for the EGC ESP site. By letter dated September 25, 2003, Exelon submitted the ESP application for the EGC ESP site in accordance with Subpart A, "Early Site Permits," of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants." The EGC ESP site is located approximately 6 miles east of the city of Clinton in central Illinois, and is adjacent to an existing nuclear power reactor operated by AmerGen, which is a subsidiary of Exelon Generation Company. In its application, EGC seeks an ESP that could support a future application to construct and operate additional nuclear power reactors at the ESP site with a total nuclear generating capacity of up to 6800 megawatts (thermal).

This SER presents the results of the staff's review of information submitted in conjunction with the ESP application. The staff has identified, in Appendix A to this SER, certain site-related items that will need to be addressed at the combined license or construction permit stage, if an applicant desires to construct one or more new nuclear reactors on the EGC ESP site. The staff determined that these items do not affect the staff's regulatory findings at the ESP stage and are, for reasons specified in Section 1.7, more appropriately addressed at later stages in the licensing process. Appendix A to this SER also identifies the permit conditions that the staff recommends the Commission impose, if an ESP is issued to the applicant.

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In accordance with U.S. Nuclear Regulatory Commission Review Standard (RS)-002, "Processing Applications for Early Site Permits," the chapter and section layout of this safety evaluation report is consistent with the format of (1) NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," (2) Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," and (3) the applicant's site safety analysis report. Numerous sections and chapters in the NUREG-0800 are not within the scope of or addressed in an early site permit (ESP) proceeding. The reader will therefore note "missing" chapter and section numbers in this document. The subjects of chapters and sections in NUREG-0800 not addressed herein will be addressed, as appropriate and applicable, in other regulatory actions (design certification, construction permit, operating license, and/or combined license) for a reactor or reactors that might be constructed on the EGC ESP site.

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EXECUTIVE SUMMARY

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," contains requirements for licensing new nuclear power plants.[1] These regulations address early site permits (ESPs), design certifications, and combined licenses (COLs). The ESP process (10 CFR Part 52, Subpart A, "Early Site Permits") is intended to address and resolve site-related issues. The design certification process (10 CFR Part 52, Subpart B, "Standard Design Certifications") provides a means for a vendor to obtain U.S. Nuclear Regulatory Commission (NRC) certification of a particular reactor design. Finally, the COL process (10 CFR Part 52, Subpart C, "Combined Licenses") allows an applicant to seek authorization to construct and operate a new nuclear power plant. A COL may reference an ESP, a certified design, both, or neither. It is incumbent on a COL applicant to resolve issues related to licensing that were not resolved as part of an ESP or design certification proceeding before the NRC can issue a COL.

This safety evaluation report (SER) describes the results of a review by the NRC staff of an ESP application submitted by Exelon Generation Company, LLC (EGC or the applicant), for the Exelon Generation Company ESP site. The staff's review verified the applicant's compliance with the requirements of Subpart A of 10 CFR Part 52. This SER serves to identify the matters resolved in the safety review and to identify remaining items to be addressed by a future COL applicant.

The NRC regulations also contain requirements for an applicant to submit an environmental report pursuant to 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Activities." The NRC reviews the environmental report as part of the Agency's responsibilities under the National Environmental Policy Act of 1969, as amended. The NRC presents the results of that review in a final environmental impact statement, which is a report separate from this SER.

By letter dated September 25, 2003, EGC submitted an ESP application (ADAMS[2] Accession No. ML032721596) for the EGC ESP site. The EGC ESP site is located in DeWitt County in east-central Illinois about 6 miles east of the city of Clinton. The site is located between the cities of Bloomington and Decatur to the north and south, respectively, and Lincoln

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[1]Applicants may also choose to seek a construction permit and operating license in accordance with 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," instead of using the 10 CFR Part 52 process.

[2]ADAMS (Agencywide Documents Access and Management System) is the NRC's information system. It provides access to all image and text documents that the NRC has made public since November 1, 1999, as well as bibliographic records (some with abstracts and full text) that the NRC made public before November 1999. Documents available to the public may be accessed via the Internet at http://www.nrc.gov/reading-rm/adams/web-based.html. Documents may also be viewed by visiting the NRC's Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, Maryland. Telephone assistance for using Web-based ADAMS is available at (800) 397-4209 between 8:30 a.m. and 4:15 p.m., eastern standard time, Monday through Friday, except Federal holidays. The staff is also making this DSER available on the NRC's new reactor licensing public Web site at http://www.nrc.gov/reactors/new-licensing/esp/clinton.html.

and Champaign-Urbana to the west and east, respectively, and is adjacent to an existing nuclear power reactor, Clinton Power Station, operated by AmerGen Energy Company, LLC (AmerGen).

In accordance with 10 CFR Part 52, Exelon submitted an ESP application that includes (1) a description of the site and nearby areas that could affect or be affected by a nuclear power plant(s) located at the site, (2) a safety assessment of the site on which the facility would be located, including an analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site, and (3) the proposed major features of an emergency plan. The application describes how the site complies with the requirements of 10 CFR Part 52 and the siting criteria of 10 CFR Part 100, "Reactor Site Criteria."[3]

This SER presents the conclusions of the staff's review of information the applicant submitted to the NRC in support of the ESP application. The staff has reviewed the information provided by the applicant to resolve the open and confirmatory items identified in the draft safety evaluation report (DSER) and the supplemental DSER for the EGC ESP. In Section 1.6 of this SER, the staff provides a brief summary of the process used to resolve these items; details of the resolution for each open item are presented in the corresponding section of this report.

The staff has identified, in Appendix A to this SER, the proposed permit conditions that it will recommend the Commission impose if an ESP is issued to the applicant. Appendix A also includes a list of COL action items or certain site-related items that will need to be addressed at the COL or construction permit stage, if an applicant desires to construct one or more new nuclear reactors on the EGC ESP site. The staff determined that these items do not affect the staff's regulatory findings at the ESP stage and are, for reasons specified in Section 1.7, more appropriately addressed at these later stages in the licensing process. In addition, Appendix A lists the site characteristics and the bounding parameters identified by the staff for this site.

Inspections conducted by the NRC have verified, where appropriate, the conclusions in this SER. The inspections focused on selected information in the ESP application and its references. This SER identifies applicable inspection reports as reference documents.

The NRC's Advisory Committee on Reactor Safeguards (ACRS) also reviewed the bases for the conclusions in this report. The ACRS independently reviewed those aspects of the application that concern safety, as well as the safety evaluation report, and provided the results of its review to the Commission in the interim report dated September 22, 2005, and in a final report dated March 24, 2006. This SER incorporates the ACRS comments and

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[3] The applicant has also submitted information intended to partially address some of the general design criteria (GDC) in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." Only GDC 2, "Design Bases for Protection Against Natural Phenomena," applies to an ESP application, and it does so only to the extent necessary to determine the safe-shutdown earthquake (SSE) and the seismically induced flood. The staff has explicitly addressed partial compliance with GDC 2, in accordance with 10 CFR 52.17(a)(1) and 10 CFR 50.34(a)(12), only in connection with the applicant's analysis of the SSE and the seismically induced flood. Otherwise, an ESP applicant need not demonstrate compliance with the GDC. The staff has included a statement to this effect in those sections of the SER that do not relate to the SSE or the seismically induced flood. Nonetheless, this SER describes the staff's evaluation of information submitted by the applicant to address GDC 2.

recommendations, as appropriate. Appendix E includes a copy of the report by the ACRS on the final safety evaluation report, as required by 10 CFR 52.23, "Referral to the ACRS."

ABBREVIATIONS

ABWR	Advanced Boiling Water Reactor
ac	acre(s)
ACR-700	Advanced CANDU Reactor
ACRS	Advisory Committee on Reactor Safeguards
ADAMS	Agencywide Documents Access and Management System
AFDD	accumulated freezing degree days
ALARA	as low as is reasonably achievable
ALI	annual limits on intake
ALWR	advanced light water reactor
ANS	American Nuclear Society or alert notification system
ANSI	American National Standards Institute
ANSS	Advanced National Seismic System
AP1000	Advanced Plant 1000
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AT	area type
BA	Blytheville arch
BP	before present
BWR	boiling water reactor
CAR	corrective action report
CDF	core damage frequency
CEUS	central and eastern United States
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
CGL	commerce geophysical lineament
COL	combined license
CP	construction permit
CPS	Clinton Power Station
CPT	cone penetrometer test
CRR	cyclic resistance ratio
CRREL	Cold Regions Research and Engineering Laboratory
CSR	cyclic stress ratio
DAC	derived air concentration
DBA	design-basis accident
DCD	design control document
DCM	document control manager
DCO	dosimetry control officer
DEIS	draft environmental impact statement
DF	design factor
DOE	U.S. Department of Energy
DRS	design response spectrum
DSER	draft safety evaluation report
EAB	exclusion area boundary
EAS	emergency alert system
ECO	exposure control officer

EGC	Exelon Generation Company
EIS	environmental impact statement
ENS	Emergency Notification System
EOC	emergency operations center
EOF	emergency operations facility
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
EPZ	emergency planning zone
ER	environmental report
ERDC	U.S. Army Engineering Research and Development Center
ERDS	Emergency Response Data System
ERF	emergency response facility
ERO	emergency response organization
ESBWR	Economic and Simple Boiling Water Reactor
ESDA	DeWitt County Emergency Services and Disaster Agency
ESP	early site permit
ESW	emergency service water
ETE	evacuation time estimate
FAA	Federal Aviation Administration
FAFC	Fluorspar Area fault complex
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FDD	freezing degree days
FOS	factor of safety
FOSID	frequency of onset of significant inelastic deformation
fps	feet per second
FRERP	Federal Radiological Emergency Response Plan
FSER	final safety evaluation report
ft	feet
GDC	general design criterion/criteria
GIS	geographic information system
gpm	gallons per minute
GPS	global positioning system
GRL	GRL Engineers, Inc.
GT-MHR	Gas Turbine Modular Helium Reactor
HCLPF	high-confidence-low-probability-of-failure
HEC	Hydrologic Engineering Center
HMR	Hydrometeorological Report
HPN	health physics network
Hz	Hertz
IDNR	Illinois Department of Natural Resources
IDNS	Illinois Department of Nuclear Safety
IDOT	Illinois Department of Transportation
IDOW	Illinois Division of Waterways
IDPH	Illinois Department of Public Health
IEMA	Illinois Emergency Management Agency
ILCS	Illinois Complied Statute
INEEL	Idaho National Engineering and Environmental Laboratory

IPRA	Illinois Plan for Radiological Accidents
IRIS	International Reactor Innovative and Secure
ISCO	Illinois State Climatologist Office
ISGS	Illinois State Geologic Survey
ISP	Illinois State Police
ISWS	Illinois State Water Survey
KI	potassium iodide
lbf/ft^2	pounds-force per square foot
LLNL	Lawrence Livermore National Laboratory
LOCA	loss-of-coolant accident
LOOP	loss of offsite power
LPZ	low population zone
LWR	light-water reactor
M	magnitude
M&TE	measuring and test equipment
m/hr	mile(s) per hour
m/s	meter(s) per second
Mb	body wave magnitude
mi	mile(s)
mph	mile(s) per hour
MSF	magnitude scaling factor
msl	mean sea level
Mw	moment magnitude
MW	megawatt
MWe	megawatt electric
MWROG	Mid-west Regional Operating Group
MWt	megawatt thermal
mya	million years ago
NARS	nuclear accident reporting system
NCDC	National Climatic Data Center
NCEER	National Center for Earthquake Engineering Research
NEI	Nuclear Energy Institute
NHS	normal heat sink
NMSZ	New Madrid seismic zone
NN	New Madrid north
NOAA	National Oceanic and Atmospheric Administration
NOS	Nuclear Oversight Department (Exelon)
NPHS	normal plant heat sink
NRC	U.S. Nuclear Regulatory Commission
NS	New Madrid south
NSSL	National Severe Storms Laboratory
NWS	National Weather Service
OBE	operating-basis earthquake
OCA	owner controlled area
OL	operating license
OSC	operations support center
OSID	onset of significant inelastic deformation
PA	protected area or public address

PAG	protective action guide
PBMR	Pebble Bed Modular Reactor
PDF	probability density function
PGA	peak ground acceleration
PMF	probable maximum flood
PMP	probable maximum precipitation
PMWP	probable maximum winter precipitation
PMWS	probable maximum windstorm
PNNL	Pacific Northwest National Laboratories
PPE	plant parameter envelope
PQP	project quality plan
PRA	probabilistic risk assessment
PSHA	probabilistic seismic hazard analysis
QA	quality assurance
QMS	quality management system
R	roentgen
RAFT	radiological assessment field team
RAI	request for additional information
RCTS	resonant column and torsional shear
REAC/TS	Radiation Emergency Assistance Center/Training Site (DOE)
RF	Reelfoot fault
RG	regulatory guide
R_p	reference probability
RPM	radiation protection manager
RS	review standard
RTM	NRC's Response Technical Manual, Revision 4
S	shear
S&L	Sargent & Lundy
S_a	spectral acceleration
SCDF	seismic core damage frequency
SCR	stable continental region
SCS	Soil Conservation Service
SEI	Structural Engineering Institute
SEOC	State emergency operations center
SER	safety evaluation report
SFCP	State forward command post
SOG	Seismic Owners Group
SOP	standard operating procedure
SPF	standard project flood
SPS	standard project storm
SPT	standard penetration test
SRM	staff requirements memorandum
SRP	Standard Review Plan
SSAR	site safety analysis report
SSC	structure, system, and component
SSE	safe-shutdown earthquake
SSI	soil-structure interaction
TEDE	total effective dose equivalent

TID	technical information document
TIGER	Topologically Integrated Geographic Encoding and Referencing System
TLD	thermoluminescent dosimetry
TN	technical note
TSC	Testing Services Corporation or technical support center
UFSAR	updated final safety analysis report
UHRS	uniform hazard response spectrum
UHS	ultimate heat sink
USACE	U.S. Army Corps of Engineers
USAR	updated safety analysis report
USBR	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey
UT	University of Texas
UTM	Universal Transverse Mercator
V/H	vertical-to-horizontal
V&V	verification and validation
Vp	compressional wave velocity
Vs	shear wave velocity
WRC	Water Resources Council
WVFS	Wabash Valley fault system
WVSZ	Wabash Valley/Southern Illinois seismic zone

1. INTRODUCTION AND GENERAL DESCRIPTION

1.1 Introduction

Exelon Generation Company, LLC (EGC or the applicant), filed an application with the U.S. Nuclear Regulatory Commission (NRC), docketed on October 27, 2003, for an early site permit (ESP) for a site the applicant designated as the EGC ESP site. EGC requested an ESP with a permit duration of 20 years pursuant to Subpart A, "Early Site Permits," of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants." The proposed site is located approximately 6 miles east of the city of Clinton in east-central Illinois.

Exelon states that the purpose of its application for an ESP is to set aside the proposed site for future energy generation and sale on the wholesale energy market. This site would be reserved for a nuclear facility to be operated as a merchant generator plant. In addition, a component of the site redress plan supports a (limited work) authorization for approval of construction activities in accordance with 10 CFR 50.10(e)(1) and 10 CFR 52.17(c).

The staff has completed its review in the areas of the site seismology, geology, meteorology, and hydrology, as well as of hazards to a nuclear power plant that could result from man-made facilities and activities on or in the vicinity of the site. The staff also assessed the risks of potential accidents that could occur as a result of the operation of a nuclear plant(s) at the site and evaluated whether the site would support adequate physical security measures for a nuclear power plant(s). The staff evaluated whether the applicant's quality assurance measures were equivalent in substance to the measures discussed in Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." The NRC found that the applicant's measures provide reasonable assurance that the ESP information that could be used in the design and/or construction of structures, systems, and components (SSCs) important to safety would support satisfactory performance of such SSCs once they were in service. The staff also evaluated the adequacy of the applicant's program for compliance with 10 CFR Part 21, "Reporting of Defects and Noncompliance." Finally, the staff reviewed the proposed major features of the emergency plan that EGC would implement if new reactor unit(s) is eventually constructed at the ESP site. The NRC will review the complete and integrated emergency plan in a separate licensing action.

The EGC ESP application includes the site safety analysis report (SSAR), which describes the safety assessment of the site, as required by 10 CFR 52.17, "Contents of Applications." The public may inspect the ESP application via the Agencywide Documents Access and Management System (ADAMS) under ADAMS Accession No. ML032721596.[4] EGC

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[4]ADAMS (Agencywide Documents Access and Management System) is the NRC's information system. It provides access to all image and text documents that the NRC has made public since November 1, 1999, as well as bibliographic records (some with abstracts and full text) that the NRC made public before November 1999. Documents available to the public may be accessed via the Internet at http://www.nrc.gov/reading-rm/adams/web-based.html. Documents may also be viewed by visiting the NRC's Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, Maryland. Telephone assistance for using Web-based ADAMS is available at (800) 397-4209 between 8:30 a.m. and 4:15 p.m., eastern standard time, Monday through Friday, except Federal holidays. The staff is also making this SER available on the NRC's new

subsequently revised its application to address requests from the NRC staff for additional information. The applicant submitted the most recent version, SSAR Revision 4 (application), to the Commission on April 14, 2006 (ADAMS Accession No. ML061100260).

Appendix B to this report provides a chronological list of the licensing correspondence between the applicant and the Commission regarding the review of the EGC ESP application under Project No. 718 and Docket No. 52-007. The application and other pertinent information and materials are available for public inspection at the NRC's Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, Maryland. The application and this safety evaluation report (SER) are also available at the Vespasian Warner Public Library, 310 North Quincy Street, Clinton, Illinois, as well as on the NRC's new reactor licensing public Web site at http://www.nrc.gov/reactors/new-licensing/esp/clinton.html. This SER is also available in ADAMS under Accession No. ML060470383.

This SER summarizes the results of the staff's technical evaluation of the suitability of the proposed EGC ESP site for construction and operation of a nuclear power plant(s) within the plant parameter envelope (PPE) that EGC specified in its application. This SER delineates the scope of the technical matters that the staff considered in evaluating the suitability of the site. NRC Review Standard (RS)-002, "Processing Applications for Early Site Permits," Attachment 2, provides additional details on the scope and bases of the staff's review of the radiological safety and emergency planning aspects of a proposed nuclear power plant site. RS-002, Attachment 2, contains regulatory guidance based on NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (hereafter referred to as the SRP). The SRP reflects the staff's many years of experience in establishing and promulgating guidance to enhance the safety of nuclear facilities and in evaluating safety assessments. In addition, this SER documents the resolution of the open and confirmatory items identified in the draft safety evaluation report (DSER) for the EGC ESP, issued on February 10, 2005.

In the DSER, the NRC identified Confirmatory Item 1.1-1 to verify that EGC's future revision of its ESP application is consistent with the information provided in its requests for additional information (RAIs) responses. Throughout the course of the review, the staff requested that the applicant submit additional information to clarify the description of the EGC ESP site. This report discusses some of the applicant's responses to these RAIs. The staff reviewed the revisions of the EGC ESP application, up to and including Revision 2 of the SSAR, and determined that the ESP application is consistent with the information provided in its RAI responses. Therefore, the staff considers DSER Confirmatory Item 1.1-1 to be resolved.

At the time the DSER was issued, the staff had not completed its review in the areas of seismology and geology. In the DSER, the staff identified Confirmatory Item 1.1-2 for issuance of a supplemental DSER at a later date to summarize the results of its technical evaluation of the suitability of the proposed EGC ESP site with respect to the site's seismology and geology. The supplemental DSER was issued on August 26, 2005 (ADAMS Accession No. ML052310459). Therefore, the staff considers Confirmatory Item 1.1-2 to be resolved.

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reactor licensing public Web site at http://www.nrc.gov/reactors/new-licensing/esp/north-anna.html.

The applicant also filed an environmental report for the EGC ESP site in which it evaluated those matters relating to the environmental impact assessment that can be reasonably reviewed at this time. The staff discussed the results of its evaluation of the environmental report for the EGC ESP site in a draft environmental impact statement (DEIS) issued on March 2, 2005 (ADAMS Accession No. ML050610364). The applicant also provided a site redress plan, in accordance with 10 CFR 52.17(c), for performing the site preparation and limited construction activities allowed by 10 CFR 52.25(a) (i.e., the activities listed in 10 CFR 50.10(e)(1)). The DEIS also includes the results of the staff's evaluation of that plan.

As described above, the applicant supplemented the information in the SSAR by providing revisions to the document. The staff reviewed these revisions to determine their impact on the conclusions in this SER. On February 17, 2006, the NRC issued its SER for the EGC ESP site and made it publically available. EGC identified that the site characteristic for the probable maximum flood (PMF) elevation proposed by the staff in the SER was somewhat higher than that calculated by EGC in its ESP application. By letters dated March 24, 2006, and April 12, 2005, EGC requested that the staff review its revised PMF analysis and adopt its corresponding PMF level as the site characteristic. By letter dated April 14, 2006, EGC provided Revision 4 to the EGC ESP application, which documented EGC's revised PMF analysis. The changes reflected in Revision 4 of the application included revisions to the tables, figures and text in Section 2.4 to reflect EGC's revised PMF analysis. This included changes to the maximum rainfall rate, the maximum hydrostatic PMF water surface elevation, the coincident wind wave activity, and the maximum storm surge. EGC presented PMF calculations using two different synthetic unit hydrograph methods (the Synder method and the Soil Conservation Service method) with two different conceptual watershed layouts (a two-basin plus lake model and a seven-basin plus lake model). The staff completed its review of the most recent version, Revision 4, of the SSAR, as documented throughout this report and, for the reasons set forth herein, finds it to be acceptable. The changes to the application in Revision 4 resulted in minor modifications to the staff's SER issued February 17, 2006, including the following changes: Section 2.4 of this SER was modified to incorporate EGC's revised PMF analysis and the staff's independent confirmatory analysis; Appendix A of this SER was modified to reflect the new site characteristics related to the revised PMF elevation; Appendix B of this SER was modified to include Revision 4 of the application; and Appendix C of this SER was modified to include reference documents used by the staff in its review of EGC's revised PMF elevation. The changes to this SER also include modifications to Section 2.4 to better describe the technical information in the application regarding EGC's ice thickness calculations. The scope of all other changes to the SER issued on February 17, 2006, resulting from Revision 4, are limited to corrections of factual inaccuracies; these changes did not impact the staff's conclusions.

Appendix A to this SER contains the list of site characteristics, permit conditions, combined license (COL) action items, and the bounding parameters that the staff recommends that the Commission include in any ESP that might be issued for the proposed site. Appendix B to this SER is a chronology of the principal actions and correspondence related to the staff's review of the ESP application for the EGC ESP site. Appendix C lists the references for this SER, Appendix D lists the principal contributors to this report, and Appendix E includes a copy of the report by the ACRS.

1.2 General Site Description

The EGC ESP facility will be co-located on the property of the existing Clinton Power Station (CPS) facility. The CPS site, with its associated 4895-acre, man-made cooling reservoir (Clinton Lake), is an irregular U-shaped site in DeWitt County in east-central Illinois about 6 miles east of the city of Clinton. The site is located between the cities of Bloomington and Decatur to the north and south, respectively, and Lincoln and Champaign-Urbana to the west and east, respectively. The total area encompassed by the ESP site boundary is about 14,180 acres. The site includes an area that extends approximately 14 miles along Salt Creek and 8 miles along the North Fork of Salt Creek, and is about 3 miles northeast of the confluence of Salt Creek and the North Fork of Salt Creek. Figure 1.2-1 in the site safety analysis report (SSAR) depicts the site location; Section 2.1 of this SER discusses the site location in more detail.

With regard to the existing development of the site, CPS Unit 1 is a Boiling Water Reactor 6 (BWR-6), with a rated core thermal power level of 3473 megawatts (thermal) (MWt) and a gross electrical output of 1138.5 megawatts (electric) (MWe). AmerGen Energy Company, LLC (AmerGen), is the licensed owner and operator of the CPS. AmerGen is a wholly owned subsidiary of EGC. EGC is a wholly owned subsidiary of Exelon Ventures Company, LLC, which in turn is a wholly-owned subsidiary of Exelon Corporation. SSAR Figure 1.2-2 provides an aerial view of the EGC ESP site showing the existing development.

With regard to the proposed development of the site, AmerGen owns the real estate on which the EGC ESP facility will sit, including the exclusion area, with the exception of a right-of-way for the township road that traverses the exclusion area. The applicant entered an access and indemnity agreement with AmerGen to obtain the rights to conduct preliminary studies and perform other activities necessary to support the EGC ESP application process. The applicant has stated that before any construction, it plans to enter into an agreement with AmerGen, that will grant EGC an exclusive and irrevocable option to purchase, enter a long-term lease, and/or procure other legal right in the land required for the EGC ESP facility. The staff proposes to include a permit condition to govern exclusion area control on any ESP that may be issued in connection with this application. Section 2.1.2 of this report discusses this issue in detail.

The applicant has not selected a specific reactor type for the EGC ESP site. However, to support its ESP application, Exelon used available information from a range of possible facilities to characterize the proposed development. The EGC ESP facility would be located approximately 700 feet south of the current CPS facility on the existing CPS property. SSAR Figure 1.2-3 shows the location of the EGC ESP site footprint and the distance by sector from the outside boundary of the footprint to the CPS property line. Depending on the reactor type selected, the EGC ESP facility could have a total core thermal power rating between approximately 2400 and 6800 MWt. The EGC ESP facility would consist of a single reactor or multiple reactors (or modules) of the same reactor type. SSAR Section 1.3 provides an overview of the reactor designs considered in developing the information necessary to support Exelon's ESP application. The EGC ESP facility could be any of the reactor designs described in the application or a new design that falls within the range of the information developed to characterize the facility (i.e., the plant parameter envelope (PPE)).

According to the applicant, the EGC ESP facility would be constructed as a large industrial facility similar in general appearance to the existing CPS facility. However, unlike the existing plant, which uses the Clinton Lake for normal cooling processes, the EGC ESP facility would use cooling towers. Clinton Lake would be used as the source of makeup water for the EGC ESP facility cooling water systems.

A new intake structure, located on Clinton Lake adjacent to the existing CPS Unit 1 intake structure, would provide raw water for cooling tower makeup and other plant services. Cooling tower blowdown and other plant discharges would use the existing CPS Unit 1 discharge flume as a discharge path to Clinton Lake. The additional discharge flow from the EGC ESP facility would be insignificant relative to the capacity of the existing discharge flume. The CPS facility's safety-related systems and equipment would not be shared or cross-connected with the EGC ESP facility. However the EGC ESP facility would use the existing CPS ultimate heat sink as its source of makeup water.

The ESP facility might share some structures, such as the warehouse and training buildings and parking lots, with CPS. Some support facilities, such as the domestic water supply and sewage treatment, might also be shared. The applicant would expand the existing switchyard to accommodate the output of the new facility and to provide the necessary offsite power. EGC would use the switchyard area intended for the canceled CPS Unit 2 for this purpose. The applicant would also use the existing transmission right-of-way. SSAR Figure 1.2-4 identifies the location of the EGC ESP facility's new structures relative to the existing CPS facilities.

1.3 Plant Parameter Envelope

The regulations at 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," and 10 CFR Part 100, "Reactor Site Criteria," that apply to an ESP do not require an ESP applicant to provide specific design information. However, some design information may be required to address 10 CFR 52.17(a)(1), which calls for "an analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site under the radiological consequence evaluation factors identified in § 50.34(a)(1) of this chapter."

In Section 1.4 of the SSAR, the applicant provided a list of postulated design parameters, referred to as the "plant parameter envelope." The applicant states that the PPE is a set of design parameters that are expected to bound the characteristics of a reactor or reactors that might later be deployed at a site. This means that the design characteristics of potential designs would be no more demanding from a site suitability perspective than the bounding design parameters listed in the PPE tabulation.

The applicant states that it developed the list of plant parameters necessary to define the plant-site interface based on previous industry and Department of Energy-sponsored work performed in the early 1990s as part of the ESP Demonstration Program, as well as on current reactor vendor design input data. As a result of earlier and current efforts, the applicant identified appropriate design parameters to include in the PPE through a systematic review of regulatory criteria and guidance, ESP application content requirements, and experience with previous site suitability studies. The plant parameters characterize (1) the functional or operational needs of the plant from the site's natural or environmental resources, (2) the plant's impact on the site and surrounding environs, and (3) the site-imposed requirements on the plant. The PPE values are generally based on certified design information and the best available information for as yet uncertified designs. Some of the values have been modified to include margin.

A set of plant parameter values is developed by considering the values provided by various reactor vendors and by applying appropriate conservatism where required to characterize the surrogate facility. As applicable, the most limiting (maximum or minimum) bounding value is selected. The complete set of plant parameter values describes, or envelops, the site-facility interface. This type of facility characterization is considered sufficient to assess the future use of the site for a nuclear electric generating facility.

Tables 1.4-1 through 1.4-8 of the applicant's SSAR list the parameters used, the PPE values selected, and the site characteristic values used in assessing the safety and environmental impact of constructing and operating the EGC ESP facility. SSAR Table 1.4-9 provides a description or definition and bases for the plant parameters used to evaluate the safety and/or environmental impact of locating the proposed nuclear generating capacity at the EGC ESP site.

The applicant has stated that through the PPE, it had sufficient design information to allow it to perform the evaluation required by 10 CFR 52.17(a)(1) to determine the adequacy of the proposed exclusion area and low-population zone (LPZ) for the site. Section 3.3 of the SSAR reports the results of this evaluation in which the applicant used design information limited to the release rate of radioactivity to the environment resulting from a design-basis accident for hypothetical reactors similar to two representative reactor types that vendors have offered for construction in the United States.

In addition to the information required to support the dose consequence evaluation, the applicant provides other design information in the PPE. Because the applicant is not requesting the issuance of an ESP referencing a particular reactor design, the staff's review criterion for the PPE is that the PPE values should not be unreasonable for a reactor that might be constructed on the ESP site. The applicant's PPE is based on various reactor designs that are either certified by the NRC, are in the certification process, or may be submitted for certification in the future. The PPE references the following designs:

- Advanced Canada Deuterium Uranium (CANDU) Reactor (ACR-700) (Atomic Energy of Canada, Ltd.)
- Advanced Boiling Water Reactor (ABWR) (General Electric)
- Advanced Plant 1000 (AP1000) (Westinghouse Electric Company)
- Economic and Simplified Boiling Water Reactor (ESBWR) (General Electric)
- Gas Turbine Modular Helium Reactor (GT-MHR) (General Atomics)
- International Reactor Innovative and Secure Project (IRIS) (consortium led by Westinghouse)

- Pebble Bed Modular Reactor (PBMR (Pty) Ltd.)

The staff reviewed the applicant's PPE values and found them to be reasonable, as discussed in the individual sections in this SER. As previously noted, the applicant identified certain PPE values as appropriate for inclusion in an ESP, if one is issued. The staff also reviewed the applicant's proposed list of PPE values and identified certain PPE values as bounding parameters or controlling PPE values as discussed in the individual sections of this SER. A controlling PPE value, or bounding parameter value, is one that necessarily depends on a site characteristic. As the PPE is intended to bound multiple reactor designs, the NRC would review the actual design selected in a COL or construction permit (CP) application referencing any ESP that might be issued in connection with this application to ensure that the design falls within the bounding parameter values. Appendix A to this SER lists the bounding parameters identified for the EGC ESP site.

If an ESP is issued for the EGC ESP site, an entity may wish to reference the ESP, as well as a certified design, in a COL or CP application. Such a COL or CP applicant must demonstrate that the site characteristics established in the ESP bound the postulated site parameters established for the chosen design and that the design characteristics of the chosen design fall within the bounding parameter values specified in the ESP. Otherwise, the COL or CP applicant must demonstrate that the new design, given the site characteristics in the ESP, complies with the Commission's regulations. If an entity wishes to reference the ESP and a design that is not certified, the COL or CP applicant must demonstrate that the design characteristics of the chosen design, in conjunction with the site characteristics established for the ESP, comply with the Commission's regulations.

1.4 Identification of Agents and Contractors

EGC is the applicant for the ESP and has been the only participant in the review of the suitability of the EGC ESP site for a nuclear power plant. CH2MHILL, under contract with EGC, served as the primary contractor for the development of the ESP application, supplying personnel, systems, and project management.

Several subcontractors also assisted in the development of EGC's ESP application. Parsons Power Group, Inc., provided engineering services in preparing the SSAR; Testing Service Corporation provided engineering, technical, and laboratory services associated with geotechnical activities; Geomatrix Consultants, Inc., performed seismic and geologic data collection, site response studies, and safe-shutdown earthquake determinations; GRL Engineers, Inc., conducted standard penetration test measurement work; Stratigraphics performed cone penetrometer measurements and testing for the geotechnical aspects of the ESP; and the University of Texas performed soil sample resonant column and torsional shear testing.

1.5 Summary of Principal Review Matters

This SER summarizes the results of the NRC staff's technical evaluation of the EGC ESP site. The staff's evaluation included a technical review of the information and data the applicant submitted, with emphasis on the following matters:

- population density and land use characteristics of the site environs and the physical characteristics of the site, including seismology, meteorology, geology, and hydrology, to evaluate whether these characteristics were adequately described and appropriately considered in determining whether the site characteristics are in accordance with the Commission's siting criteria (10 CFR Part 100, Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997")

- potential hazards of man-made facilities and activities to a nuclear power plant or plants that might be constructed on the ESP site (e.g., mishaps involving storage of hazardous materials (toxic chemicals, explosives), transportation accidents (aircraft, marine traffic, railways, pipelines), and the existing nuclear power plant at the nearby CPS)

- potential capability of the site to support the construction and operation of a nuclear power plant(s) with design parameters within the parameters specified in the applicant's PPE under the requirements of 10 CFR Parts 52 and 100

- suitability of the site for development of adequate physical security plans and measures for a nuclear power plant(s)

- proposed major features for a future emergency plan if an applicant decides to seek a license to construct and operate a nuclear power plant(s) on the ESP site, any significant impediments to the development of emergency plans for the EGC ESP site, and a description of contacts and arrangements made with Federal, State, and local government agencies with emergency planning responsibilities

- quality assurance measures EGC applied to the information submitted in support of the ESP application and safety assessment

- the acceptability of the applicant's proposed exclusion area and LPZ under the dose consequence evaluation factors of 10 CFR 50.34(a)(1)

During its review, the staff held several meetings with representatives of EGC and its contractors and consultants to discuss various technical matters related to the staff's review of the EGC ESP site (refer to Appendix B to this report). The staff also visited the site to evaluate safety matters.

1.6 Summary of Open and Confirmatory Items

As a result of its review of Exelon's application for the EGC ESP, the staff identified several issues that remained open at the time the DSER and supplemental DSER were issued. The staff considers an issue to be open if the applicant has not provided requested information and the staff is unaware of what will ultimately be included in the applicant's response. For tracking purposes the staff assigned each of these issues a unique identifying number that indicates the section of this report describing it. The resolution of each open item is discussed in the SER section in which the item appears. For example, Section 2.1 of this report discusses Open Item 2.1-1.

In addition, the staff identified several confirmatory items in the DSER. An item is identified as confirmatory if the staff and the applicant have agreed on a resolution of the particular item, but the resolution has not yet been formally documented. For example, Section 1.1 of this report discusses Confirmatory Items 1.1-1 and 1.1-2.

The DSER was issued with 33 open items and 5 confirmatory items; the supplemental DSER was issued with 7 open items. As set forth in this report, all open items have been resolved and the confirmatory items have been completed. This SER documents the resolution of all the open and confirmatory items identified in the DSER and the supplemental DSER.

1.7. Summary of Combined License Action Items

The staff has also identified certain site-related items that will need to be addressed at the COL or CP stage if a COL or CP applicant desires to construct one or more new nuclear reactors on the EGC ESP site. This report refers to these items as COL action items. The COL action items relate to issues that are outside the scope of this SER. The COL action items do not establish requirements; rather, they identify an acceptable set of information to be included in the site-specific portion of the safety analysis report submitted by a COL or CP applicant referencing the EGC ESP. An applicant for a COL or CP should address each of these items in its application. The applicant may deviate from or omit these items, provided that the COL or CP application identifies and justifies the deviation or omission. The staff determined that the COL action items do not affect its regulatory findings at the ESP stage and are, for reasons specified in this report for each item, more appropriately addressed at later stages in the licensing process.

The DSER was issued with nine COL action items and the supplemental DSER was issued with eight COL action items. The staff reviewed the applicant's responses to the DSER and supplemental DSER open items and identified a number of new COL action items as a result. This report highlights these COL action items, and the staff explains them in the applicable sections of this SER. Appendix A to this SER includes a list of COL action items that must be addressed by a future COL or CP applicant. The staff identified COL action items in order to ensure that particular significant issues are tracked and considered during the COL or CP stage. The COL action items focus on matters that may be significant in any COL or CP application referencing the ESP for the EGC site, if one is issued. Usually, COL action items are not necessary for issues covered by permit conditions or explicitly covered by the bounding parameters. The list of COL action items is not exhaustive.

1.8 Summary of Permit Conditions

The staff has identified certain permit conditions that it will recommend the Commission impose, if an ESP is issued to the applicant. Appendix A to this SER summarizes these conditions. These permit conditions, or limitations on the ESP, are based on the provisions of 10 CFR 52.24, "Issuance of Early Site Permit."

The staff proposed 14 permit conditions in the DSER and 1 permit condition in the supplemental DSER. The applicant's responses to the DSER and supplemental DSER open items resulted in the resolution of some proposed DSER permit conditions. In addition, the staff determined that a permit condition is not necessary when an existing NRC regulation requires a future regulatory review and approval process to ensure adequate safety during design, construction, or inspection activities for a new plant. Based on this criterion, the staff removed a number of permit conditions proposed in the DSER and, in some cases, added new permit conditions, COL action items, or site characteristics, as appropriate, to account for the concern.

Appendix A to this SER contains the final list of permit conditions, which have been highlighted throughout this report. Each permit condition has been reassigned a number identifying the order which appears in this SER. The staff has provided an explanation of each permit condition in the applicable section of this report.

2. SITE CHARACTERISTICS

2.1 Geography and Demography

2.1.1 Site Location and Description

2.1.1.1 Technical Information in the Application

In Section 2.1.1.1 of the site safety analysis report (SSAR), the applicant presented information concerning the location and area of the early site permit (ESP) site that could affect the design of structures, systems, and components (SSCs) important to the safety of a nuclear power plant(s) falling within the applicant's plant parameter envelope (PPE) that might be constructed on the proposed ESP site. The applicant stated that the Exelon Generating Company (EGC) ESP site will be located approximately 700 feet south of the existing Clinton Power Station (CPS), which lies within Zone 16 of the Universal Transverse Mercator (UTM) coordinates. The applicant further stated that the exact UTM coordinates for a new unit(s) constructed on the proposed ESP site will be finalized at the time of a combined license (COL) application. The applicant provided the following information on site location and area:

- the site boundary for a new unit(s) on the proposed ESP site with respect to the location of CPS
- the site location with respect to political subdivisions and prominent natural and manmade features of the area within the low-population zone (LPZ) and the 50-mile population zone
- the topography surrounding the proposed ESP site
- the distance from the proposed ESP site to the nearest exclusion area boundary (EAB), including the direction and distance
- the location of potential radioactive material release points associated with a proposed new unit(s)
- the distance of the proposed ESP site from U.S. and State highways
- confirmation that no physical characteristics unique to the proposed ESP site were identified that could pose a significant impediment to the development of emergency plans

2.1.1.2 Regulatory Evaluation

In Request for Additional Information (RAI) 1.5-1, the U.S. Nuclear Regulatory Commission (NRC) staff asked the applicant to provide a comprehensive listing of regulations applicable to its ESP SSAR. In its response to RAI 1.5-1, the applicant stated that NRC Review Standard (RS)-002, "Processing Applications for Early Site Permits," Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. RS-002, Attachment 2, identifies the applicable NRC regulations regarding site location and description in Title 10 of the *Code of Federal*

Regulations, (10 CFR) Section 52.17, "Contents of Applications," and Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997," to 10 CFR Part 100, "Reactor Site Criteria." The staff finds that the applicant correctly identified the applicable regulations. The staff considered the following two regulatory requirements in reviewing the site location and site area:

(1) 10 CFR Part 100, which requires the consideration of factors relating to the size and location of proposed sites

(2) 10 CFR 52.17, which requires the applicant to submit information needed to evaluate factors involving the characteristics of the site environs

According to Section 2.1.1 of RS-002, Attachment 2, an applicant has submitted adequate information if it satisfies the following criteria:

- The site location, including the exclusion area and the proposed location of a nuclear power plant(s) of specified type falling within the applicant's PPE that might be constructed on the proposed site, is described in sufficient detail to determine whether the requirements of 10 CFR Part 100 and 10 CFR 52.17 are met, as discussed in Sections 2.1.2, 2.1.3, and 3.3 of this safety evaluation report (SER).

- Highways, railroads, and waterways which traverse the exclusion area are sufficiently distant from the planned or likely locations of any structures of a nuclear power plant(s) of specified type falling within the applicant's PPE that might be constructed on the proposed site so that routine use of these routes is not likely to interfere with normal plant operation.

2.1.1.3 Technical Evaluation

The proposed EGC ESP site is located approximately 700 feet south of the existing CPS facility. The CPS lies within Zone 16 of the UTM coordinates. Figure 2.1-8 of the SSAR depicts the EAB and the LPZ for the proposed ESP site. The applicant stated that the exact UTM coordinates for a new unit(s) constructed on the proposed ESP site will depend upon the specific reactor technology selected for deployment. This decision will be finalized at the time of a COL application. The staff will review the exact UTM coordinates of the new unit(s) at the time of a COL application. This is **COL Action Item 2.1-1.**

The applicant elected to define the EAB envelope as a circular radius of 3,362 feet (0.64 miles) and the LPZ as a circular radius of 13,182 feet (2.5 miles) from the center of the proposed ESP facility footprint. The EAB for the proposed ESP site overlaps the existing EAB for CPS; however, the two are not concentric. Also, the EAB for the existing CPS is slightly smaller, with a circular radius of 3199 feet (0.6 miles), and both CPS and the proposed ESP site have the same LPZ. The applicant established the EAB and the LPZ to ensure that the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1) and the siting evaluation factors in Subpart B of 10 CFR Part 100 are met. No persons live within either the CPS EAB or the proposed ESP site EAB. The staff verified that the exclusion area distance is consistent with the distance used in the radiological consequence analyses the applicant performed and which Section 3.3 of the SSAR describes, as well as the analysis the staff performed and which Section 3.3 of this SER describes.

The proposed ESP site, located in east-central Illinois, falls within Harp Township in DeWitt County. Specifically, the site is about 6 miles east of the City of Clinton and lies between the cities of Bloomington and Decatur, 22 miles to the north and 22 miles to the south, respectively. Regionally, the proposed site is located between the cities of Lincoln and Champaign-Urbana, 28 miles to the west and 30 miles to the east, respectively. The nearest major highways are Illinois State Routes 54, 10, and 48, all of which cross the CPS facility property. Other major highways within the region include Interstate 155 to the west, Interstate 72 to the southeast, Interstate 55 to the northwest, Interstate 74 to the northeast, Interstate 39 to the north, and Interstate 57 to the east. The closest of these highways (State Route 54) approaches within 1 mile north of the proposed ESP facility footprint. Routine use of State Route 54 is not likely to interfere with normal plant operation.

The gaseous effluent release limits for a new unit(s) would apply at the proposed ESP exclusion area site boundary, and the liquid effluent release limits for a new unit(s) would apply at the end of the discharge canal into Clinton Lake, the outfall of which joins the Sangamon River approximately 56 miles downstream. The staff finds that these release points are acceptable for determining whether the radiation exposures to the public meet the criterion, "as low as reasonably achievable," cited in Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable,' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." (For a further discussion of this subject, see Section 5.4 of the staff's environmental impact statement (EIS) for the Exelon ESP application.)

In addition, for the reasons set forth in Section 13.3 of this SER, the staff finds that no physical characteristics unique to the proposed ESP site have been identified that could pose a significant impediment to the development of emergency plans.

2.1.1.4 Conclusions

As set forth above, the applicant provided and substantiated information concerning the site location and area that could affect the design of SSCs important to the safety of a nuclear power plant(s) of specified type falling within the applicant's PPE that might be constructed on the proposed ESP site. The staff has reviewed the applicant's information, as described above, and concludes that it is sufficient for the staff to evaluate compliance with the siting evaluation factors in 10 CFR Part 100 and 10 CFR 52.17, as well as with the radiological consequence evaluation factors in 10 CFR 50.34(a)(1). The staff further concludes that the applicant provided sufficient details about the site location and site area to allow the staff to evaluate, as documented in Sections 2.1.2, 2.1.3, and 3.3 of this SER, whether the applicant met the relevant requirements of 10 CFR Part 100 and 10 CFR 52.17.

2.1.2 Exclusion Area Authority and Control

2.1.2.1 Technical Information in the Application

In Section 2.1.2 of the SSAR, the applicant presented information concerning its plan to ensure the legal authority necessary to determine all activities within the designated EAB, if the applicant decides to proceed with the development of a new reactor unit(s) at the proposed ESP site. The regulations at 10 CFR 100.3, "Definitions," require that a reactor licensee have the authority to determine all activities within the designated exclusion area, including the exclusion or removal of personnel and property. With respect to this requirement, the applicant stated the following:

> EGC will ensure that it has or will be granted the necessary authority, rights, and control of the EGC ESP Site, including the exclusion area prior to commencing actions allowed pursuant to any ESP granted from the Application.

In RAI 2.1.2-1, the staff asked the applicant for additional information regarding its approach to obtaining a grant from the appropriate regulatory agencies and other private parties for the necessary authority, rights, and control of the ESP site. In its response, the applicant stated the following:

> EGC plans to enter into an agreement with AmerGen prior to construction that will grant EGC an exclusive and irrevocable option to purchase, enter a long-term lease for, and/or procure other legal right in the land required for the EGC ESP facility. Additionally, EGC will enter into an Exclusion Area Agreement with AmerGen. This agreement will provide EGC with authority to determine the activities within the EGC ESP exclusion area, including the exclusion of personnel and property, to the extent necessary to comply with applicable NRC guidance. EGC anticipates that this Agreement and the lease will extend for 99 years.

2.1.2.2 Regulatory Evaluation

In RAI 1.5-1, the staff asked the applicant to provide a comprehensive listing of NRC regulations applicable to its ESP SSAR. In its response to RAI 1.5-1, the applicant stated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. RS-002, Attachment 2, identifies the applicable NRC regulations regarding exclusion area authority and control as 10 CFR 52.17, 10 CFR Part 100, and 10 CFR 50.34(a)(1). The staff reviewed this portion of the application for conformance with the applicable regulations, and considered the corresponding regulatory guidance.

In reviewing the applicant's legal authority to determine all activities within the designated exclusion area, the staff considered the relevant requirements of 10 CFR 100.3 which state the following:

> Exclusion area means that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. This area may be traversed by

a highway, railroad, or waterway, provided these are not so close to the facility as to interfere with normal operations of the facility and provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety.... Activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result.

To meet the requirements of 10 CFR Part 100, the applicant must demonstrate, before the issuance of an ESP, that it has an exclusion area and an LPZ, as defined in 10 CFR 100.3, and that it has the required authority within the exclusion area, also defined in 10 CFR 100.3. If not, the applicant must provide reasonable assurance that it will have such authority before construction of a new unit(s) commences.

2.1.2.3 Technical Evaluation

The applicant has stated that it plans to enter into an agreement with AmerGen, before any construction, that will grant Exelon an exclusive and irrevocable option to purchase, enter a long-term lease, and/or procure other legal right in the land required for the EGC ESP facility. The applicant has not attempted to demonstrate that it currently has the authority to determine all activities, including exclusion or removal of personnel and property from the area, as required by 10 CFR 100.3. To meet the exclusion area control requirements of 10 CFR 100.21(a), "Non-Seismic Site Criteria," and 10 CFR 100.3, the applicant does not need to demonstrate total control of the property before issuance of the ESP. In the draft safety evaluation report (DSER), the NRC staff stated that the applicant must provide reasonable assurance that it can acquire the required control, i.e., that it has the legal right to obtain control of the exclusion area. The staff had not then obtained information sufficient to enable the staff to determine whether the applicant had such a legal right. Accordingly, the NRC staff identified DSER Open Item 2.1-1, which stated:

> Demonstrate that the applicant has the legal right to control the exclusion area, or has an irrevocable right to obtain such control.

Specifically, the applicant should provide a detailed explanation of the corporate relationship between Exelon (the parent company) and AmerGen (the subsidiary).

In its response to the open item, the applicant indicated as follows: AmerGen is the licensed owner and operator of the Clinton Power Station. AmerGen is a wholly-owned subsidiary of the applicant, Exelon Generation Company, LLC (EGC). EGC is a wholly owned subsidiary of Exelon Ventures Company, LLC, which in turn is a wholly-owned subsidiary of Exelon Corporation. Additionally, the AmerGen Management Committee, which has the authority to manage AmerGen, authorized AmerGen's officers to negotiate all necessary agreements to support EGC with its ESP application, which may include, without limitation, a long-term interest in the real estate that is the subject of the ESP application and an exclusion area agreement. (See letter from Marilyn C. Kray, Vice President, Project Development, Exelon Nuclear, to NRC, "Response to Draft Safety Evaluation Report (DSER) Items" (April 26, 2005), ADAMS Accession No. ML051230326.)

Based on the above information, the staff has determined that AmerGen is prepared to negotiate with EGC in order to grant the applicant an exclusive and irrevocable option to purchase, enter a long-term lease, and/or procure other legal right in the land required for the EGC ESP facility, and no new nuclear power plant could be built in the absence of an agreement. It further appears that there is no legal impediment to EGC's acquisition of such rights.

Accordingly, the NRC staff proposes to include a condition in any ESP that might be issued regarding the Clinton site, to govern exclusion area control. This condition would require that an agreement granting EGC an exclusive and irrevocable option to purchase, enter a long-term lease, and/or other legal right in the land required to satisfy the requirements of 10 CFR Part 100 for the EGC ESP facility, be obtained and executed before submission of an application for a COL seeking authority to construct and operate a nuclear power plant referencing the ESP. Such a condition provides reasonable assurance for purposes of issuance of an ESP. This is **Permit Condition 1.** Therefore, DSER Open Item 2.1-1 is closed.

The applicant stated that the CPS operator, AmerGen, owns the property associated with the proposed ESP site, with the exception of a right-of-way for the township road that traverses the exclusion area. This road provides access to privately owned property which lies outside the proposed ESP exclusion area. The applicant further stated that in an emergency, Exelon, together with the local law enforcement agency, will control access to the exclusion area via this road. Furthermore, the property ownership and mineral rights provide AmerGen the authority to control activities, including exclusion and removal of personnel and property, within the exclusion area. There are no residents within the EAB.

Should the NRC grant the ESP, and the ESP holder decide to perform the activities authorized by 10 CFR 52.25, "Extent of Activities Permitted," the ESP holder, or the applicant for a construction permit (CP) or COL who references the permit, will need to obtain the authority to undertake such activities on the ESP site. In obtaining such a right, the ESP holder, or the applicant for a CP or COL who references the permit, will also need to obtain the corresponding right to implement the site redress plan described in the staff's final EIS in the event that no plant is built on the ESP site. This is **Permit Condition 2.**

A small area of Clinton Lake lies within the proposed ESP EAB and is used for public recreation lake activities. Should the NRC grant the ESP and the ESP holder decide to apply for a COL (or for a CP and operating license), the ESP holder will need to make arrangements with the appropriate Federal, State, local, or other public agencies to provide for control of the portion of Clinton Lake that lies within the exclusion area. These public agencies, together with the ESP holder, will need sufficient authority over these bodies of water to allow for the exclusion and ready removal, in an emergency, of any persons present on them. This is **COL Action Item 2.1-2.**

2.1.2.4 Conclusions

As set forth above, the applicant provided and substantiated information concerning its plan to obtain legal authority to determine all activities within the designated exclusion area. The staff has reviewed the applicant's information and concludes that it is sufficient to evaluate compliance with the exclusion area control requirements of 10 CFR 100.21(a) and 10 CFR

100.3. In addition, the applicant appropriately described the exclusion area and the methods by which it will control access and occupancy of this exclusion area during normal operation and in the event of an emergency situation.

Based on the above, the staff concludes that the applicant's exclusion area is acceptable and meets the requirements of 10 CFR Part 100, subject to the limitation and conditions identified in this SER. Such permit conditions provide reasonable assurance that an ESP provides for control of the exclusion area. Further, the ESP holder must demonstrate that it will have authority to perform the activities authorized by 10 CFR 52.25, should it choose to do so, and the corresponding right to implement the site redress plan, as described in the discussion of Permit Condition 2 above.

2.1.3 Population Distribution

2.1.3.1 Technical Information in the Application

In SSAR Section 2.1.3, the applicant estimated and provided the population distribution within a 50-mile radius of the proposed ESP site, based on the most recent U.S. Census data, and the projected population estimates up to 2060, including transient populations. The applicant also provided the population distribution within the LPZ, facilities and institutions within the vicinity of the LPZ, the nearest population center, population densities within a 50-mile radius of the proposed ESP site for 2000, and estimated population data for 2060.

The population distribution provided by the applicant encompasses nine concentric rings at various distances out to 50 miles from the proposed ESP site and 16 directional sectors. The applicant also estimated and provided transient population data out to 50 miles for 2000 and projected population estimates to 2060 based on the recreational use of Clinton Lake State Recreational Area, seasonal residents, and business and migrant workers that normally do not live in the area.

2.1.3.2 Regulatory Evaluation

In RAI 1.5-1, the staff asked the applicant to provide a comprehensive listing of NRC regulations applicable to its ESP SSAR. In its response to RAI 1.5-1, the applicant stated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. RS-002, Attachment 2, identifies the applicable NRC regulations and guidance regarding population distribution as 10 CFR 52.17, 10 CFR Part 100, and Regulatory Guide (RG) 4.7, "General Site Suitability Criteria for Nuclear Power Stations," issued April 1998. The staff reviewed this portion of the application for conformance with the applicable regulations, and considered the corresponding regulatory guidance.

The staff considered the following regulatory requirements in its review of this SSAR section:

- 10 CFR 52.17, which requires each applicant to provide a description and safety assessment of the site and which requires site characteristics to comply with the criteria of 10 CFR Part 100

- 10 CFR Part 100, which establishes requirements with respect to population center distance and the LPZ

In particular, the staff considered the population density and use characteristics of the site environs, including the exclusion area, LPZ, and population center distance. The regulations in 10 CFR Part 100 provide definitions and other requirements for determining an exclusion area, LPZ, and population center distance.

As stated in Section 2.1.3 of RS-002, Attachment 2, the applicable requirements of 10 CFR 52.17 and 10 CFR Part 100 are deemed to have been met if the population density and use characteristics of the site meet the following criteria:

- Either there are no residents in the exclusion area or, if residents do exist, they are subject to ready removal, in case of necessity.

- The specified LPZ is acceptable if it is determined that appropriate protective measures could be taken on behalf of the enclosed populace in the event of a serious accident.

- The population center distance (as defined in 10 CFR Part 100) is at least one and one-third times the distance from the reactor to the outer boundary of the LPZ.

- The population center distance is acceptable if there are no likely concentrations of greater than 25,000 people over the lifetime of a nuclear power plant(s) of specified type, or falling within a PPE, that might be constructed on the proposed site (plus the term of the ESP) closer than the distance designated by the applicant as the population center distance. The boundary of the population center shall be determined upon considerations of population distribution. Political boundaries are not controlling.

- The population data supplied by the applicant in the safety assessment are acceptable if (1) they contain population data for the latest census, projected year(s) of startup of a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site (such date(s) reflecting the term of the ESP) and projected year(s) of end of plant life, all in the geographical format given in Section 2.1.3 of RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants—LWR Edition," Revision 3, issued November 1978, (2) they describe the methodology and sources used to obtain the population data, including the projections, (3) they include information on transient populations in the site vicinity, and (4) the population data in the site vicinity, including projections, are verified to be reasonable by other means, such as U.S. Census publications, publications from State and local governments, and other independent projections.

- If the population density at the ESP stage exceeds the guidelines given in RG 4.7, special attention to the consideration of alternative sites with lower population densities is necessary. A site that exceeds the population density guidelines of Regulatory Position C.4 of RG 4.7 can nevertheless be selected and approved if, on balance, it offers advantages compared with available alternative sites, when all of the environmental, safety, and economic aspects of the proposed and alternative sites are considered.

2.1.3.3 Technical Evaluation

The staff reviewed the population data in the site environs, as presented in the applicant's SSAR, to determine whether the exclusion area, LPZ, and population center distance for the proposed ESP site comply with the requirements of 10 CFR Part 100 and the acceptance criteria in Section 2.1.3.2 of this SER. The staff also evaluated whether, consistent with Regulatory Position C.4 of RG 4.7, the applicant should consider alternate sites with lower population densities. The staff also reviewed whether appropriate protective measures could be taken on behalf of the enclosed populace within the emergency planning zone (EPZ), which encompasses the LPZ, in the event of a serious accident.

The staff compared and verified the applicant's population data against U.S. Census Bureau Internet data. The staff reviewed the projected population data provided by the applicant, including transient populations for 2010, 2020, 2030, 2040, 2050, and 2060 (see Section 13.3 of this SER). If the ESP were approved and issued in 2006, assuming a COL application is submitted around the middle of the ESP term, with a projected startup of a new unit(s) in about 2020 and an operational period of 40 years, the projected year for end of plant life is about 2060. Accordingly, the staff finds that the applicant's projected population data cover an appropriate number of years and are therefore reasonable.

The staff reviewed the transient population data provided by the applicant. The transient population up to a 50-mile radius is based on recreational use of Clinton Lake Recreational Area, seasonal residents, special populations (e.g., schools, hospitals, nursing homes, and correctional facilities), and business and migrant workers who do not normally live in the area. The applicant stated that it collected the transient population estimates for the larger business transient population, recreation areas, and special populations using surveys performed during August and September 2002; the DeWitt County Emergency Services and Disaster Agency Coordinator verified the data. The applicant further stated that it obtained the data on the recreation area population from the Illinois Department of Natural Resources. The applicant obtained data on migrant workers from the Bureau of Economic Analysis, U.S. Department of Commerce. Based on this information, the staff finds that the applicant's estimate of the transient population is reasonable.

The staff notes that no member of the public lives within the exclusion area.

Section 3.3 of the SSAR describes the applicant's evaluation of design-basis accidents (DBAs); Section 3.3 of this SER describes the staff's independent verification of the applicant's evaluation. These analyses demonstrate that the radiological consequences of design-basis reactor accidents at the proposed EAB and LPZ would be within the dose consequence evaluation factors set forth in 10 CFR 50.34(a)(1).

The applicant stated that the nearest population center greater than 25,000 people likely to exist over the lifetime of the proposed ESP site is Decatur, Illinois, with a population of 81,860, located approximately 22 miles south-southwest of the proposed ESP site. The distance to Decatur is well in excess of the minimum population center distance of 3.3 miles (one and one-third times the distance of 2.5 miles from the reactor to the outer boundary of the LPZ as required per 10 CFR 100.21(b)). The proposed LPZ is the area immediately surrounding the exclusion area encompassed by a circle, centered on the proposed ESP facility footprint, with a radius of 2.5 miles.

Therefore, the staff concludes that the proposed ESP site meets the population center distance requirement, as defined in 10 CFR Part 100. The staff determined that it is unlikely that a population center with 25,000 people or more will exist within the 3.3-mile minimum population center distance during the lifetime of any new unit(s) that might be constructed on the site. This conclusion is based on projected cumulative resident and transient populations within 10 miles of the site during the lifetime of any new unit(s) (i.e., to 2060).

The staff evaluated the site against the criterion in Regulatory Position C.4 of RG 4.7 regarding the need to consider alternative sites with lower population densities. This criterion specifies that if the population densities in the vicinity of the proposed site, including the transient population, projected at the time of initial site approval and within about 5 years thereafter, were to exceed 500 persons per square mile averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the area at that distance), then alternative sites should be considered. The staff has determined that population densities for the proposed ESP site would be well below 500 persons per square mile. Therefore, the staff concludes that the site conforms to Regulatory Position C.4 in RG 4.7, Revision 2. Assuming that construction of a new nuclear reactor(s) at the proposed site would begin near the middle of the term of the ESP, and based on its review of the applicant's population density data and projections, the staff finds that the site also meets the guidance of RS-002, Attachment 2, regarding population densities over the lifetime of any facility that might be constructed at the site. Specifically, the population density over that period would be expected to remain below 500 persons per square mile averaged out to a radial distance of 20 miles from the site.

The staff reviewed the applicant's information regarding its ability to take appropriate protective measures on behalf of the permanent and transient residents in the LPZ in the event of a serious accident. The applicant stated that the LPZ was selected to provide reasonable probability that appropriate protective measures could be taken in such an event. The staff finds that the applicant's statement is satisfactory because it is consistent with emergency planning for the 10-mile plume exposure EPZ. The LPZ is located entirely within the 10-mile EPZ. Comprehensive emergency planning for the protection of all persons within the 10-mile EPZ, as addressed in Section 13.3 of this SER, would include those persons within the LPZ. Based on the information the applicant presented on this subject and the staff's review provided in Section 13.3 of this SER, the staff concludes that appropriate protective measures could be taken on behalf of the populace enclosed within the LPZ in the event of a serious accident.

2.1.3.4 Conclusions

As set forth above, the applicant provided an acceptable description of current and projected population densities in and around the site. These densities projected at the time of initial site approval (assuming a new unit(s) is constructed on the site) and within about 5 years thereafter are within the guidelines of Regulatory Position C.4 of RG 4.7. The applicant has properly specified the LPZ and population center distance. The staff finds that the proposed LPZ and population center distance meet the definitions in 10 CFR 100.3. Therefore, the staff concludes that the applicant's population data and population distribution are acceptable and meet the requirements of 10 CFR 52.17 and 10 CFR Part 100. In Section 3.3 of this SER, the staff documents that the radiological consequences of bounding DBAs at the EAB and the outer boundary of the LPZ also meet the requirements of 10 CFR 52.17.

2.2 Nearby Industrial, Transportation, and Military Facilities

2.2.1–2.2.2 Identification of Potential Hazards in Site Vicinity

For an ESP application, the NRC staff reviews the site distance from industrial, military, and transportation facilities and routes. Facilities and routes of potential concern include air, ground, and water traffic; pipelines; and fixed manufacturing, processing, and storage facilities. The staff's review focuses on potential external hazards or hazardous materials that are present or which may reasonably be expected to be present during the projected lifetime of a nuclear power plant(s) that might be constructed on the proposed site. The staff prepared Sections 2.2.1 through 2.2.2 of this SER in accordance with the review procedures described in RS-002, Attachment 2, using information presented in Section 2.2 of the applicant's SSAR, responses to staff RAIs, and the reference materials described in the appropriate sections of RS-002, Attachment 2.

2.2.1.1–2.2.2.1 Technical Information in the Application

Section 2.2 of the SSAR presents information on the industrial, transportation, and military facilities in the vicinity of the proposed ESP site.

Specifically, in Section 2.2.2.1, the applicant states that the proposed site is in DeWitt County, Illinois, which is a rural and agricultural area. According to the applicant, the 461-acre ESP site is zoned for industrial uses. The applicant identifies three small industrial facilities within 5 miles of the proposed ESP site: two agricultural chemical and fertilizer production and storage facilities, and a propane storage facility. Figure 2.2.1-1 shows the locations of the facilities. EGC's wholly owned subsidiary, AmerGen, owns the surrounding areas within the exclusion area boundary. No industrial facilities, pipelines, or other developments are located in the proposed exclusion area other than CPS, operated by AmerGen.

Section 2.2.1 of the SSAR describes the roads within 5 miles of the proposed ESP site. Several Illinois State routes (Routes 54, 48, and 10) pass 1 mile or more from the proposed site, and U.S. Route 51 passes about 6 miles west of the proposed site. The applicant states that the Gilman Line of the Canadian National Railroad parallels State Route 54 and passes about 1 mile to the north of the proposed site.

In SSAR Section 2.2.2.3, the applicant states that five pipelines cross the CPS property; one of these pipelines passes within 1 mile of the ESP site. The Shell/Equilon 14-inch pipeline currently transports gasoline and diesel, but is configured so it could transport higher volatility products like propane. The SSAR states that the pipeline owner has agreed to notification protocols if propane or other high-volatility substances are moved through the pipeline. However, the SSAR states that recent discussions with the pipeline owner indicate that the use of the pipeline is not likely to change. Table 2.2-4 of the SSAR indicates that three other pipelines carrying refined petroleum products pass no closer than 12,000 feet from the ESP site.

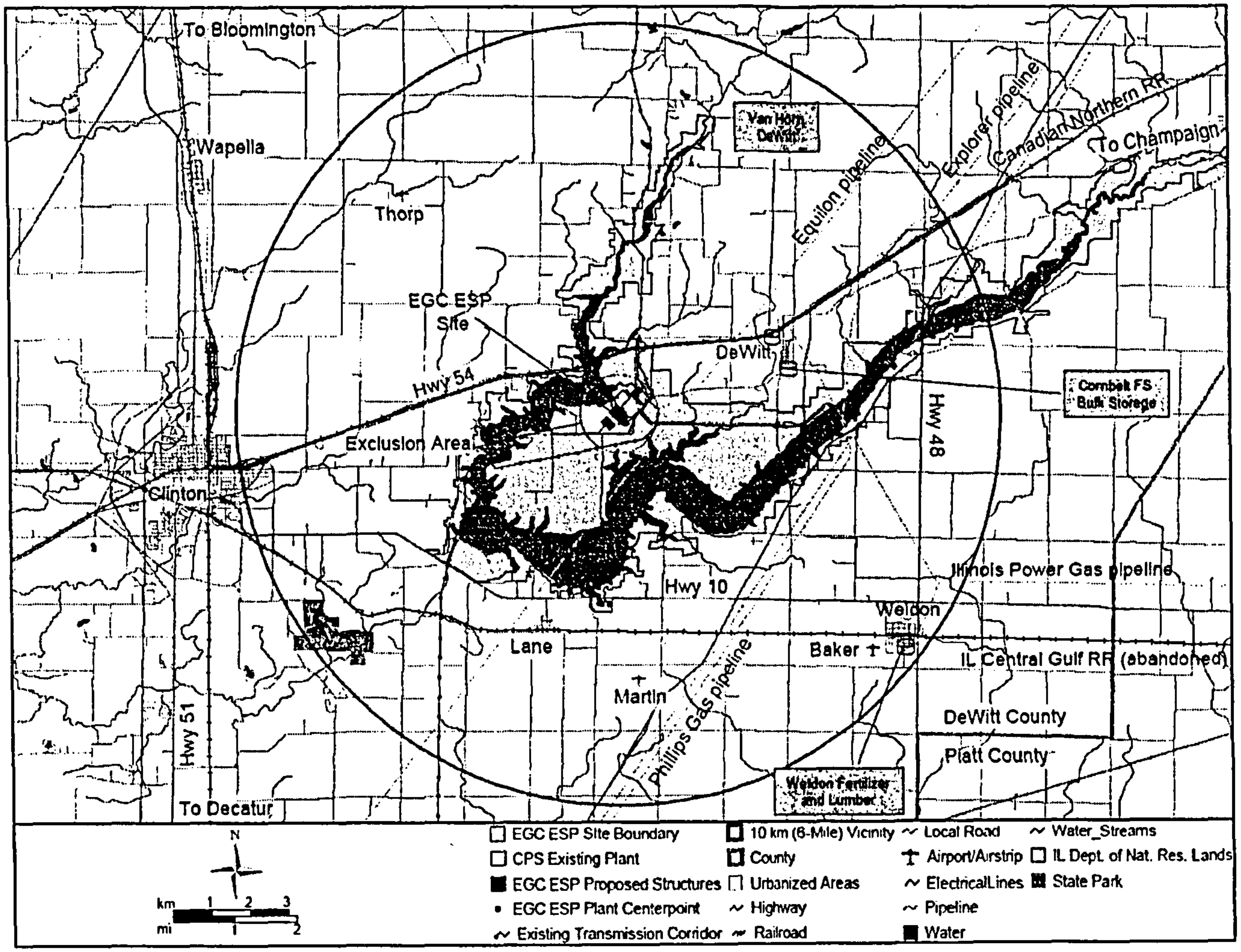


Figure 2.2.1-1 Industrial facilities in the vicinity of the ESP site.

In SSAR Section 2.2.2.5, the applicant describes aircraft activities (nearby airports and airways) in the vicinity of the proposed ESP site. SSAR Figure 2.2-1 identifies four small private airstrips within 6 miles of the ESP site. The SSAR indicates that these small private strips have turf runways of 1500–2000 feet and can only accommodate small single- or twin-engine propeller craft. The airstrip closest to the ESP site (Spencer), owned by AmerGen, is not operational. A heliport at CPS is for the exclusive use of CPS staff. The applicant revised SSAR Section 2.2.2.5.1 in response to RAI 2.2.2-1 to include flight traffic estimates for these airstrips.

The aircraft activities associated with the three operational airstrips in the vicinity of the ESP site involve light aircraft. These airstrips handle an estimated 800 operations per year in aircraft traffic. In SSAR Figure 2.2-3, EGC indicates that four low-altitude Federal airways cross near the ESP site. Airway V313 passes 2 miles east of the ESP site. Airway V233 passes 3 miles northwest. Airway V72 passes 5 miles to the northeast, and Airway V434 passes 6 miles north-northeast of the ESP site.

The SSAR states that Clinton Lake is the only navigable waterway in the vicinity of the ESP site. The only water navigation on the lake is recreational boating. Seven public boat launch ramps and one marina provide boat access to the lake.

2.2.1.2–2.2.2.2 Regulatory Evaluation

In RAI 1.5-1, the staff asked the applicant to provide a comprehensive list of NRC regulations applicable to its ESP SSAR. In its response to RAI 1.5-1, the applicant stated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. The staff considered the following regulatory requirements identified in RS-002, Attachment 2, in reviewing information on potential site hazards that could affect the safe design and siting of a nuclear power plant(s) that might be constructed at the proposed site within the applicant's PPE:

- 10 CFR 52.17(a)(1)(vii) with respect to information on the location and description of any nearby industrial, military, or transportation facilities and routes
- 10 CFR 100.20(b) with respect to information on the nature and proximity of man-related hazards
- 10 CFR 100.21(e) with respect to potential hazards associated with nearby transportation routes and industrial and military facilities

In SSAR Section 2.2, the applicant identifies the following applicable NRC guidance on potential hazards in the vicinity of the proposed ESP site:

- RG 1.91, "Evaluation of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plant Sites," issued February 1978
- RG 1.78, Revision 1, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," issued December 2001
- RG 1.70, Revision 3

- NUREG-0800, Revision 3, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," issued in July 1981 (Standard Review Plan (SRP))

- RS-002, Attachment 2

The staff used the regulatory positions and criteria in RG 1.91 and RG 1.78, Revision 1, which describe acceptable methods for hazard evaluation, to determine the applicant's compliance with the NRC regulations listed above.

Sections 2.2.1–2.2.2, 2.2.3, and 3.5.1.6 of RS-002, Attachment 2, and RG 1.70, Revision 3, provide guidance on the information appropriate for identifying, describing, and evaluating potential man-related hazards. The staff reviewed this portion of the application for conformance with the applicable regulations, and considered the corresponding regulatory guidance.

2.2.1.3–2.2.2.3 Technical Evaluation

The staff evaluated the potential for man-related hazards in the vicinity of the proposed ESP site by reviewing (1) the information in SSAR Sections 2.2.1–2.2.2, (2) the applicant's responses to the staff's RAIs, (3) information obtained during the staff's visit to the proposed ESP site and its vicinity, and (4) other publicly available reference material published by the U.S. Geological Survey (USGS) (see the Clinton, Heyworth, Maroa, Farmer City North, Farmer City South, LeRoy, Weldon East, Weldon West, and DeWitt, Illinois, 7.5-minute quadrangle maps) and other topographic maps (see *Illinois Atlas and Gazetteer*, issued in 2000), aerial imagery (Terraserver-usa.com, 2004), and Geographic Information System (GIS) coverage files (see the Platts POWERmap GIS spatial data, issued 2004, which include map layers depicting natural gas pipelines, railroads, and electric transmission lines).

The staff reviewed the information provided by the applicant on nearby industrial facilities. Because the ESP facility would be located adjacent to the existing CPS facility, the applicant relied on the CPS updated safety analysis report (USAR), which identifies and evaluates the potential hazards from nearby industrial facilities. The applicant provided a list of the volumes of the chemical and potentially hazardous materials stored at the CPS site. Van Horn-DeWitt stores herbicides, insecticides, and fertilizers within 5 miles of the site. Cornbelt FS has a large propane tank at its facility in DeWitt. The staff's review did not identify any relevant facilities not previously noted by the applicant.

The applicant neither identified nor evaluated any hazards that the existing CPS may pose to a new facility that might be constructed and operated on the proposed ESP site. Design-specific interactions between the existing unit and any new units would need to be evaluated and addressed in a COL application that references an ESP for the EGC ESP site. This is **COL Action Item 2.2-1.**

2.2.1.4–2.2.2.4 Conclusions

As discussed above, in accordance with the requirements of 10 CFR 52.17 and the guidance of RG 1.70, Revision 3, the applicant's SSAR provides enough information on potential site hazards, for the staff to evaluate the applicant's compliance with the requirements of 10 CFR

100.20 and 10 CFR 100.21. The staff reviewed the nature and extent of activities involving potentially hazardous materials at industrial, military, and transportation facilities near the ESP site to identify any potential hazards that might pose an undue risk to the proposed facility in this ESP application. Figure 2.2.1-1 shows the locations of the facilities in relation to the ESP site. On the basis of its evaluation of the SSAR, a review of the information in responses to RAIs, and independently obtained information, the staff concludes that the applicant has identified all potentially hazardous activities on and near the site. SSAR and SER Sections 2.2.3 and 3.5.1.6 discuss the evaluation of the hazards.

2.2.3 Evaluation of Potential Accidents

In SSAR Section 2.2.3, the applicant identifies potential accident situations on and near the ESP site. The staff reviewed this information to determine its completeness and accuracy as a basis for the potential accidents that need to be considered in the design of a facility that might be constructed on the proposed ESP site within the applicant's PPE (see SER Section 2.2.1–2.2.2).

The applicant elected to use a PPE approach as a surrogate for plant design in analyzing potential accidents. The applicant has not determined the precise design of the facility control room. Some potential accidents on or near of the ESP site might affect control room habitability (e.g.,toxic gases, asphyxiants). The design of the actual facility that might be constructed on the proposed site must address design basis accidents (as determined by the review conducted using Section 2.2.3 of RS-002, Attachment 2). The staff will review these potential accidents at the COL or CP stage, using the guidance in SRP Section 6.4.

The staff reviewed the applicant's probability analyses of potential accidents involving hazardous materials or activities on and near a new nuclear power plant(s) constructed on the ESP site and determined that these analyses used the appropriate data and analytical models. The staff also reviewed the applicant's analyses of the consequences of accidents involving nearby industrial, military, and transportation facilities to determine if any should be identified as design-basis events.

2.2.3.1 Technical Information in the Application

Section 2.2.3 of the SSAR presents information on potential accidents including flammable vapor clouds, aircraft crashes, and toxic chemicals. The SSAR states that potential accidents involving transportation routes or flammable, explosive, chemical, or toxic storage at the CPS site were dismissed as design concerns in the CPS USAR. The SSAR further states that certain toxic chemical hazards cannot be evaluated until the COL stage because the precise design of the ESP control room habitability systems will not be known until then.

Section 2.2.2.5.3 of the SSAR describes the applicant's analysis of the potential for accidents originating from airports or airways. SER Section 2.2.1–2.2.2 discusses the locations of airports and airways, as identified by the applicant. The applicant relied on the CPS USAR and the SRP for guidance on determining the accident probabilities of airways 5 miles from the ESP site. The applicant determined that the probability of accidents from plane crashes in the civil and military airways in the vicinity was less than the SRP guideline of about 10^{-7} per year.

The SSAR also states that none of the airports within 10 miles of the ESP site support operations in excess of the threshold criteria in RG 1.70, Revision 3. Section 2.2.3.1.3 of the SSAR describes the applicant's analysis of potential accidents involving toxic chemicals. The Van Horn-DeWitt facility stores and distributes agricultural products such as pesticides, herbicides, and fertilizers. This facility is next to State Route 54, about 2.6 miles from the ESP site. The applicant used the guidance in RG 1.78 to demonstrate that a potential spill of anhydrous ammonia is not a concern because of the small number of shipments made to the Van Horn-DeWitt facility.

The applicant also found that the CPS USAR used the guidance in RG 1.78 to determine that the likelihood of potential accidents on the Gilman Line of the Canadian National Railroad, which runs parallel to State Route 54, is acceptably low. However, CPS has committed to survey the rail line every 3 years to keep abreast of changes in hazardous material shipments. The applicant states in SSAR Section 2.2.3.1.2, that a new analysis will be required at the COL stage for the hazards associated with the Gilman Line. Specifically, the applicant will have to evaluate the location of the control room of the EGC ESP facility, the control room ventilation system design, and the analytic methodology for dispersion and transport of airborne hazardous materials.

SSAR Section 2.2.3.1.2 also states that the probability of a flammable vapor cloud and an explosion and subsequent overpressure, which could exceed the RG 1.91 acceptance criteria, is less than 10^{-6} per year.

2.2.3.2 Regulatory Evaluation

In RAI 1.5-1 the staff asked the applicant to provide a comprehensive list of NRC regulations applicable to its ESP SSAR. In its response to RAI 1.5-1, the applicant stated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. The staff considered the following regulatory requirements identified in RS-002, Attachment 2, in reviewing information on potential accidents that could affect the safe design and siting of a nuclear power plant(s) that might be constructed at the proposed site within the applicant's PPE:

- 10 CFR 52.17(a)(1)(vii) with respect to the location and description of any nearby industrial, military, or transportation facilities and routes
- 10 CFR 100.20(b) with respect to the nature and proximity of man-related hazards
- 10 CFR 100.21(e) with respect to the evaluation of potential hazards associated with nearby transportation routes and industrial and military facilities

In SSAR Section 2.2, the applicant identifies the following applicable NRC guidance regarding the evaluation of potential accidents in the vicinity of the proposed ESP site:

- RG 1.91
- RG 1.78, Revision 1
- RG 1.70, Revision 3
- NUREG-0800 (SRP)
- RS-002, Attachment 2

The staff used the regulatory positions and criteria in Revision 3 of RG 1.70 to determine the applicant's compliance with the regulations listed above. Sections 2.2.1–2.2.2, 2.2.3, and 3.5.1.6 of RS-002, Attachment 2, and RG 1.70, Revision 3, provide guidance on the information appropriate for identifying, describing, and evaluating potential accidents. The staff reviewed this portion of the application for conformance with the applicable regulations, and considered the corresponding regulatory guidance.

2.2.3.3 Technical Evaluation

The staff evaluated potential accidents in the vicinity of the proposed ESP site by reviewing (1) the information provided by the applicant in SSAR Section 2.2.3, (2) the applicant's responses to RAIs, (3) information obtained during a visit to the proposed ESP site and its vicinity, and (4) other publicly available reference material published by the USGS (see the Clinton, Heyworth, Maroa, Farmer City North, Farmer City South, LeRoy, Weldon East, Weldon West, and DeWitt, Illinois, 7.5-minute quadrangle maps) and other topographic maps (see the Illinois Atlas and Gazetteer), aerial imagery (see Terraserver-usa.com, 2004), and GIS coverage files (see the Platts POWERmap GIS spatial data).

Section 2.2.1–2.2.2 of this SER describes potential hazards affecting the ESP site. These hazards include the presence of commercial airways and airport facilities in or near the ESP site, the onsite storage of chemicals and other materials at the CPS site, three additional industrial plant sites in the vicinity, and the Gilman Line of the Canadian National Railroad. The staff notes that the CPS USAR did not find that the potential hazards from flammable, chemical, explosive, and toxic material storage at CPS constitute design concerns. Therefore, the staff believes it is unlikely that these hazards would be significant for the ESP site. However, the staff will review the impact of these hazards at the COL stage to verify that no design-specific vulnerabilities exist.

Section 3.5.1.6 of this SER provides the staff's evaluation of aircraft hazards.

The staff reviewed the applicant's analysis of the effects of potential explosions and the formation of flammable vapor clouds. The staff finds that, because of the distance of the potential ESP facility from the worst-case train tank explosion accident (according to RG 1.91), *no significant* damage would be expected to the typical nuclear power plant safety related structures, systems, and components that might be located on the ESP site. The staff relied on the CPS USAR analysis of a single year of rail shipment data during the 1981–1982 period. Reporting of significant changes in the shipment data for the Gilman Rail Line will be required at the COL stage to account for current shipment characteristics and the actual design of the control room systems of the new nuclear unit(s).

To ensure that the hazards of the Gilman Rail Line remain acceptably low, the applicant has noted that the rail shipment data for hazardous materials may need to be periodically updated.

The staff reviewed the applicant's analysis of potential toxic chemical accidents. These accidents include train and truck tanker spills of anhydrous ammonia, chemical materials that are stored and used on site at CPS and that could be used and stored at future facilities that might be constructed on the ESP site, and anhydrous ammonia storage tank failure at the Van Horn-DeWitt facility. Since the PPE does not specify a control room design, no specific determination can be made with respect to control room habitability in the event of a toxic chemical accident at the site or in the vicinity. Although the applicant cited the USAR's inventory of toxic chemicals, the actual determination of their impact on a specific plant design cannot be determined at the ESP stage without a precise set of plant design parameters. Therefore, the staff cannot evaluate the potential effects of accidents on control room habitability at this time. The staff will evaluate such effects at the COL stage.

2.2.3.4 Conclusions

As discussed above, the applicant has identified potential accidents related to the presence of hazardous materials or activities on or near the ESP site that could affect a nuclear power plant(s) represented by the chosen PPE. The applicant also identified accidents that should be considered as design-basis events at the COL or CP stage according to 10 CFR Part 100. Therefore, the staff concludes that the site location is acceptable with regard to potential accidents that could affect a nuclear power plant(s) based on the applicant's PPE that might be constructed on the site, and that the site location meets the requirements of 10 CFR 52.17(a)(1)(vii), 10 CFR 100.20(b), and 10 CFR 100.21(e).

2.3 Meteorology

To ensure that a nuclear power plant(s) can be designed, constructed, and operated on an applicant's proposed ESP site in compliance with the NRC regulations, the NRC staff evaluates regional and local climatological information, including climate extremes and severe weather occurrences, that may affect the design and siting of a nuclear plant. The staff reviews information concerning the atmospheric dispersion characteristics of a nuclear power plant site to determine whether the radioactive effluents from postulated accidental releases, as well as routine operational releases, are within Commission guidelines. The staff prepared Sections 2.3.1 through 2.3.5 of this SER in accordance with the review procedures described in RS-002, Attachment 2, using information presented in Section 2.3 of the SSAR, responses to staff RAIs, and generally available reference materials, as described in the applicable sections of RS-002, Attachment 2.

2.3.1 Regional Climatology

2.3.1.1 Technical Information in the Application

In this section of the SSAR, Exelon Generation Company, LLL (EGC or the applicant) presented information concerning the averages and the extremes of climatic conditions and regional meteorological phenomena that could affect the design and siting of a nuclear power plant(s) that falls within the applicant's PPE and that might be constructed on the proposed site. The applicant provided the following information:

- a description of the general climate of the region with respect to types of air masses, synoptic features (high- and low-pressure systems and frontal systems), general airflow patterns (wind direction and speed), temperature and humidity, precipitation (rain, snow, and sleet), and relationships between synoptic-scale atmospheric processes and local (site) meteorological conditions

- seasonal and annual frequencies of severe weather phenomena, including tornadoes, waterspouts, thunderstorms, lightning, hail (including probable maximum size), and high air pollution potential

- meteorological site characteristics to be used as minimum design and operating bases, including the following:

  - the maximum snow and ice load (water equivalent) on the roofs of safety-related structures

  - the ultimate heat sink (UHS) meteorological conditions resulting in the maximum evaporation and drift loss of water and minimum water cooling

  - the tornado parameters, including translational speed, rotational speed, and the maximum pressure differential with the associated time interval

  - the 100-year return period straight-line winds

  - other meteorological conditions used for design- and operating-basis considerations

The applicant characterized the regional climatology pertinent to the EGC ESP site using data reported by the U.S. National Weather Service (NWS) at the Peoria, Illinois, and Springfield, Illinois, first-order weather stations, as well as nearby cooperative observer stations, such as Decatur, Illinois. The applicant considered the Peoria and Springfield weather stations to be representative of the climate at the EGC ESP site, because of their relatively close proximity to the site and similarities in terrain and vegetation features. The applicant obtained information on severe weather from a variety of sources, such as publications by the National Climatic Data Center (NCDC), the American Society of Civil Engineers (ASCE), the Illinois State Climatologist Office (ISCO), and the Illinois State Water Survey (ISWS).

The EGC ESP site is located in the central climatic division of Illinois. The applicant described the climate as continental, with cold winters, warm summers, and frequent, short-period fluctuations in temperature, humidity, cloudiness, and wind direction. The great variability in the central Illinois climate is because of its location in a confluence zone, particularly during the cooler months, between different air masses. The air masses that affect central Illinois typically include maritime tropical air, which originates in the Gulf of Mexico; continental tropical air, which originates in Mexico and the southern Rockies; Pacific air, which originates in Mexico and the eastern North Pacific Ocean; and continental polar and continental arctic air, which originates in Canada.

The applicant noted that, for the most part, the general synoptic conditions dominate the climactic characteristics of the site region. However, during periods of extreme temperatures or light wind conditions, the local conditions influence the site's meteorology. Nearby Clinton Lake can have a moderating effect with respect to extreme temperatures in the immediate vicinity of the site.

The applicant reported that Peoria and Springfield average approximately 2.2 hail days per year, with about 55 percent of all hail days occurring in the spring. There is considerable year-to-year variation in the number of days with hail, with some years reporting as many as 8 hail days. During the 13-year period from 1955 to 1967, the 1-degree latitude by longitude square containing the EGC ESP site (approximately 9400 square kilometers) had 15 hailstorms producing hail 0.75 inch in diameter or greater.

According to the applicant, about 48 thunderstorm days can be expected yearly, most frequently during June and July. The applicant conservatively estimated that there are approximately 9.4 lightning flashes to earth per year per square kilometer around the site area. Considering the frequency of thunderstorms and the size of the EGC ESP site (14,000 acres or 56.7 square kilometers (the EGC ESP site boundary is the same as the Clinton Power Station (CPS) property lines), the applicant estimated the expected frequency of lightning flashes at the site at 533 per year. The expected frequency of lightning flashes within the 3.3 square kilometer exclusion area is 31 flashes per year.

The applicant originally reported 11 tornadoes for DeWitt County during the period 1950–2002. Since there were numerous tornadoes reported in Illinois during 2003, the staff requested, in RAI 2.3.1-1, that the applicant update the tornado data presented in its SSAR to include tornado occurrences recorded during 2003. In its response to RAI 2.3.1-1, the applicant revised its tornado statistics for DeWitt County, stating that 18 tornadoes were reported during the period 1950–2003. Using various sets of tornado data statistics for the EGC ESP site region, the applicant calculated an annual tornado probability for a tornado of any intensity in the EGC ESP site region as ranging from 1.5×10^{-3} to 3.1×10^{-3}, which corresponds to a tornado return period ranging from 325 to 670 years. For violent tornadoes (F4 or greater; wind speeds in excess of 207 miles per hour (mi/h)), the applicant calculated an annual tornado probability ranging from 3.8×10^{-5} to 7.9×10^{-5}, which corresponds to a return period ranging from 12,800 to 26,300 years.

The applicant chose a tornado site characteristic wind speed of 300 mi/h based on the maximum tornado wind speed recommended in SECY-93-087, "Policy, Technical, Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," for use in the design of evolutionary and passive advanced light-water reactors (ALWRs). Since it does not believe that citing SECY-93-087 (or any other document related to design certification) is an adequate justification for selecting a site characteristic tornado wind speed, the staff requested, in RAI 2.3.1-9, that the applicant provide a safety justification for choosing 300 mi/h as the site characteristic tornado wind speed. In its response to RAI 2.3.1-9, the applicant cited a tornado study covering much of the United States east of the Rocky Mountains which showed that the maximum tornado wind speed expected in central Illinois (where the EGC ESP site is located), at a probability level of 10^{-7} per year, is between 250 and 300 mi/h. The applicant chose the other tornado site characteristics (e.g., maximum pressure drop, rate of pressure drop) based on the characteristics associated with a tornado wind speed of 300 mi/h, as identified in the staff's interim position on the design-basis tornado (NRC, "ALWR Design-Basis Tornado").
Table 2.3.1-1 lists the applicant's proposed tornado site characteristics.

Table 2.3.1-1 Applicant's Proposed Tornado Site Characteristics

SITE CHARACTERISTIC	VALUE	DESCRIPTION
Maximum Wind Speed	300 mi/h	The design assumption for the sum of maximum rotational and maximum translational wind speed components
Maximum Translational Speed	60 mi/h	The design assumption for the component of tornado wind speed resulting from the movement of the tornado over the ground
Maximum Rotational Speed	240 mi/h	The design assumption for the component of tornado wind speed caused by the rotation within the tornado
Radius of Maximum Rotational Speed	150 feet	The design assumption for distance from the center of the tornado at which the maximum rotational wind speed occurs
Maximum Pressure Drop	2.0 pounds-force per square inch ($lbf/in.^2$)	The design assumption for the decrease in ambient pressure from normal atmospheric pressure resulting from the passage of the tornado
Rate of Pressure Drop	1.2 $lbf/in.^2/s$	The assumed design rate at which the pressure drops resulting from the passage of the tornado

The applicant stated that the highest "fastest mile" wind speeds observed at the Peoria and Springfield weather stations were 75 mi/h. In RAI 2.3.1-3, the staff requested that the applicant clarify the fastest mile and peak wind speed data that it presented in the SSAR. As part of its response to RAI 2.3.1-3, the applicant reported that the Peoria and Springfield data represent the 67-year period between 1930 and 1996. The applicant selected this wind speed value as the basic wind speed site characteristic. In RAI 2.3.1-2, the staff asked the applicant to also provide a 3-second gust wind speed that represents a 100-year return. In its response to RAI 2.3.1-2, the applicant provided a 3-second gust wind speed value of 96 mi/h, but did not propose this value as a site characteristic. Instead, the applicant stated that the 3-second gust wind speed site characteristic will be determined at the COL or CP stage, based on the applicable design standard at the time. In its subsequent letter dated April 26, 2005, the applicant chose to identify the 3-second gust wind speed value of 96 mi/h as a site characteristic at the ESP stage rather than at the COL stage.

Table 2.3.1-2 presents the applicant's proposed basic wind speed site characteristics.

Table 2.3.1-2 Applicant's Proposed Basic Wind Speed Site Characteristics

SITE CHARACTERISTIC	VALUE	DESCRIPTION
Basic Wind Speed	75 mi/h	The design wind, or fastest mile of wind with a 100-year return period, for which the facility is designed
3-Second Gust	96 mi/h	The 3-second gust wind velocity associated with a 100-year return period at 33 feet (10 meters) above the ground level in the site area

In the SSAR, the applicant reported that severe winter storms, which usually produce snowfall in excess of 6 inches and are often accompanied by damaging glaze ice, produce more damage than any other form of short-term severe weather, including hail, tornadoes, and lightning. Central Illinois had 107 occurrences of a 6-inch snow or glaze damage area during the years from 1900 through 1960, and about 42 of those storms deposited more than 6 inches of snowfall in DeWitt County. During this same 61-year period, there were 92 severe glaze storms in Illinois, defined as damaging, widespread, or both. The EGC ESP site region averaged slightly more than 5 days of glaze per year during the period 1901–1962, and 11 localized areas within the central third of Illinois can expect to receive damaging glaze during a typical 10-year period. An average of one storm every 3 years will produce glaze ice 0.75 inch or thicker on wires.

According to the applicant, the estimated 2-day and 7-day maximum snowfalls for the EGC ESP site region associated with a 50-year recurrence interval are 15.2 inches and 22.0 inches, respectively. The staff requested clarification on the regional snowfall and snowpack data, as well as the winter probable maximum precipitation value (also known as the "probable maximum winter precipitation" or PMWP) in RAIs 2.3.1-4, 2.3.1-5, 2.3.1-6, and 2.3.1-10. In its response to RAI 2.3.1-4, the applicant stated that the maximum monthly and 24-hour snowfalls recorded in the Springfield area are 24.4 inches and 15.0 inches, respectively. In its response to RAI 2.3.1-10, the applicant noted that the maximum recorded monthly snowfall in the EGC ESP site region is 30.5 inches, which was recorded in Decatur.

The applicant initially provided a 100-year return period ground-level snowpack estimate of 22 pounds-force per square foot (lbf/ft^2), which it later revised to 24.4 lbf/ft^2 in response to RAI 2.3.1-5. The applicant also provided a 48-hour PMWP value of 15.2 inches of water, which it subsequently revised to 16.6 inches of water in response to RAI 2.3.1-6. The 48-hour PMWP value of 16.6 inches corresponds to approximately 86 lbf/ft^2. The combined 100-year return snowpack and the estimated PMWP is 110.4 lbf/ft^2, which the applicant contends is an extremely conservative and highly unlikely snow/ice roof loading for a structure in Illinois. In its response to RAI 2.3.1-6, the applicant proposed defining the site characteristic ground snow load as 40 lbf/ft^2, which represents a combination of the 100-year return snowpack (24.4 lbf/ft^2) and the maximum recorded monthly snowfall in the region (30.5 inches of snow, which is approximately equivalent to 3 inches of water or 15.6 lbf/ft^2).

Table 2.3.1-3 cites the applicant's proposed winter precipitation site characteristics.

Table 2.3.1-3 Applicant's Proposed Winter Precipitation Site Characteristics

SITE CHARACTERISTIC	VALUE	DESCRIPTION
Snow Load	40 lbf/ft^2	The maximum load on structure roofs resulting from the accumulation of snow that can be accommodated by a plant design

In the SSAR, the applicant indicated that the controlling meteorological parameters for the type of UHS that it selected (i.e., mechanical draft cooling towers with makeup water from Clinton Lake) is the wet-bulb temperature. In RAI 2.3.1-7, the NRC staff requested that the applicant clarify the meteorological data that it would use to evaluate the performance of the UHS mechanical draft cooling towers with respect to maximum evaporation, drift loss, and minimum water cooling, as discussed in RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants." In its response to RAI 2.3.1-7, the applicant reiterated that it calculated a maximum evaporation rate of 700 gallons per minute (Item 3.3.7 in SSAR Table 1.4-1) based on the maximum system heat load and the amount of water that would need to be evaporated to dissipate that heat load. The applicant considers this a highly conservative value because the actual amount of evaporative cooling that would be necessary would be less for any time period, including the worst 30-day period discussed in RG 1.27. The applicant stated that the final design of the cooling towers would account for the bounding ambient air temperature and humidity site characteristic conditions presented in SSAR Table 1.4-1, which include a design wet-bulb temperature of 77.2 °F that is exceeded less than 1 percent of the time and a maximum wet-bulb temperature of 86 °F. The applicant indicated that it did not expect drift loss to be a critical design parameter since the drift in a modern cooling tower is typically very low (on the order of 0.1 percent or less).

In Open Item 2.3-1, the staff reiterated that the applicant did not adequately identify the meteorological data to use in evaluating the performance of a mechanical draft cooling tower UHS with respect to maximum evaporation and minimum water cooling, as discussed in RG 1.27. In its submission to the NRC dated April 4, 2005, the applicant responded to Open Item 2.3-1 by examining temperature and humidity data from both the Peoria and Springfield weather stations for the years 1961–1990 to determine the meteorological site characteristics for the UHS, in accordance with RG 1.27. The applicant stated that the controlling parameters for the type of UHS it selected are the wet-bulb temperature and the coincident dry-bulb temperature. The applicant considered the worst (i.e., highest) 30-day running average of wet-bulb temperatures and coincident dry-bulb temperatures to represent the meteorological conditions resulting in maximum evaporation and drift loss. Likewise, the applicant considered the worst (i.e., highest) 1-day and 5-day running average of wet-bulb temperatures and coincident dry-bulb temperatures to represent the meteorological conditions resulting in minimum water cooling. Consequently, the applicant calculated the worst 1-day, worst 5-day, and worst 30-day running average wet-bulb temperatures and coincident dry-bulb temperatures as UHS meteorological site characteristic values.

In Open Item 2.3-2, the staff identified the need for an additional UHS meteorological site characteristic for use in evaluating the potential for water freezing in the UHS water storage facility, a phenomenon which would reduce the amount of water available for use by the UHS. In its submission to the NRC dated April 26, 2005, the applicant responded to Open Item 2.3-2 by proposing to use the maximum cumulative degree-days below freezing during the winter as the relevant site characteristic. This site characteristic is discussed in detail in Section 2.4.7 of this SER.

Table 2.3.1-4 presents the applicant's proposed UHS meteorological site characteristics.

Table 2.3.1-4 Applicant's Proposed Ultimate Heat Sink Meteorological Site Characteristics

SITE CHARACTERISTIC	VALUE	DESCRIPTION
Maximum 30-Day Average Wet-Bulb Temperature	74.7 °F	The historical maximum 30-day running average wet-bulb temperature observed in the site region
Coincident 30-Day Average Dry-Bulb Temperature	82 °F	The 30-day average dry-bulb temperature that coincides with the historical maximum 30-day average wet-bulb temperature
Maximum 1-Day Average Wet-Bulb Temperature	81 °F	The historical maximum 1-day average wet-bulb temperature observed in the site region
Coincident 1-Day Average Dry-Bulb Temperature	87.6 °F	The 1-day average dry-bulb temperature that coincides with the historical maximum 1-day average wet-bulb temperature
Maximum 5-Day Average Wet-Bulb Temperature	79.7 °F	The historical maximum 5-day average wet-bulb temperature observed in the site region
Coincident 5-Day Average Dry-Bulb Temperature	86.2 °F	The 5-day average dry-bulb temperature that coincides with the historical maximum 5-day average wet-bulb temperature

The applicant stated that central Illinois is in a relatively favorable dispersion regime that has a relatively low frequency of extended periods of high air pollution potential. Inversions based below 500 feet occur in the general area of the EGC ESP site during approximately 33 percent of the total hours throughout the year and occur most frequently in the fall (39 percent of the total time) and least frequently in the winter and spring (29 percent of the total time for each season). Seasonal morning average mixing layer heights in the EGC ESP site region range from a low of 330 meters during the summer to a high of 490 meters in the spring, and seasonal afternoon average mixing layer heights range from a low of 690 meters in the winter to a high of 1600 meters in the summer.

In RAI 2.3.1-8, the staff requested that the applicant provide ambient air temperature and humidity site characteristics. In its response to RAI 2.3.1-8, the applicant provided dry-bulb and wet-bulb temperature site characteristics based on temperature and humidity data recorded at the Peoria and Springfield weather stations. Table 2.3.1-5 presents the applicant's proposed ambient air temperature and humidity site characteristics.

Table 2.3.1-5 Applicant's Proposed Ambient Air Temperature and Humidity Site Characteristics

SITE CHARACTERISTIC		VALUE	DESCRIPTION
Maximum Dry-Bulb Temperature	2% annual exceedance	88 °F with 74 °F concurrent wet-bulb	Wet-bulb and dry-bulb temperatures associated with the listed exceedance values and the 100-year return period
	1% annual exceedance	91 °F	
	0.4% annual exceedance	94 °F with 77 °F concurrent wet-bulb	
	0% annual exceedance	117 °F	
	100-year return period	117 °F with 86 °F concurrent wet-bulb	
Minimum Dry-Bulb Temperature	1% annual exceedance	0 °F	
	0.4% annual exceedance	-6 °F	
	0% annual exceedance	-36 °F	
	100-year return period	-36 °F	
Maximum Wet-Bulb Temperature	1% annual exceedance	78 °F	
	0.4% annual exceedance	80 °F	
	0% annual exceedance	86 °F	
	100-year return period	86 °F	

2.3.1.2 Regulatory Evaluation

In response to RAI 1.5-1, the applicant stated that RS-002, Attachment 2, identifies the regulations applicable to the ESP SSAR. RS-002, Attachment 2, identifies the following applicable NRC regulations regarding regional climatology:

- Appendix A, "General Design Criteria for Nuclear Power Plants," to Part 50, "Domestic Licensing of Production and Utilization Facilities," of Title 10 of the *Code of Federal Regulations* (10 CFR), General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," with respect to information on severe regional weather phenomena that have historically been reported for the region and that are reflected in the design bases for SSCs important to safety

- Appendix A to 10 CFR Part 50, GDC 4, "Environmental and Dynamic Effects Design Bases," with respect to information on tornadoes that could generate missiles

- 10 CFR 100.20(c) and 10 CFR 100.21(d), with respect to the consideration of the regional meteorological characteristics of the site

In SSAR Sections 1.1.1, 1.5, and 2.3.1, the applicant identified the following applicable NRC guidance regarding regional climatology:

- RG 1.27, Revision 2, with respect to the meteorological conditions that should be considered in the design of the UHS

- Section 2.3.1 of RG 1.70 with respect to the type of general climate and regional meteorological data that should be presented

- RG 1.76, "Design-Basis Tornado for Nuclear Power Plants," issued April 1974, with respect to the characteristics of the design-basis tornado

The staff reviewed this portion of the application for conformance with the applicable regulations, and considered the corresponding regulatory guidance, with the exception that an ESP applicant need not demonstrate compliance with the GDC.

Section 2.3.1 of RS-002, Attachment 2, and RG 1.70 provide the following guidance on information appropriate for determining regional climatology:

- The description of the general climate of the region should be based on standard climatic summaries that the National Oceanic and Atmospheric Administration compiles. Consideration of the relationships between regional synoptic-scale atmospheric processes and local (site) meteorological conditions should be based on appropriate meteorological data.

- Data on severe weather phenomena should be based on standard meteorological records from nearby representative NWS, military, or other stations recognized as standard installations that have long periods of data on record. The applicability of these data to represent site conditions during the expected period of reactor operation should be substantiated.

- Tornado site characteristics may be based on RG 1.76 or the staff's interim position on design-basis tornado characteristics (NRC, "ALWR Design-Basis Tornado"). An ESP applicant may specify any tornado wind speed site characteristics that are appropriately justified, provided that it conducts a technical evaluation of site-specific data.

- Basic (straight-line) wind speed site characteristics should be based on appropriate standards, with suitable corrections for local conditions.

- The UHS meteorological data, as stated in RG 1.27, should be based on long-period regional records that represent site conditions. Suitable information may be found in climatological summaries for the evaluation of wind, temperature, humidity, and other meteorological data used for UHS design.

- Freezing rain estimates should be based on representative NWS station data.

- High air pollution potential information should be based on U.S. Environmental Protection Agency (EPA) studies.

- All other meteorological and air quality data to be used for safety-related plant design and operating bases should be documented and substantiated.

2.3.1.3 Technical Evaluation

The staff evaluated regional meteorological conditions using information that the NCDC, National Severe Storms Laboratory (NSSL), ISCO, and ASCE reported. The staff reviewed statistics for the following climatic stations located in the vicinity of the EGC ESP site:

- Clinton, Illinois, located approximately 7 miles west-southwest of the ESP site
- Decatur, Illinois, located approximately 24 miles south-southwest of the ESP site
- Lincoln, Illinois, located approximately 26 miles west of the ESP site
- Springfield, Illinois, located approximately 50 miles west-southwest of the ESP site
- Peoria, Illinois, located approximately 56 miles west-northwest of the ESP site

The staff concurs with the applicant's description of the general climate of the region, which is consistent with a narrative of the climate of Illinois published by ISCO (ISCO, "Climate of Illinois"). The staff also finds the applicant's estimates of thunderstorm-day frequency consistent with regional data and its estimates of expected frequency of lightning flashes to be consistent with accepted methodology.

Hail often accompanies severe thunderstorms and can be a major weather hazard, causing damage to crops and property. According to NSSL, the threat of hail occurring within 25 miles of the EGC ESP site is approximately 2–3 days per year for damaging hail, or hail 0.75 inch in diameter or greater, and 0.50 to 0.75 days per year for hail 2 inches or more in diameter (NSSL, "Severe Thunderstorm Climatology").

The above discussion on lightning and hail provides a general climatic understanding of the severe weather phenomena in the site region but does not result in the generation of site characteristics for use as design or operating bases.

According to NSSL, the mean number of days per year with the threat of tornados occurring within 25 miles of the EGC ESP site is approximately 1.0 to 1.2 days per year for any tornado, approximately 0.20 to 0.25 days per year for a significant tornado (F2 or greater; wind speeds in excess of 113 mi/h), and approximately 0.015 to 0.020 days per year for a violent tornado (F4 or greater; wind speeds in excess of 207 mi/h) (NSSL, "Severe Thunderstorm Climatology").

At the staff's direction, Pacific Northwest National Laboratories (PNNL) prepared a technical evaluation report evaluating the tornado site characteristics for the EGC ESP site (Ramsdell, "Technical Evaluation Report on Design Basis Tornadoes for the EGC ESP Site"). This report derived a best estimate annual tornado strike probability of 1.2×10^{-3}, based on tornado data from the period January 1950 through August 2003. This corresponds to a mean recurrence interval of 833 years, which is slightly less conservative than the applicant's calculated tornado return period (i.e., 325 to 670 years). The PNNL report also derived a best estimate 10^{-7} per year occurrence tornado site characteristic wind speed of 300 mi/h, which is equal to the applicant's tornado site characteristic wind speed. The applicant chose the other design-basis tornado characteristics (such as translation speed, rotational speed, etc.) associated with a tornado wind speed of 300 mi/h as identified in the staff's interim position (NRC, "ALWR Design Basis Tornado"). Therefore, the staff concludes that the applicant's design-basis tornado site characteristics are acceptable.

The applicant's proposed basic wind speed site characteristic of 75 mi/h is compatible with the fastest mile wind speeds having a 1 percent annual probability of being exceeded (100-year mean recurrence interval) of 75 mi/h and 74 mi/h for Peoria and Springfield, respectively, as reported in Table A7 of American National Standards Institute (ANSI) A58.1-1982, "Minimum Design Loads for Buildings and Other Structures." Therefore, the staff concludes that a fastest mile basic wind speed site characteristic of 75 mi/h is acceptable.

The applicant also defined a 3-second gust wind speed site characteristic of 96 mi/h, based on a 100-year return period at 10 meters above the ground. The applicant determined this value in accordance with the guidance provided by Structural Engineering Institute (SEI)/ASCE 7-02, "Minimum Design Loads for Buildings and Other Structures." Therefore, the staff concludes that a 3-second gust basic wind speed site characteristic of 96 mi/h is acceptable.

The NCDC reports a 50-year period return period uniform radial ice thickness of 1 inch because of freezing rain, with a concurrent 3-second gust wind speed of 40 mi/h for the EGC ESP site area (Jones et al., "The Development of a U.S. Climatology of Extreme Ice Loads").

Snowfall in the site vicinity averages approximately 21.9 inches per year, based on historical data collected during the period 1971–2000 at the Decatur cooperative weather station. The highest monthly and seasonal total snowfalls recorded at Decatur during the period of record 1893–2001 were 30.5 inches and 49.7 inches, respectively (ISCO, "Historical Climate Summary—112193 Decatur, IL"). One of the highest reported 24-hour snowfall observations in the site region was 17.0 inches in December 1972 at Springfield (ISCO, "Historical Climate Summary—118179 Springfield WSO AP, IL").

RG 1.70 specifies both the weight of the 100-year return period snowpack and the weight of the 48-hour PMWP as a means of assessing the potential snow loads on the roofs of safety-related structures. The staff's branch position on winter precipitation loads (see memorandum dated March 24, 1975, from Harold R. Denton to R. R. Maccary) provides clarification as to the load combinations to be used in evaluating the roofs of safety-related structures. Consistent with the staff's branch position on winter precipitation loads, the winter precipitation loads included in the combination of normal live loads considered in the design of a nuclear power plant that might be constructed on a proposed ESP should be based on the weight of the 100-year snowpack or snowfall, whichever is greater, recorded at ground level. Likewise, the winter precipitation loads included in the combination of extreme live loads considered in the design of a nuclear power plant that might be constructed on a proposed ESP should be based on the weight of the 100-year snowpack at ground level plus the weight of the 48-hour PMWP at ground level for the month corresponding to the selected snowpack. A COL or CP applicant may choose to justify an alternative method for defining the extreme winter precipitation load by demonstrating that the 48-hour PMWP could neither fall nor remain on the top of the snowpack and/or building roofs.

The applicant identified a 100-year return period snowpack of 24.4 lbf/ft^2 for the EGC ESP site, determining this value in accordance with the guidance of ASCE 7-98, "Minimum Design Loads for Buildings and Other Structures." Because the applicant performed its analysis in accordance with the appropriate guidance and the results bound the observations described above, the staff concludes that a 100-year return period snowpack site characteristic value of 24.4 lbf/ft^2 is acceptable.

The applicant identified a 48-hour PMWP value of 16.6 inches of water for the EGC ESP site. The applicant determined this value for a 296 square-mile drainage area (representing the drainage area surrounding the ESP site) using information available from HMR 51, "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," and HMR 53, "Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates, United States East of the 105th Meridian." The staff performed an independent 48-hour PMWP evaluation for a smaller (more conservative) 10 square-mile drainage basin using information available from HMR 53. The staff derived a 48-hour PMWP value of 18.2 inches of water for those months with the historically highest snow depths (i.e., December through March). The staff's slightly higher value is most likely the result of using a smaller drainage area (i.e., 10 square miles versus 296 square miles). Nonetheless, since the staff's 48-hour PMWP value is within 10 percent of the applicant's 48-hour PMWP value, the staff concludes that the applicant's 48-hour PMWP site characteristic value of 16.6 inches of water is acceptable.

The applicant proposed a site characteristic ground snow load value of 40 lbf/ft^2, which represents a combination of the 100-year return snowpack (24.4 lbf/ft^2) and the maximum-recorded monthly snowfall in the region (30.5 inches of snow, which is approximately equivalent to 15.6 lbf/ft^2). The applicant believes that the extreme winter precipitation roof load of 110.4 lbf/ft^2 (which represents the combined loading of the 100-year return snowpack and the 48-hour PMWP) is an unreasonable snow/ice roof loading for a structure at the EGC ESP site. Nonetheless, the staff has chosen not to include the applicant's proposed ground snow load value of 40 lbf/ft^2 as an ESP site characteristic. Once the roof design is known, the COL or CP applicant has the option to demonstrate that the 48-hour PMWP could neither fall nor remain entirely on top of the 100-year snowpack and/or building roofs.

In response to Open Item 2.3-1, the applicant provided UHS meteorological site characteristics to use in evaluating the performance of a mechanical draft cooling tower UHS with respect to maximum evaporation and minimum water cooling. To verify the applicant's site characteristics, the staff examined 30 years (1961–1990) of hourly temperature and humidity data from Peoria and Springfield (NCDC, "Solar and Meteorological Surface Observational Network (SAMSON) for Central U.S. CDROM"). The staff calculated 1-day, 5-day, and 30-day average wet-bulb temperatures from the hourly data and selected the periods with the highest average wet-bulb temperatures as the worst periods. The resulting maximum 1-day, 5-day, and 30-day average wet-bulb temperature values were similar to the values presented by the applicant. Therefore, the staff considers open Items 2.3-1 resolved.

The applicant provided an additional UHS meteorological site characteristic for use in evaluating the potential for water freezing in the UHS water storage facility in response to Open Item 2.3-2. This site characteristic is discussed in detail in Section 2.4.7 of this SER. Based on the discussion in Section 2.4.7 of this SER, the staff considers open Items 2.3-2 resolved.

Based on the discussion presented above, the staff concludes that the UHS meteorological site characteristics proposed by the applicant are acceptable.

Large-scale episodes of atmospheric stagnation are not common in the site region. During the 40-year period from 1936 to 1975, high-pressure stagnation conditions lasting for 4 days or more occurred about 15 times, with an average of 5.4 stagnation days per case. Only two of these stagnation cases lasted 7 days or longer (Korshover, "Climatology of Stagnating Anticyclones East of the Rocky Mountains, 1936–1975"). This discussion of atmospheric stagnation provides a general climatic understanding of the air pollution potential in the region. Section 2.3.2 of this SER discusses the ESP air quality conditions considered for design and operating bases. Sections 2.3.4 and 2.3.5 of this SER present the atmospheric dispersion site characteristics used to evaluate short-term postaccident airborne releases and long-term routine airborne releases.

Normal climatic data for the period 1971–2000 that the NCDC reported for the central climatic division of Illinois indicate that the annual mean temperature in the area is about 50.9 °F and ranges from a low monthly mean value of 22.9 °F in January to a high monthly mean value of 74.9 °F in July (NCDC, "Central Illinois Divisional Normals—Temperature, Period 1971–2000"). One of the highest temperatures recorded in the site region was 113 °F at Decatur on July 14, 1954 (ISCO, "Historical Climate Summary—112193 Decatur, IL"), Lincoln on July 15, 1936 (ISCO, "Historical Climate Summary—115079 Lincoln, IL"), and Peoria on July 15, 1936 (ISCO, "Historical Climate Summary—116711 Peoria WSO Airport, IL"). One of the lowest temperatures recorded in the site region was -29 °F at Lincoln on December 26, 1914 (ISCO, "Historical Climate Summary—115079 Lincoln, IL").

The annual mean wet-bulb temperatures at Peoria and Springfield are 47.0 °F and 47.5 °F, respectively. The Peoria wet-bulb temperatures range from a high monthly mean value of 69.2 °F in July to a low monthly mean value of 23.4 °F in January, while the Springfield wet-bulb temperatures range from a high monthly mean value of 68.4 °F in July to a low monthly mean value of 25.5 °F in January. The annual mean relative humidity is 70 percent at both Peoria and Springfield (NCDC, "Peoria, Illinois, 2003 Local Climatological Data, Annual Summary with Comparative Data," and NCDC, "Springfield, Illinois, 2003 Local Climatological Data, Annual Summary with Comparative Data").

For the following reasons, the staff concurs with the applicant's temperature and humidity site characteristics. The applicant's 2-percent, 1-percent, and 0.4-percent annual exceedance maximum dry-bulb (and, where applicable, concurrent wet-bulb) temperatures, the 1-percent and 0.4-percent annual exceedance minimum dry-bulb temperatures, and the 1-percent and 0.4-percent exceedance maximum wet-bulb temperatures are based on the Peoria and

Springfield data published by the NCDC (NCDC, "Engineering Weather Data CDROM").[1] The staff believes that the applicant used the record highest temperature for Illinois, as reported by both the NCDC (NCDC, "Temperature Extremes") and ISCO (ISCO, "Illinois Records"), to represent the 0-percent annual exceedance and 100-year return period maximum dry-bulb temperature values. Likewise, the applicant apparently used the record lowest temperature for Illinois, as reported by both the NCDC (NCDC, "Temperature Extremes") and ISCO (ISCO, "Illinois Records"), to represent the 0-percent annual exceedance and 100-year return period minimum dry-bulb temperature values. The applicant estimated the 100-year return period maximum wet-bulb temperature from the 2-percent occurrence and median annual extreme high wet-bulb temperatures reported for Peoria, Springfield, and Decatur (NCDC, "Engineering Weather Data CDROM").

To verify the applicant's 100-year return period data, the staff also calculated 100-year return period maximum and minimum dry-bulb temperatures and maximum wet-bulb temperatures using NCDC data for Peoria and Springfield during the period 1961–1990 (NCDC, "Solar and Meteorological Surface Observational Network (SAMSON) for Central U.S. CDROM") and algorithms based on the Gumbel Type 1 extreme value distribution defined in Chapter 27, "Climatic Design Information," of the 2001 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Handbook, *Fundamentals*. The staff found that the 100-year return period maximum and minimum dry-bulb temperatures and maximum wet-bulb temperature values presented by the applicant bound the corresponding values that the staff calculated.

The staff will include the regional climatology site characteristics listed in Table 2.3.1-6 in any ESP permit that the NRC might issue for the EGC ESP site.

Table 2.3.1-6 Staff's Proposed Regional Climatic Site Characteristics

SITE CHARACTERISTIC		VALUE	DESCRIPTION
Ambient Air Temperature and Humidity			
Maximum Dry-Bulb Temperature	2% annual exceedance	88 °F with 74 °F concurrent wet-bulb	The ambient dry-bulb temperature (and coincident wet-bulb temperature) that will be exceeded 2% of the time annually
	1% annual exceedance	91 °F	The ambient dry-bulb temperature that will be exceeded 1% of the time annually
	0.4% annual exceedance	94 °F with 77 °F concurrent wet-bulb	The ambient dry-bulb temperature (and coincident wet-bulb temperature) that will be exceeded 0.4% of the time annually
	100-year return period	117 °F	The ambient dry-bulb temperature that has a 1% annual probability of being exceeded (100-year mean recurrence interval)

[1] The data presented by the applicant as minimum 1-percent and 0.4-percent annual exceedance values are equivalent to the NCDC 99.0 and 99.6 percent occurrence values.

SITE CHARACTERISTIC		VALUE	DESCRIPTION
Minimum Dry-Bulb Temperature	99% annual exceedance	0 °F	The ambient dry-bulb temperature below which dry-bulb temperatures will fall 1% of the time annually
	99.6% annual exceedance	-6 °F	The ambient dry-bulb temperature below which dry-bulb temperatures will fall 0.4% of the time annually
	100-year return period	-36 °F	The ambient dry-bulb temperature for which a 1% annual probability of a lower dry-bulb temperature exists (100-year mean recurrence interval)
Maximum Wet-Bulb Temperature	1% annual exceedance	78 °F	The ambient wet-bulb temperature that will be exceeded 1% of the time annually
	0.4% annual exceedance	80 °F	The ambient wet-bulb temperature that will be exceeded 0.4% of the time annually
	100-year return period	86 °F	The ambient wet-bulb temperature that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Basic Wind Speed			
Fastest Mile		75 mi/h	The fastest-mile wind speed to be used in determining wind loads, defined as the fastest-mile wind speed at 33 feet (10 meters) above the ground that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
3-Second Gust		96 mi/h	The 3-second gust wind speed to be used in determining wind loads, defined as the 3-second gust wind speed at 33 feet (10 meters) above the ground that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Tornado			
Maximum Wind Speed		300 mi/h	Maximum wind speed resulting from passage of a tornado having a probability of occurrence of 10^{-7} per year
Translational Speed		60 mi/h	Translation component of the maximum tornado wind speed
Rotational Speed		240 mi/h	Rotation component of the maximum tornado wind speed
Radius of Maximum Rotational Speed		150 feet	Distance from the center of the tornado at which the maximum rotational wind speed occurs
Maximum Pressure Drop		2.0 lbf/in.^{2}	Decrease in ambient pressure from normal atmospheric pressure resulting from passage of the tornado

SITE CHARACTERISTIC	VALUE	DESCRIPTION
Maximum Rate of Pressure Drop	1.2 lbf/in.^{2}/s	Rate of pressure drop resulting from the passage of the tornado
Winter Precipitation		
100-Year Snowpack	24.4 lbf/ft^2	Weight of the 100-year return period snowpack (to be used in determining normal winter precipitation loads for roofs)
48-Hour Probable Maximum Winter Precipitation	16.6 in. of water	Probable maximum precipitation during the winter months (to be used in conjunction with the 100-year snowpack in determining extreme winter precipitation loads for roofs)
Ultimate Heat Sink		
Meteorological Conditions Resulting in the Minimum Water Cooling during Any 1 Day	81 °F wet-bulb temperature with coincident 87.6 °F dry-bulb temperature	Historic worst 1-day average wet-bulb temperature and coincident dry-bulb temperature
Meteorological Conditions Resulting in the Minimum Water Cooling during Any Consecutive 5 Days	79.7 °F wet-bulb temperature with coincident 86.2 °F dry-bulb temperature	Historic worst 5-day average wet-bulb temperature and coincident dry-bulb temperature
Meteorological Conditions Resulting in the Maximum Evaporation and Drift Loss during Any Consecutive 30 Days	74.7 °F wet-bulb temperature with coincident 82 °F dry-bulb temperature	Historic worst 30-day average wet-bulb temperature and coincident dry-bulb temperature

The staff acknowledges that long-term climatic change resulting from human or natural causes may introduce trends into design conditions. However, no conclusive evidence or consensus of opinion is available on the rapidity or nature of such changes. If in the future the ESP site is no longer in compliance with the terms and conditions of the ESP (e.g., new information shows that the climatic site characteristics no longer represent extreme weather conditions resulting from climate change), the staff will seek to modify the ESP or impose requirements on the site in accordance with the provisions of 10 CFR 52.39, "Finality of Early Site Permit Determinations."

2.3.1.4 Conclusions

As set forth above, the applicant presented and substantiated information relative to the regional meteorological conditions important to the safe design and siting of a nuclear power plant(s) falling within its PPE that might be constructed on the proposed site. The staff reviewed the available information provided and, for the reasons given above, concludes that the identification and consideration of the regional and site meteorological characteristics set forth above meet the requirements of 10 CFR 100.20(c) and 10 CFR 100.21(d).

The staff finds that the applicant considered the most severe regional weather phenomena in establishing the site characteristics identified above. The staff has generally accepted the methodologies used by the applicant to determine the severity of the weather phenomena reflected in these site characteristics, as documented in SERs for previous licensing actions.

Accordingly, the staff concludes that the use of these methodologies results in site characteristics containing margin sufficient for the limited accuracy, quantity, and period of time in which the data were accumulated. In view of the above, the site characteristics identified above are acceptable for use as part of the design bases for SSCs important to safety, as may be proposed in a COL application.

With regard to tornado wind speed, the applicant cited a tornado study covering much of the United States east of the Rocky Mountains, including central Illinois where the EGC ESP site is located. The staff conducted its own evaluation of site-specific tornado data and concluded that the results justify the applicant's proposed site tornado characteristics. In addition, the staff finds that these tornado site characteristics are acceptable for the design-basis tornado used for the generation of missiles.

The staff reviewed the applicant's proposed site characteristics related to climatology for inclusion in an ESP for the site, if one is issued, and finds these characteristics acceptable. The staff also reviewed the applicant's proposed design parameters (PPE values) for inclusion in such an ESP (SSAR Section 1.3) and finds them to be reasonable. The staff did not perform a detailed review of these parameters.

2.3.2 Local Meteorology

2.3.2.1 Technical Information in the Application

In this section of the SSAR, the applicant presented local (site) meteorological information. This SSAR section also addresses the potential influence of construction and operation of a nuclear power plant(s) falling within the applicant's PPE on local meteorological conditions that might in turn adversely impact such plant(s) or the associated facilities. Finally, the applicant provided a topographical description of the site and its environs and presented the following information:

- a description of the local (site) meteorology in terms of airflow, temperature, atmospheric water vapor, precipitation, fog, atmospheric stability, and air quality

- an assessment of the influence on the local meteorology of the construction and operation of a nuclear power plant(s) and its facilities falling within the applicant's PPE that might be built on the proposed site, including the effects of plant structures, terrain modification, and heat and moisture sources resulting from plant operation

- a topographical description of the site and its environs, as modified by the structures of a nuclear power plant(s) falling within the applicant's PPE that might be constructed on the proposed site

The applicant characterized local meteorological conditions using data collected from the meteorological monitoring program at the existing CPS. According to the applicant, the meteorological variables collected by the CPS monitoring program are appropriate for use in describing local meteorological conditions because of the proximity of the CPS meteorological tower to the ESP site. The applicant used two periods of record to characterize local meteorological conditions—April 1972 through April 1977 (pre-CPS construction) and January 2000 through August 2002 (post-CPS construction).

The applicant presented wind data from the 10-meter (33-foot) level of the CPS onsite meteorological tower for both the pre-CPS construction period (1972–1977) and the post-CPS construction period (2000–2002). The 1972–1977 wind direction data indicate that the predominant wind directions were from the south and south-southwest (about 10 percent of the time for each sector). The 2000–2002 wind data indicate that the predominant wind directions were from the south (about 11 percent of the time) and south-southwest (about 10 percent of the time). The 1972–1977 median wind speed was about 3.8 meters per second (m/s) as compared to the 2000–2002 median wind speed of approximately 2.8 m/s. Seasonal variations are also evident from the data, with winter months showing generally higher wind speeds, fewer calms, and more west-northwest wind in comparison to the summer months.

The average ambient dry-bulb temperature recorded on site during the period of record 1972–1977 was 10.5 °C (50.9 °F), ranging from a low monthly mean value of -5.1 °C (22.8 °F) in January to a high monthly mean value of 23.6 °C (74.5 °F) in July. The annual average relative humidity during the same period of record was 68.3 percent. The annual average dewpoint temperature was 4.7 °C (40.5 °F), ranging from a low monthly mean value of -7.8 °C (18.0 °F) in January to a high monthly mean value of 16.5 °C (61.7 °F) in July. Table 2.3-13 of the SSAR also contains a summary of CPS wet-bulb temperature measurements.

In RAI 2.3.2-6, the staff inquired about the CPS wet-bulb temperature statistics, given that nearly all of the CPS wet-bulb temperature values presented in SSAR Table 2.3-13 exceeded the corresponding CPS dry-bulb temperature values presented in SSAR Table 2.3-9. In its response to RAI 2.3.2-6, the applicant agreed that the wet-bulb temperatures presented in SSAR Table 2.3-13 were inconsistent with what would be expected when compared to the dry-bulb temperatures in SSAR Table 2.3-9. Since it did not use the wet-bulb temperatures presented in Table 2.3-13 to define any site characteristics, the applicant committed to deleting the SSAR Table 2.3-13 wet-bulb temperature data from the SSAR.

Since the temperature and humidity data presented in the SSAR were collected during the period 1972–1977 (before the installation of Clinton Lake and the operation of the CPS once-through cooling system), the staff asked the applicant in RAI 2.3.2-2 whether these data remain representative of the EGC ESP site, given that the site is now adjacent to a heated lake. The applicant responded that, since the meteorological tower is located approximately 0.5 miles from the nearest shoreline and the nearest shoreline is more than 4 miles downstream of the CPS thermal plume discharge location, it expects that the heating effects attributable to elevated water temperatures in the lake are minimal, if even measurable, at the location of the meteorological tower. The applicant made qualitative comparisons of the 1972–1977 and 2000–2002 temperature and humidity datasets, concluding that the two datasets were compatible, given the kinds of variations that would be expected for the two periods of record.

The average yearly precipitation recorded on site during the period of record, 1972–1977, was 25.47 inches, with monthly averages ranging from 1.15 inches in February to 4.16 inches in June.

According to the applicant, the closest locations to the EGC ESP site that have a fog dataset are Peoria and Springfield. Peoria averages 20 days per year of heavy fog, whereas Springfield averages 18.5 days of heavy fog per year. The highest occurrence of fog is in the winter months for both locations. The applicant noted that the Peoria and Springfield fog statistics should be considered regional estimates because they do not account for any local fog occurrences resulting from the once-through cooling system (Clinton Lake) used by the existing CPS. The applicant presented the results of an analytical model used as part of the license application for CPS to estimate the impacts of fog associated with the presence of Clinton Lake and the once-through cooling system. This model predicted that 316 hours of heavy fog would occur at the CPS reactor building complex. The model also predicted the maximum horizontal extent of steam fog from Clinton Lake as 1 mile or less, with the extent of extremely dense steam fog being limited to an area immediately adjacent to Clinton Lake.

The SSAR presents atmospheric stability data for the periods 1972–1977 and 2000–2002, based on delta-temperature measurements between the 60-meter and 10-meter levels on the CPS meteorological tower and the variation of horizontal wind direction. Data for the later time period show that neutral (Pasquill type "D") and slightly stable (Pasquill type "E") conditions predominate, occurring about 35 percent and 25 percent of the time, respectively. Moderately stable (Pasquill type "F") and extremely stable (Pasquill type "G") conditions occur about 9 percent and 4 percent of the time, respectively.

In RAI 2.3.2-5, the staff asked the applicant to identify the air quality characteristics that would be included in the design and operating bases for a nuclear plant(s) that might be constructed on the ESP site. The applicant responded that the ESP site is located within the east-central Illinois Interstate Air Quality Control Region, which has been designated as in attainment of the national ambient air quality standards. Before construction, the Illinois EPA will require the ESP facility to obtain air permits demonstrating that the ambient air quality standards will not be threatened or exceeded as a result of the facility's operation.

The applicant stated that the construction and operation of the ESP facility may influence the local meteorology of the area in the immediate vicinity of the ESP facility, primarily because of minor changes to the topography resulting from the construction of additional buildings and supporting infrastructure and the use of cooling towers for system heat rejection to the atmosphere. The applicant expects that the minor changes in local topography will not have a significant impact on diffusion characteristics except in the immediate vicinity of the buildings themselves.

The use of natural draft cooling towers or mechanical draft cooling towers or both for system heat rejection will result in visible moisture plumes from the cooling towers, primarily during winter months when ambient air temperatures are cool and the air is moist. Icing caused by the freezing of condensed water vapor from the cooling tower plumes could affect vertical surfaces (such as buildings and equipment) and horizontal surfaces (such as roadways) in the immediate vicinity of the cooling towers. The applicant expects that these impacts will occur only at onsite locations. In the SSAR, the applicant stated that the quantification of these ambient impacts will require a more in-depth assessment once it determines the facility's cooling system configuration and design parameters.

The applicant stated that the ESP site region is characterized by relatively flat terrain ranging from 95 feet below to 25 feet above the site elevation within 5 miles of the site. A large portion of the topographic relief in the immediate site area is filled by Clinton Lake, which is approximately 45 feet below plant grade. Because of the lake's complex configuration, over-water trajectories would generally be less than 1.1 miles. The applicant expects that the low hills and shallow river valleys that exist in the site region could exert a small effect upon nocturnal wind drainage patterns and fog frequency under certain atmospheric conditions.

2.3.2.2 Regulatory Evaluation

In response to RAI 1.5-1, the applicant stated that RS-002, Attachment 2, identifies the regulations applicable to the ESP SSAR. RS-002, Attachment 2, identifies the following applicable NRC regulations regarding local meteorology:

- Appendix A to 10 CFR Part 50, GDC 2, with respect to information on severe regional weather phenomena that has historically been reported for the region and that is reflected in the design bases for SSCs important to safety

- 10 CFR 100.20(c) and 10 CFR 100.21(d), with respect to the consideration that has been given to the regional meteorological characteristics of the site

In SSAR Sections 1.1.1 and 1.5, and in response to RAI 2.3.3-2, the applicant identified the following applicable NRC guidance regarding local meteorology:

- RG 1.23, second proposed Revision 1, "Meteorological Measurement Programs for Nuclear Power Plants," issued April 1986, with respect to the criteria for an acceptable onsite meteorological measurements program

- Section 2.3.2 of RG 1.70, with respect to the type of local meteorological information that should be presented, including the potential impact of the plant on local meteorology and the local meteorological and air quality conditions used for design- and operating-basis considerations

The staff reviewed this portion of the application for conformance with the applicable regulations, and considered the corresponding regulatory guidance, with the exception that an ESP applicant need not demonstrate compliance with the GDC.

Section 2.3.2 of RS-002, Attachment 2, and RG 1.70 provide the following guidance on information appropriate for a presentation on local meteorology:

- Local meteorological data based on onsite measurements and data from nearby NWS stations or other standard installations should be presented in the format specified in Section 2.3.2 of RG 1.70. Guidance related to onsite meteorological measurements is in RG 1.23.

- A topographical description of the site and environs should be provided. Section 2.3.2.2 of RG 1.70 provides guidance on the topographical description.

- A discussion and evaluation of the influence of a nuclear power plant(s) and its facilities of specified type (or falling within a PPE) that might be constructed on the proposed site on local meteorological and air quality conditions should be provided. Potential changes in the normal and extreme values resulting from plant construction and operation should be discussed.

2.3.2.3 Technical Evaluation

The staff evaluated local meteorological conditions using data from the CPS onsite meteorological monitoring system, as well as climatic data that NCDC and ISCO reported. Section 2.3.3 of this SER provides a discussion of the representativeness of the CPS onsite data.

The staff's review of the applicant's wind data from April 1972 through April 1977 and January 2000 through August 2002 shows that the data from these two periods compare well, with a general shift toward lower wind speeds in the more recent data. A comparison of the atmospheric stability distributions for these two measurement periods indicates that there may have been a shift in the distribution toward unstable conditions between the earlier period and the later period. This shift may be because of the heated cooling water in Clinton Lake from CPS affecting the lower level of the delta-temperature measurements. Clinton Lake was created and heated for the first time after the applicant completed the first data collection period and before it began the second data collection period.

The NCDC-reported normal climatic data for the period 1971–2000 for the central climatic division of Illinois indicate an annual mean temperature in the area of 50.9 °F, ranging from a low monthly mean value of about 22.9 °F in January to a high monthly mean value of about 74.9 °F in July (NCDC, "Central Illinois Divisional Normals—Temperature, Period 1971–2000"). These climatic division mean temperature values compare well with the mean temperature values recorded on site during the period of record 1972–1977 (e.g., annual mean temperature of 10.5 °C (50.9 °F) with a low monthly mean value of -5.1 °C (22.8 °F) in January and a high monthly mean value of 23.6 °C (74.5 °F) in July). One of the highest temperatures recorded in the site region was 113 °F at Decatur on July 14, 1954 (ISCO, "Historical Climate Summary—112193 Decatur, IL"), and one of the lowest temperatures recorded in the site region was -29 °F at Lincoln on December 26, 1914 (ISCO, "Historical Climate Summary—115079 Lincoln, IL"). These values bound the highest and lowest temperatures recorded on site, 35.2 °C (95.4 °F) and -28.8 °C (-19.8 °F), respectively, during the relatively short onsite period of record, 1972–1977.

The annual mean wet-bulb temperature at Peoria is 47.0 °F and ranges from a high monthly mean value of 69.2 °F in July to a low monthly mean value of 23.5 °F in January. The normal relative humidity at Peoria (71 percent) is similar to the onsite annual relative humidity (68.3 percent). Likewise, the mean dewpoint temperature at Peoria (42.2 °F) is compatible with the onsite annual dewpoint temperature of 4.7 °C (40.5 °F) (NCDC, "Peoria, Illinois, 2003 Local Climatological Data, Annual Summary with Comparative Data").

Precipitation for the central Illinois climatic division averages 37.39 inches per year, with monthly climate division normals ranging from a minimum of about 1.70 inches in January and February to a maximum of about 4.29 inches in May (NCDC, "Central Illinois Divisional Normals—Precipitation, Period 1971-2000"). Onsite precipitation data recorded during the period 1972–1977 show slightly lower precipitation totals. Maximum and minimum monthly amounts of precipitation observed in the area are 16.96 inches in May 1961 at Clinton (ISCO, "Historical Climate Summary—111743 Clinton, IL") and 0 inches in September 1979 at Springfield (ISCO, "Historical Climate Summary—118179 Springfield WSO AP, IL"). One of the highest 1-day precipitation totals recorded for the site region was 14.25 inches at Clinton on May 8, 1961 (ISCO, "Historical Climate Summary—111743 Clinton, IL").

The staff reviewed the applicant's description of the local meteorology and determined that it represents the conditions at and near the site. The wind, temperature, precipitation, and atmospheric stability data are based on onsite data recorded by the CPS meteorological monitoring system. Section 2.3.3 of this SER provides a discussion of the representativeness of the CPS onsite data. The other meteorological summaries are based on data from nearby stations with long periods of record. A review of the recorded extreme values shows that they are reflected in the site characteristics presented in SSAR Section 2.3.1.

The staff reviewed the topographic maps and topographic cross sections included in the SSAR, concluding that the information needed is well labeled and can be readily extracted.

Because of the limited and localized nature of the expected terrain modifications associated with the development of the ESP facility, the staff finds that these terrain modifications, along with the resulting plant structures and associated improved surfaces, will not have enough of an impact on local meteorological conditions to affect plant design and operation. However, the use of natural draft cooling towers or mechanical draft cooling towers or both would cause visible moisture plumes and icing on nearby surfaces during the winter months. The applicant noted that the quantification of these ambient impacts will require a more in-depth assessment once the facility's cooling system configuration and design parameters are determined. The COL or CP applicant will then need to describe how these potential increases in atmospheric moisture and icing would impact plant design and operation. This is **COL Action Item 2.3-1.**

Since the EGC ESP site is located in an air quality control region that has been designated as being in attainment of the national ambient air quality standards, the staff finds that it is not likely that the ESP site air quality conditions would be a significant factor in the design and operating bases for the ESP facility.

2.3.2.4 Conclusions

As set forth above, the applicant presented and substantiated information on local meteorological, air quality, and topographic characteristics of importance to the safe design and operation of a nuclear power plant(s) falling within its PPE that might be constructed on the proposed site. The staff reviewed the available information provided, and, for the reasons given, concludes that the applicant's identification and consideration of the meteorological, air quality, and topographical characteristics of the site and the surrounding area meet the requirements of 10 CFR 100.20(c) and 10 CFR 100.21(d) and are sufficient to determine the acceptability of the site.

The staff also reviewed available information relative to severe local weather phenomena at the site and in the surrounding area. As set forth above, the staff concludes that the applicant identified the most severe local weather phenomena at the site and surrounding area.

2.3.3 Onsite Meteorological Measurements Program

2.3.3.1 Technical Information in the Application

In this section of the SSAR, the applicant presented the following information concerning its onsite meteorological measurements program, including instrumentation and measured data:

- a description of meteorological instrumentation, including siting of sensors, sensor performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, and data acquisition and reduction procedures
- meteorological data, including consideration of the period of record and amenability of the data for use in characterizing atmospheric dispersion conditions

The applicant currently uses the existing onsite meteorological measurements program for the CPS facility to collect data for the EGC ESP site and intends to use it in the future for any additional reactors that might be constructed on the ESP site.

The existing CPS monitoring program began in April 1972. The applicant referenced and used two different periods of onsite meteorological data in the SSAR. The first period, April 1972 through April 1977, is representative of the EGC ESP site before construction of CPS (including the filling of Clinton Lake). The applicant used data from this first period in the original construction and operating license environmental reports and the updated safety analysis report for CPS. The applicant used data from the second period, January 2000 through August 2002, to characterize current site-specific meteorological conditions. The applicant obtained data from both periods from the same instrumented onsite tower at the same levels above ground. During the course of operation, the applicant replaced various electronic components and sensors with equivalent or upgraded components as a matter of routine maintenance and repair.

In RAI 2.3.3-2, the staff asked the applicant to clarify the EGC ESP meteorological monitoring program commitments to regulatory guidance documents. In response to RAI 2.3.3-2, the applicant indicated that, since the meteorological monitoring system at CPS began operation, the system has been in compliance with NRC requirements. The CPS meteorological monitoring system currently meets the guidance of ANSI/American Nuclear Society (ANS) 2.5-1984, "Standard for Determining Meteorological Information at Nuclear Power Plants," proposed as Revision 1 to RG 1.23 with some exceptions.

The CPS meteorological monitoring program consists of a guyed, triaxial, open lattice 199-foot-tall tower located approximately 3200 feet south-southeast of the center of the CPS containment structure and approximately 1800 feet south-southeast of the center of the proposed location for a future EGC ESP facility. Wind speed and direction are measured at the 10-meter (33-foot) and 60-meter (198-foot) elevations. Ambient temperature and dewpoint temperature are measured at the 10-meter elevation and vertical temperature difference (delta-temperature) is measured between the 60-meter and 10-meter elevations. Precipitation is monitored at the ground level.

For the 1972–1977 period of operation, meteorological data were recorded on strip charts. The hourly database used for the climatic data summaries and atmospheric dispersion analyses was derived from the strip charts. For the 2000–2002 period of operation, a microprocessor recorded the meteorological data and generated the hourly database used for the climatic data summaries and atmospheric dispersion analyses presented in the SSAR.

The wind sensors are mounted on booms approximately twice the tower face width and are positioned so that the tower does not influence the prevailing south-southwest windflow. The ambient temperature, dewpoint temperature, and delta-temperature sensors are housed in motor-aspirated shields to insulate them from the effects of precipitation and thermal radiation.

The meteorological monitoring system is calibrated at least semiannually. Data recovery for the 2000–2002 period of record used to evaluate atmospheric dispersion exceeded 90 percent.

Measurements are also available from a backup system. The backup monitoring system consists of wind speed and wind direction sensors located at the 10-meter level on the CPS microwave tower. The backup system is intended to function when the primary system is out of service, providing further assurance that basic meteorological information will be available during and immediately following an accidental release of airborne radioactivity.

In RAI 2.3.3-1, the staff asked the applicant to provide an hourly listing of the January 2000–August 2002 onsite meteorological database used to generate the SSAR Section 2.3.4 short-term diffusion estimates and the SSAR Section 2.3.5 long-term diffusion estimates. In its response to RAI 2.3.3-1, Exelon provided a copy of the January 2000–December 2002 database.

2.3.3.2 Regulatory Evaluation

In response to RAI 1.5-1, the applicant stated that RS-002, Attachment 2, identifies regulations applicable to the ESP SSAR. RS-002, Attachment 2, identifies the following applicable NRC regulations regarding onsite meteorological measurement programs:

- Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50, as it relates to meteorological data used to determine compliance with the numerical guides for doses in meeting the criterion of "as low as is reasonably achievable" (ALARA)

- 10 CFR 100.20(c), 10 CFR 100.21(c), and 10 CFR 100.21(d), as they relate to meteorological data collected for use in characterizing the site's meteorological conditions

In SSAR Sections 1.1.1, 1.5, and 2.3.3, as well as in its response to RAI 2.3.3-2, the applicant identified the following applicable NRC guidance regarding onsite meteorological measurements programs:

- RG 1.23, with respect to the criteria for an acceptable onsite meteorological measurements program

- Section 2.3.3 of RG 1.70, with respect to describing the meteorological measurements at the site and providing joint frequency distributions of wind speed and direction by atmospheric stability class

The staff reviewed this portion of the application for conformance with the applicable regulations, and considered the corresponding regulatory guidance.

Both RG 1.23 and RS-002, Attachment 2, Section 2.3.3, document the criteria for an acceptable onsite meteorological measurements program. The onsite meteorological measurements program should produce data that describe the meteorological characteristics of the site and its vicinity for the purpose of making atmospheric dispersion estimates for both postulated accidental and expected routine airborne releases of effluents, as well as for comparing with offsite sources to determine the appropriateness of climatological data used for design considerations.

Section 2.3.3 of RS-002, Attachment 2, and RG 1.70 provide guidance on information appropriate for presentation on an onsite meteorological measurements program. As set forth in this guidance, at least one annual cycle of onsite meteorological data should be provided. These data should be presented in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class in the format described in RG 1.23. If a site has a high occurrence of low wind speeds, a finer category breakdown should be used for the lower speeds so that data are not clustered in a few categories. A listing of each hour of the hourly averaged data should also be provided on electronic media in the format described in Appendix A to RS-002, Attachment 2, Section 2.3.3. Evidence of how well these data represent long-term conditions at the site should be discussed.

2.3.3.3 Technical Evaluation

The staff evaluated the onsite meteorological measurements program by reviewing the program description presented in the SSAR and conducting a site visit. The site visit consisted of reviewing the meteorological monitoring system location and exposure, sensor type and performance specifications, data transmission and recording, data acquisition and reduction, and instrumentation maintenance and calibration procedures. In addition, the staff reviewed an hourly listing of the January 2000–December 2002 meteorological database that the applicant provided in its response to RAI 2.3.3-1.

The staff considers the meteorological data collected by the existing CPS monitoring program to be representative of the dispersion conditions at the EGC ESP site. The EGC ESP site is within the existing CPS site, and the new nuclear unit(s) are intended to be in close proximity to the existing facility. The CPS meteorological tower is located far enough away from existing plant structures to preclude any adverse impact on measurements. The base of the tower is at an elevation similar to plant grade at both CPS and at the proposed location for a future EGC ESP facility. The ground cover at the base of the meteorological tower is primarily native grasses.

The staff reviewed the location of the meteorological tower with respect to nearby ground features and potential obstructions to flow (e.g., trees, buildings), including existing and proposed plant structure layouts, and concluded that there are minimal adverse effects on the measurements taken at the towers. The staff also evaluated the types and heights of the meteorological variables being measured and found them compatible with the criteria of RG 1.23. During the site visit, the staff reviewed the sensor types and performance specifications, data transmission, and recording methods, as well as the inspection, maintenance, and calibration procedures and frequencies, and found them to be consistent with the guidance in RG 1.23.

The staff performed a quality review of the post-CPS construction (January 2000–December 2002) hourly meteorological database that the applicant provided in response to RAI 2.3.3-1 using the methodology described in NUREG-0917, "Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data." The staff performed further review using computer spreadsheets. Its examination of the data revealed generally stable and neutral atmospheric conditions at night and unstable and neutral conditions during the day, which was expected. Wind speed, wind direction, and stability class frequency distributions for each measurement channel were reasonably similar from year to year. The post-CPS construction 2000–2002 wind speed, wind direction, and stability class frequency distributions were also reasonably consistent with the pre-CPS construction 1972–1977 data, with a general shift toward lower wind speeds and more unstable conditions in the more recent data. The shift toward unstable conditions may have resulted from the effect of the heated cooling water in Clinton Lake from CPS on the lower level of the delta-temperature measurements or from the more frequent use of the variation of horizontal wind direction to determine atmospheric stability.

The staff compared the January 2000–December 2002 joint frequency distribution used by the applicant as input to the NRC-sponsored PAVAN atmospheric dispersion model (NUREG/CR-2858, "PAVAN: An Atmospheric Dispersion Program for Evaluating Design Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations") and a staff-generated January 2000–December 2002 joint frequency distribution from the hourly database and found them to be consistent.

2.3.3.4 Conclusions

As set forth above, the applicant provided and substantiated information on the onsite meteorological measurements program. The staff reviewed the available information relative to the meteorological measurements program and the data collected by the program. On the basis of this review and as set forth above, the staff concludes that the system provides data adequate to represent onsite meteorological conditions, as required by 10 CFR 100.20. The onsite data also provide an acceptable basis for (1) making estimates of atmospheric dispersion for design-basis accident and routine releases from a nuclear power plant(s) falling within the applicant's PPE that might be constructed on the proposed site, and (2) meeting the requirements of 10 CFR Part 100 and Appendix I to 10 CFR Part 50.

2.3.4 Short-Term Diffusion Estimates

2.3.4.1 Technical Information in the Application

In this section of the SSAR, the applicant presented the following information on atmospheric dispersion estimates for postulated accidental airborne releases of radioactive effluents to the EAB and LPZ:

- atmospheric transport and diffusion models to calculate relative concentrations for postulated accidental radioactive releases
- meteorological data summaries used as input to diffusion models
- specification of diffusion parameters
- probability distributions of relative concentrations
- determination of relative concentrations used for assessment of consequences of postulated radioactive atmospheric releases from design-basis and other accidents

The applicant used PAVAN to estimate relative concentration (χ/Q) values at the EAB and LPZ for potential accidental releases of radioactive material. The PAVAN model implements the methodology outlined in RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants."

The PAVAN code estimates χ/Q values for various time-averaging periods ranging from 2 hours to 30 days. The meteorological input to PAVAN consists of a joint frequency distribution of wind speed, wind direction, and atmospheric stability data. The PAVAN code computes χ/Q values at the EAB and LPZ for each combination of wind speed and atmospheric stability for each of the 16 downwind direction sectors. The code then ranks χ/Q values for each sector in descending order, and it derives an associated cumulative frequency distribution based on the frequency distribution of wind speed and stabilities for that sector. The χ/Q value that is equaled or exceeded 0.5 percent of the total time is determined for each sector, and the highest 0.5 percentile χ/Q value among the 16 sectors becomes the maximum sector-dependent χ/Q value. The code also ranks χ/Q values independent of wind direction into a cumulative frequency distribution for the entire site. The PAVAN program then selects the χ/Q value that is equaled or exceeded 5 percent of the total time. The code uses larger of the two values, the maximum sector-dependent 0.5-percent χ/Q value or the overall site 5-percent χ/Q value to represent the χ/Q value for a 0–2-hour time period.

To determine χ/Q values for longer time periods, PAVAN calculates annual average χ/Q values. Logarithmic interpolation is then used between the 0–2-hour χ/Q values and the annual average χ/Q values to calculate the values for intermediate time periods (i.e., 8 hours, 16 hours, 72 hours, and 624 hours).

The applicant used the following input data and assumptions in applying the PAVAN model to the EGC ESP site:

- The initial meteorological input to PAVAN consisted of a joint frequency distribution of wind speed, wind direction, and atmospheric stability data based on January 2000 through August 2002 onsite meteorological data. The wind data were from the 10-meter (33-foot) level of the onsite meteorological tower. The stability data were derived from the vertical temperature difference (delta-temperature) measurements taken between the 60-meter (198-foot) and 10-meter (33-foot) levels of the onsite meteorological tower, as well as horizontal wind variability. In RAI 2.3.3-4, the staff asked the applicant to explain why it used only 32 months of onsite data (January 2000 through August 2002) to generate the χ/Q values, since potential bias could exist resulting from the underrepresentation of autumn and the early winter months. The applicant responded that the data from the period January 2000 through August 2002 represented the most recent continuous data record available that was obtained and processed using a consistent methodology. While there is a potential for a seasonal bias in the 32-month period of record data, the applicant noted that it performed a variety of comparisons with the original 1972–1977 data analyses and concluded that there were no undue biases in the results.

The staff made an independent evaluation of the resulting atmospheric diffusion estimates by rerunning the PAVAN computer model using a joint frequency distribution derived from the 3-year meteorological database (January 2000–December 2002) provided in the applicant's response to RAI 2.3.3-1 and concluded that the resulting EAB χ/Q value could increase as much as 10 percent. Consequently, the staff identified in Open Item 2.3-3 the need to use appropriately conservative meteorological data to calculate short-term accident atmospheric dispersion estimates.

- The applicant modeled one ground-level release point and took no credit for building wake effects.

- The proposed EAB is the perimeter of a circle having a radius of 1025-meter centered on the ESP facility footprint (e.g., the proposed area for locating the ESP site powerblock structures), and the proposed LPZ is the area encompassed by a 4018-meter radius circle centered on the same ESP facility footprint. The applicant placed the release point at the center of the ESP facility footprint for the purposes of determining the downwind distances to the EAB and LPZ (1025 meters and 4018 meters, respectively). In RAI 2.3.4-2, the staff asked the applicant to recalculate the EAB and LPZ χ/Q values using the shortest distances between the ESP plant envelope boundaries and the EAB and LPZ radii for each downwind sector. The applicant responded that, although the major potential release point(s) would be somewhat displaced from the center point, it did not expect the resultant changes in χ/Q values to be significant and did not recalculate the EAB and LPZ χ/Q values. The staff made an independent evaluation of the resulting atmospheric diffusion estimates by rerunning the PAVAN computer model and concluded that reducing the downwind distance to the EAB from 1025 meters to 805 meters could result in increasing the EAB χ/Q value by as much as 30 percent. Consequently, the staff identified in Open Item 2.3-3 the need to use appropriately conservative distances from postulated release points to calculate short-term accident atmospheric dispersion estimates.

In its submission to the NRC dated April 4, 2005, the applicant responded to Open Item 2.3-3 by recalculating its short-term accident χ/Q values using 3 complete years of meteorological data (January 2000–December 2002) and a distance of 805 meters to the EAB. The applicant also provided a copy of the input files it used to execute PAVAN. The applicant stated that 805 meters is the minimum distance to the proposed EAB from any point on the envelope of the ESP facility footprint.

Based on the PAVAN modeling results presented in its submission dated April 4, 2005, the applicant proposed the short-term (accident release) atmospheric dispersion site characteristics presented in Table 2.3.4-1 for inclusion in an ESP, should one be issued for the applicant's proposed ESP site.

Table 2.3.4-1 Applicant's Proposed Short-Term (Accident Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
0–2 hour χ/Q Value @ EAB (5% value)	2.52×10^{-4} s/m^3	The atmospheric dispersion coefficients used in the SSAR to estimate dose consequences of accidental airborne releases
0–8 hour χ/Q Value @ LPZ (5% value)	3.00×10^{-5} s/m^3	
8–24 hour χ/Q Value @ LPZ (5% value)	2.02×10^{-5} s/m^3	
1–4 day χ/Q Value @ LPZ (5% value)	8.53×10^{-6} s/m^3	
4–30 day χ/Q Value @ LPZ (5% value)	2.48×10^{-6} s/m^3	

2.3.4.2 Regulatory Evaluation

In response to RAI 1.5-1, the applicant stated that RS-002, Attachment 2, identifies the NRC regulations applicable to the ESP SSAR regarding short-term (accident release) diffusion estimates. RS-002, Attachment 2, identifies the applicable regulation as 10 CFR 100.21, with respect to the meteorological considerations used in the evaluation to determine an acceptable exclusion area and LPZ.

In SSAR Sections 1.5 and 2.3.4, the applicant identified the following applicable NRC guidance regarding accident release diffusion estimates:

- RG 1.23, with respect to the criteria for an acceptable onsite meteorological measurements program
- Section 2.3.4 of RG 1.70, with respect to providing conservative and realistic estimates of atmospheric diffusion at the EAB and LPZ, based on the most representative meteorological data and impacts caused by local topography
- RG 1.145, with respect to acceptable methods for choosing atmospheric dispersion factors (χ/Q values) for evaluating the consequences of potential accidents

The staff reviewed this portion of the application for confirmation with applicable regulations, and considered the corresponding regulatory guidance.

Section 2.3.4 of RS-002, Attachment 2, and RG 1.70 provide the following guidance on information appropriate for a presentation on short-term (accident release) diffusion estimates. The application should present or describe the following:

- conservative estimates of atmospheric transport and diffusion conditions at appropriate distances from the source for postulated accidental releases of radioactive materials to the atmosphere

- a description of the atmospheric dispersion models used to calculate relative concentrations (χ/Q values) in air resulting from accidental releases of radioactive material to the atmosphere, with models documented in detail and substantiated within the limits of the model so that the staff can evaluate their appropriateness to site characteristics, plant characteristics (to the extent known), and release characteristics

- the meteorological data used for the evaluation (as input to the dispersion models), which represent annual cycles of hourly values of wind direction, wind speed, and atmospheric stability for each mode of accidental release

- an explanation of the variation of atmospheric diffusion parameters used to characterize lateral and vertical plume spread (σ_y and σ_z) as a function of distance, topography, and atmospheric conditions, as related to measured meteorological parameters, and a description of a methodology for establishing these relationships that is appropriate for estimating the consequences of accidents within the range of distances that are of interest with respect to site characteristics and established regulatory criteria

- cumulative probability distributions of relative concentrations (χ/Q values) and the probabilities of these χ/Q values being exceeded for appropriate distances (e.g., the EAB and LPZ) and time periods, as specified in Section 2.3.4.2 of RG 1.70, as well as an adequate description of the methods used for generating these distributions

- the relative concentrations used for assessing the consequences of atmospheric radioactive releases from design-basis and other accidents

2.3.4.3 Technical Evaluation

The applicant generated its atmospheric diffusion estimates for postulated accidental airborne releases of radioactive effluents to the EAB and LPZ using the staff-endorsed computer code PAVAN. The staff evaluated the applicability of the PAVAN model and concluded that no unique topographic features preclude the use of the PAVAN model for the EGC ESP site. The staff also reviewed the applicant's input to the PAVAN computer code, including the assumptions used concerning plant configuration and release characteristics and the appropriateness of the meteorological data input. The staff found that the applicant made conservative assumptions by ignoring building wake effects and treating all releases as ground-level releases.

The staff made an independent evaluation of the resulting atmospheric diffusion estimates by running the PAVAN computer model using the following input data and assumptions:

- The meteorological input to PAVAN consisted of a joint frequency distribution of wind speed, wind direction, and atmospheric stability data derived from the complete 3-year meteorological database (January 2000–December 2002) provided in the applicant's response to RAI 2.3.3-1. Unlike the applicant's joint frequency distribution, the staff used a larger number of wind speed categories at the lower wind speeds as suggested in Section 4.6 of NUREG/CR-2858. The important aspect of having a large number of lower wind speed categories is to generate more χ/Q values at the lower end of the cumulative χ/Q frequency since the 0.5 percent χ/Q value is desired.

- The staff ignored building wake effects and treated all releases as ground-level releases.

- The proposed EAB is the perimeter of a circle having a radius of 1025-meter centered on the ESP facility footprint, and the proposed LPZ is the area encompassed by a 4018-meter radius circle centered on the same ESP facility footprint. To calculate the χ/Q values for the EAB, the staff used the shortest distance to the proposed EAB from any point on the envelope of the ESP facility footprint (805 meters). Similarly, to calculate the χ/Q values for the LPZ, the staff used the shortest distance to the proposed LPZ from any point on the envelope of the ESP facility footprint (3798 meters).

The staff obtained PAVAN results similar to that of the applicant.

From this review, the staff concludes that the applicant used an adequately conservative atmospheric dispersion model and appropriate meteorological data to calculate relative concentrations for appropriate offsite (EAB and LPZ) distances and directions from postulated release points for accidental airborne releases of radioactive materials.

To evaluate atmospheric dispersion characteristics with respect to radiological releases to the control room, detailed design information (e.g., vent heights, intake heights, distance and direction from release vents to the room) is necessary. Because little detailed design information is available for the nuclear power plant(s) that might be constructed on the proposed site, the COL or CP applicant will need to evaluate the dispersion of airborne radioactive materials to the control room at the COL or CP stage. This is **COL Action Item 2.3-2.**

The staff intends to include the short-term (accident release) atmospheric dispersion factors listed in Table 2.3.4-2 as site characteristics in any ESP that might be issued for the EGC ESP site. Based on the discussion above, the staff considers open Item 2.3-3 resolved.

Table 2.3.4-2 Staff's Proposed Short-Term (Accident Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
0–2hour χ/Q Value @ EAB (5% value)	2.52×10^{-4} s/m^3	The 0–2 hour atmospheric dispersion factor to be used to estimate dose consequences of design-basis accidents at the EAB
0–8 hour χ/Q Value @ LPZ (5% value)	3.00×10^{-5} s/m^3	The 0–8 hour atmospheric dispersion factor to be used to estimate dose consequences of design-basis accidents at the LPZ
8–24 hour χ/Q Value @ LPZ (5% value)	2.02×10^{-5} s/m^3	The 8–24 hour atmospheric dispersion factor to be used to estimate dose consequences of design-basis accidents at the LPZ
1–4 day χ/Q Value @ LPZ (5% value)	8.53×10^{-6} s/m^3	The 1–4 day atmospheric dispersion factor to be used to estimate dose consequences of design-basis accidents at the LPZ
4–30 day χ/Q Value @ LPZ (5% value)	2.48×10^{-6} s/m^3	The 4–30 day atmospheric dispersion factor to be used to estimate dose consequences of design-basis accidents at the LPZ

2.3.4.4 Conclusions

As set forth above, the applicant made conservative assessments of postaccident atmospheric dispersion conditions using its meteorological data and appropriate diffusion models. The applicant calculated representative atmospheric transport and diffusion conditions for the EAB and the LPZ. The staff has reviewed the applicant's proposed short-term atmospheric dispersion site characteristics for inclusion in an ESP for the applicant's site, should one be issued, and, as discussed above, finds these characteristics to be acceptable. Therefore, the staff concludes that the applicant's atmospheric dispersion estimates are appropriate for the assessment of consequences from radioactive releases for postulated (i.e., design-basis) accidents, in accordance with 10 CFR 100.21.

Based on these considerations, the staff concludes that the applicant's short-term atmospheric dispersion estimates are acceptable and meet the relevant requirements of 10 CFR Part 100. The staff will address atmospheric dispersion estimates used to evaluate radiological doses for the control room in its review of the COL or CP application that references this information.

2.3.5 Long-Term Diffusion Estimates

2.3.5.1 Technical Information in the Application

In this section of the SSAR, the applicant presented its atmospheric diffusion estimates for routine releases of effluents to the atmosphere, providing the following information:

- the atmospheric dispersion models used to calculate concentrations in air and the amount of material deposited as a result of routine releases of radioactive material to the atmosphere
- the meteorological data used as input to diffusion models
- diffusion parameters
- relative concentration (χ/Q) and relative deposition (D/Q) values used to assess the consequences of routine airborne radioactive releases
- points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations

The applicant used the subprogram XDCALC from the MIDAS suite of software programs to estimate the χ/Q and D/Q values resulting from routine releases. The applicant indicated that the XDCALC model is consistent with the guidance in RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors." The applicant used the following input data and assumptions in applying the XDCALC model for the EGC ESP site:

- The meteorological input to XDCALC consisted of hourly CPS onsite wind speed, wind direction, and atmospheric stability data from January 2000 through August 2002. The wind data were from the 10-meter level of the onsite meteorological tower. The stability data were derived from the vertical temperature difference (delta-temperature) measurements taken between the 60-meter and 10-meter levels of the onsite meteorological tower, as well as horizontal wind variability.
- The applicant modeled one ground-level release point, assuming a minimum building cross-sectional area of 2069 square meters and a containment building height of

76.1 meters. The applicant placed the release point at the center of the ESP facility footprint for the purposes of determining the downwind distances to the EAB and LPZ.

The applicant calculated annual average undepleted/no decay, undepleted/2.26-day decay, and depleted/8.00-day decay χ/Q values and D/Q values for the site boundary, EAB, LPZ, and special receptors of interest (nearest milk cow, milk goat, garden, meat animal, and residence within 5 miles in each downwind sector), as well as for various radial sectors out to a distance of 50 miles.

Table 2.3.5-1 lists the long-term atmospheric dispersion estimates that the applicant derived based on the XDCALC modeling results.

Table 2.3.5-1 Applicant's Long-Term (Routine Release) Diffusion Estimates

TYPE OF LOCATION	χ/Q VALUE (s/m^3) UNDEPLETED NO DECAY	χ/Q VALUE (s/m^3) UNDEPLETED 2.26-DAY DECAY	χ/Q VALUE (s/m^3) DEPLETED 8.00-DAY DECAY	D/Q VALUE ($1/m^2$)
EAB	2.04×10^{-6} (1025 meters NNE)	2.04×10^{-6} (1025 meters NNE)	1.84×10^{-6} (1025 meters NNE)	1.46×10^{-8} (1025 meters NNE)
Nearest Milk Cow	1.10×10^{-6} (1500 meters N)	1.10×10^{-6} (1500 meters N)	9.63×10^{-7} (1500 meters N)	6.76×10^{-9} (1500 meters N)
Nearest Goat Milk	9.90×10^{-8} (8000 meters NNE)	9.72×10^{-8} (8000 meters NNE)	7.28×10^{-8} (8000 meters NNE)	4.21×10^{-10} (8000 meters NNE)
Nearest Garden	1.10×10^{-6} (1500 meters N)	1.10×10^{-6} (1500 meters N)	9.63×10^{-7} (1500 meters N)	6.76×10^{-9} (1500 meters N)
Nearest Meat Animal	1.10×10^{-6} (1500 meters N)	1.10×10^{-6} (1500 meters N)	9.63×10^{-7} (1500 meters N)	6.76×10^{-9} (1500 meters N)
Nearest Resident	1.50×10^{-6} (1170 meters SW)	1.49×10^{-6} (1170 meters SW)	1.34×10^{-6} (1170 meters SW)	6.76×10^{-9} (1500 meters N)

2.3.5.2 Regulatory Evaluation

In response to RAI 1.5-1, the applicant stated that RS-002, Attachment 2, identifies the NRC regulations applicable to the ESP SSAR regarding long-term (routine release) diffusion estimates. RS-002, Attachment 2, identifies the applicable regulation as 10 CFR 100.21(c)(1), with respect to evaluating site atmospheric dispersion characteristics and establishing dispersion parameters such that radiological effluent release limits associated with normal operation from the type of facility proposed to be located at the site can be met for any individual located off site.

The staff finds that the applicant should have also identified Appendix I to 10 CFR Part 50, which requires demonstrating compliance with the numerical guides for doses contained in this appendix by characterizing atmospheric transport and diffusion conditions to estimate the radiological consequences of routine releases of materials to the atmosphere. Nonetheless, the staff finds that the applicant meets these regulatory requirements.

In SSAR Sections 1.5 and 2.3.5, the applicant identified the following applicable NRC guidance regarding routine release diffusion estimates:

- Section 2.3.5 of RG 1.70, with respect to providing realistic estimates of annual average atmospheric transport and diffusion characteristics to a distance of 50 miles from the plant, including a detailed description of the model used and a calculation of the maximum annual average atmospheric dispersion factor (χ/Q value) at or beyond the site boundary for each venting location

- RG 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," with respect to the criteria for identifying specific receptors of interest (applicable at the ESP stage to the extent the applicant provides receptors of interest)

- RG 1.111 with respect to the criteria for characterizing atmospheric transport and diffusion conditions for evaluating the consequences of routine releases

The staff finds that the applicant should have also identified RG 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," issued May 1977, with respect to the criteria to be used to identify release points and release characteristics (applicable to the extent the applicant provides release points and release characteristics at the ESP stage). Nonetheless, the staff finds that the applicant meets the criteria in all applicable RGs for performing routine release diffusion estimates.

Section 2.3.5 of RS-002, Attachment 2, and RG 1.70 provide the following guidance on information appropriate for a presentation on long-term (routine release) diffusion estimates:

- The applicant should provide a description of the atmospheric dispersion models used to calculate concentrations in air and the amount of material deposited as a result of routine releases of radioactive material to the atmosphere. The models should be sufficiently documented and substantiated to allow a review of their appropriateness for site characteristics, plant characteristics (to the extent known), and release characteristics.

- The applicant should discuss the relationship between atmospheric diffusion parameters, such as vertical plume spread (σ_z), and measured meteorological parameters. The applicant should substantiate the appropriateness of the use of these parameters in estimating the consequences of routine releases from the site boundary to a radius of 50 miles from the plant site.

- The applicant should provide the meteorological data used as input to the dispersion models. Data used for this evaluation should represent hourly average values of wind speed, wind direction, and atmospheric stability, which are appropriate for each mode of release. The data should reflect atmospheric transport and diffusion conditions in the vicinity of the site throughout the course of a year.

- The applicant should provide the χ/Q and D/Q values used for assessing the consequences of routine radioactive gas releases, as described in Section 2.3.5.2 of RG 1.70.

- The applicant should identify points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations (if available at the ESP stage). Bounding values for these parameters may be provided at the ESP stage. In such a case, the applicant will need to confirm, at the COL or CP stage, that the parameters submitted at the ESP stage bound the actual values provided at the COL or CP stage, and that the calculational methodology used for the confirmation is consistent with that employed at the ESP stage.

2.3.5.3 Technical Evaluation

The applicant generated its atmospheric diffusion estimates for routine airborne releases of radioactive effluents to the site boundary, EAB, LPZ, and special receptors of interest using the MIDAS software subprogram XDCALC. The applicant stated that the XDCALC code is consistent with the guidance in RG 1.111. The staff reviewed the applicant's input assumptions to the XDCALC computer code concerning plant configuration and release characteristics and found these assumptions to be appropriate. The staff found that the applicant made conservative assumptions by treating all releases as ground-level releases.

The staff made an independent evaluation of the applicant's resulting atmospheric diffusion estimates by executing the staff computer code XOQDOQ (NUREG/CR-2919, "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations") using the onsite January 2000–December 2002 meteorological data provided as part of the applicant's response to RAI 2.3.3-1. The XOQDOQ model implements the methodology outlined in RG 1.111. The staff obtained results similar to those obtained by the applicant.

From this review, the staff concluded that the applicant used an appropriate atmospheric dispersion model and adequate meteorological data to calculate relative concentration and relative deposition at appropriate distances from postulated release points for evaluation of routine airborne releases of radioactive material. Any COL or CP application referencing this information will need to confirm that the specific release point characteristics (e.g., release height, building height, and cross-sectional area) and the direction and distance to specific locations of receptors of interest (e.g., EAB and the nearest milk cow, goat milk, garden, meat animal, and resident) used to generate the ESP long-term (routine release) atmospheric dispersion site characteristics bound the actual values provided at the COL or CP stage. This is **COL Action Item 2.3-3.**

The staff will include the long-term (routine release) atmospheric dispersion factors listed in Table 2.3.5-2 as site characteristics in any ESP that the NRC might issue for the EGC ESP site.

Table 2.3.5-2 Staff's Proposed Long-Term (Routine Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
Annual Average Undepleted/No Decay χ/Q Value @ EAB	2.04×10^{-6} s/m^3	The maximum annual average EAB undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ EAB	2.04×10^{-6} s/m^3	The maximum annual average EAB undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-Day Decay χ/Q Value @ EAB	1.84×10^{-6} s/m^3	The maximum annual average EAB depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ EAB	1.46×10^{-8} 1/m^2	The maximum annual average EAB D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Milk Cow	1.10×10^{-6} s/m^3	The maximum annual average milk cow undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Milk Cow	1.10×10^{-6} s/m^3	The maximum annual average milk cow undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Milk Cow	9.63×10^{-7} s/m^3	The maximum annual average milk cow depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Milk Cow	6.76×10^{-9} 1/m^2	The maximum annual average milk cow D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Goat Milk	9.90×10^{-8} s/m^3	The maximum annual average goat milk undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Goat Milk	9.72×10^{-8} s/m^3	The maximum annual average goat milk undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Goat Milk	7.28×10^{-8} s/m^3	The maximum annual average goat milk depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual

SITE CHARACTERISTIC	VALUE	DEFINITION
Annual Average D/Q Value @ Nearest Goat Milk	4.21×10^{-10} 1/m²	The maximum annual average meat animal D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Garden	1.10×10^{-6} s/m³	The maximum annual average garden undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Garden	1.10×10^{-6} s/m³	The maximum annual average garden undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Garden	9.63×10^{-7} s/m³	The maximum annual average garden depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Garden	6.76×10^{-9} 1/m²	The maximum annual average garden D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Meat Animal	1.10×10^{-6} s/m³	The maximum annual average meat animal undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Meat Animal	1.10×10^{-6} s/m³	The maximum annual average meat animal undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Meat Animal	9.63×10^{-7} s/m³	The maximum annual average meat animal depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Meat Animal	6.76×10^{-9} 1/m²	The maximum annual average meat animal D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Resident	1.50×10^{-6} s/m³	The maximum annual average resident undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Resident	1.49×10^{-6} s/m³	The maximum annual average resident undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Resident	1.34×10^{-6} s/m³	The maximum annual average resident depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual

SITE CHARACTERISTIC	VALUE	DEFINITION
Annual Average D/Q Value @ Nearest Resident	6.76×10^{-9} 1/m^2	The maximum annual average resident D/Q value for use in determining gaseous pathway doses to the maximally exposed individual

2.3.5.4 Conclusions

As set forth above, the applicant provided meteorological data and an atmospheric dispersion model appropriate for the characteristics of the site and release points. The applicant calculated representative atmospheric transport and diffusion conditions for 16 radial sectors from the site boundary to a distance of 50 miles, as well as for specific receptor locations. The staff reviewed the long-term atmospheric dispersion estimates that the applicant proposed for inclusion as site characteristics in an ESP for the site (if one is issued) and, for the reasons set forth above, finds these estimates to be acceptable. Therefore, the staff concludes that the applicant provided the information necessary to address the requirements of 10 CFR 100.21(c)(1).

Based on these considerations, the staff concludes that the applicant's characterization of long-term atmospheric transport and diffusion conditions is appropriate for use in demonstrating compliance with the numerical guides for doses contained in Appendix I to 10 CFR Part 50.

The applicant provided bounding values for points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations. Any COL or CP applicant will need to confirm that the parameters submitted at the ESP stage bound the actual values provided at the COL or CP stage and that the calculational methodology used for the confirmation is consistent with that employed at the ESP stage.

2.4 Hydrologic Engineering

The Exelon Generation Company (EGC or the applicant) early site permit (ESP) site is located 6 miles (mi) east of Clinton, which is in DeWitt County in central Illinois, and is adjacent to the currently operating Clinton Power Station (CPS) Unit 1. Clinton Lake, an impoundment on Salt Creek, currently serves as the principal water source for the existing unit, which uses a once-through cooling system to dissipate heat from the turbine condenser. Water held behind a submerged dam constructed within the North Fork of Salt Creek in Clinton Lake provides the 30-day shutdown cooling water supply for the CPS Unit 1 ultimate heat sink (UHS). The applicant refers to this water source as the submerged UHS pond.

The ESP facility would also use Clinton Lake as the source of cooling water. The applicant proposed that the ESP facility use closed-cycle cooling with wet, dry, or wet/dry hybrid cooling towers as the plant's normal heat sink (NHS). Clinton Lake would supply makeup water for the ESP facility's NHS. The UHS for the ESP facility would consist of mechanical draft cooling tower(s) with no water storage, if the selected reactor design for the ESP facility requires a UHS. The UHS, if required, would be a safety-related structure and, thus, must be designed, constructed, operated, and maintained as such. The submerged UHS pond would use new intake structures to supply the makeup water required for the UHS for a period of 30 days. The new ESP facility's UHS intake would be an integral part of the UHS and is, therefore, a safety-related structure.

2.4.1 Hydrologic Description

2.4.1.1 Technical Information in the Application

The construction of an earthen dam, 1200 feet (ft) downstream from the confluence of the North Fork of Salt Creek with Salt Creek, formed Clinton Lake (see Figure 2.4-1 of this safety evaluation report (SER)). Clinton Lake has two arms, one on Salt Creek and the other on the North Fork of Salt Creek. These arms extend 14 miles and 8 miles, respectively, upstream from the dam. The top elevation of the dam is 711.8 ft mean sea level (MSL), with a crest width of 22.8 ft. The surface area of the lake is 4895 acres (ac) at the normal level of 690 ft MSL. The ESP site is located about 3.5 miles northeast of the dam between the two arms of Clinton Lake, at a grade elevation of 735 ft MSL.

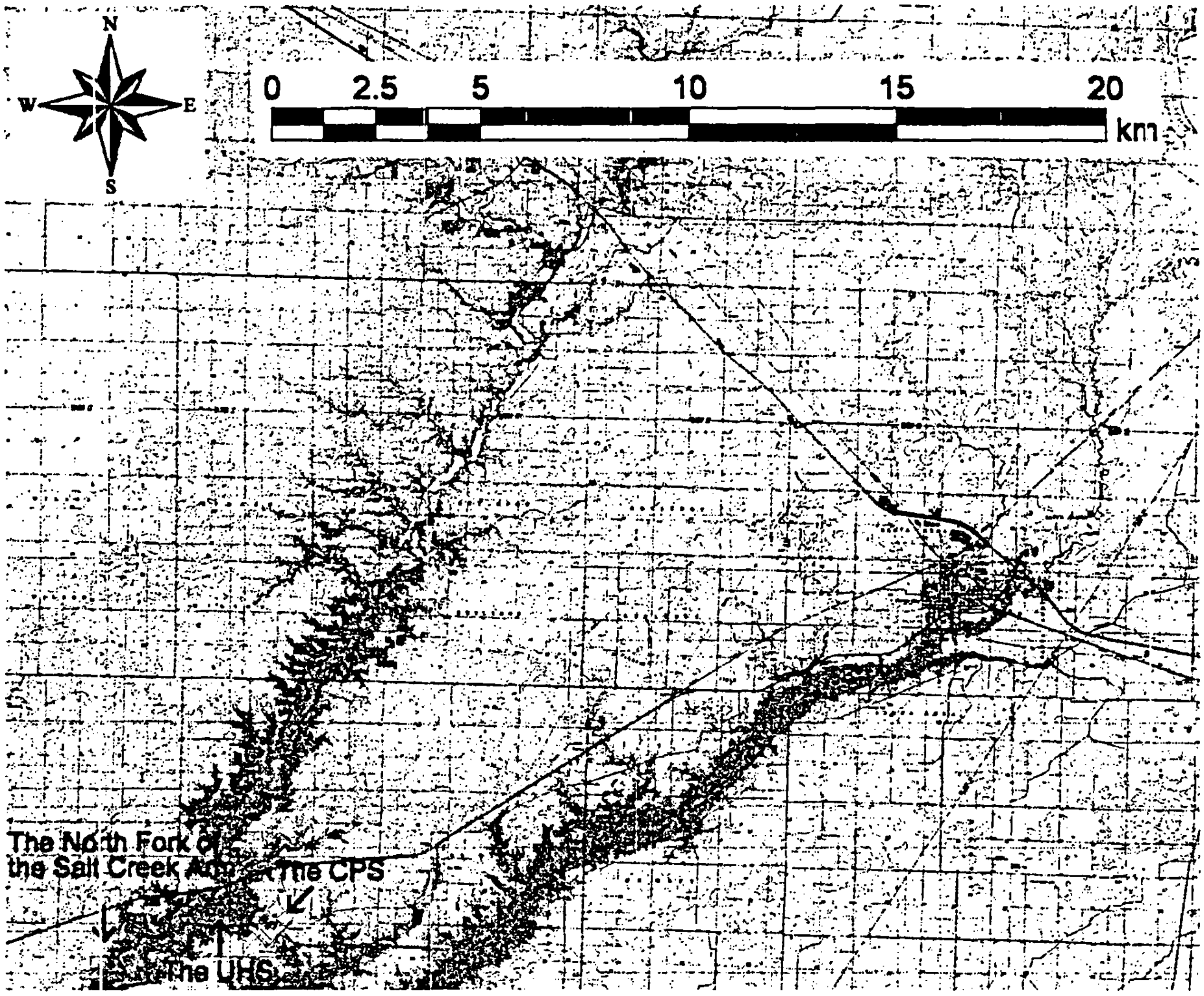


Figure 2.4-1 Clinton Lake

The water intake for CPS Unit 1 is located on the North Fork of Salt Creek. Outflow from CPS Unit 1 is discharged into the Salt Creek arm through a 3.4-mile-long discharge flume. The hot discharge then travels through Clinton Lake to the North Fork of the Salt Creek arm (see Figure 2.4-2 of this SER). Excess heat, which causes the water temperature to rise above the ambient equilibrium temperature, is primarily transferred from the lake's surface to the atmosphere through sensible, long-wave radiation and latent heat flux of evaporation.

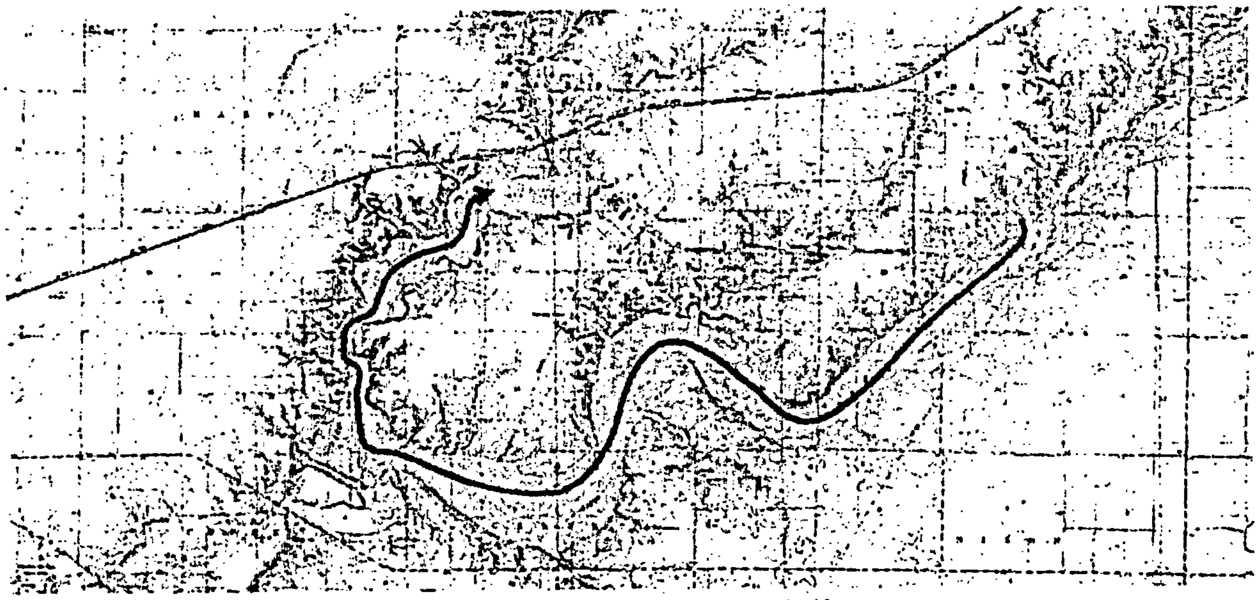


Figure 2.4-2 CPS once-through discharge and subsequent mixing and cooling path

The submerged dam is located approximately 1 mile west of the CPS intake structure. The top of the submerged dam is at elevation 675 ft MSL. A baffle dike divides the submerged UHS pond in approximately equal halves (see Figure 2.4-3 of this SER). The top of the baffle dike is at an elevation of 676 ft MSL. The UHS surface area at the design water surface elevation of 675 ft MSL is 158 ac with a total volume of 1067 acre-feet (ac-ft) or 46.62 million cubic feet (ft^3).

The intake for CPS Unit 1 is located on the submerged UHS pond (see Figure 2.4-3 of this SER). During emergency operation, CPS Unit 1 UHS discharges into the submerged UHS pond downstream (i.e., south) of the baffle, allowing mixing and heat exchange to the atmosphere to occur before the discharge reaches the intake. The ESP facility would have a similar UHS intake structure (see Figure 2.4-3 of this SER). The ESP facility UHS blowdown will be discharged to the discharge flume.

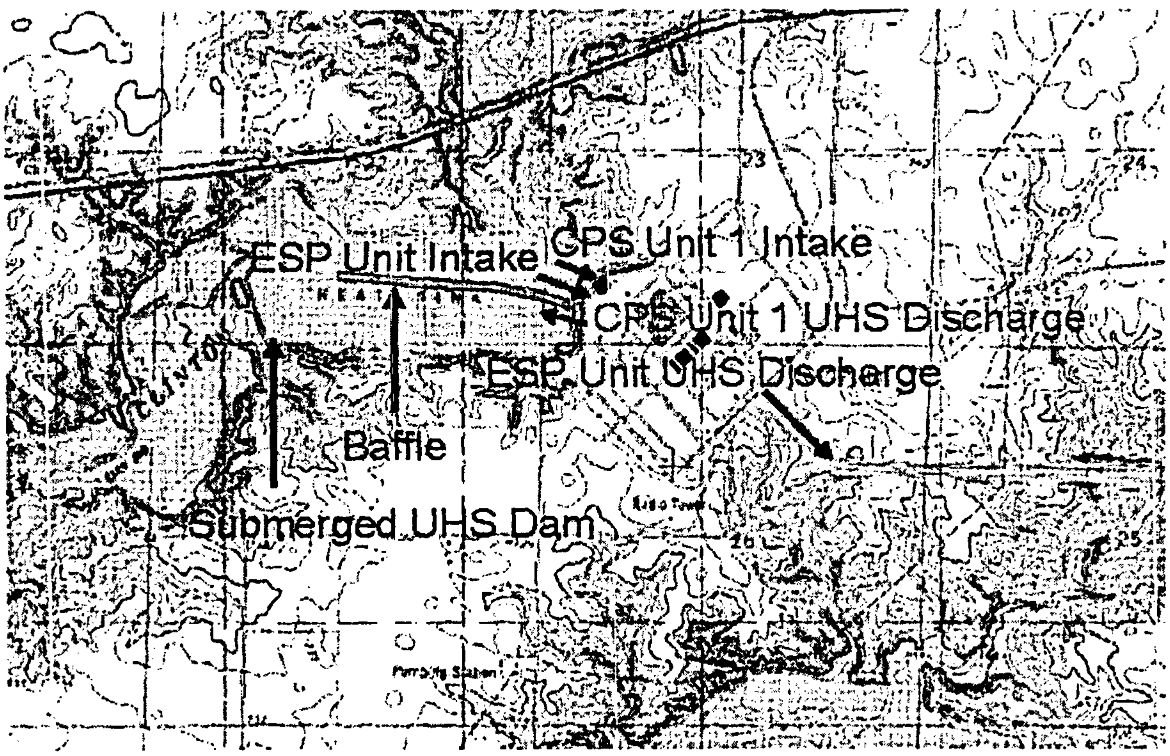


Figure 2.4-3 Proposed locations of ESP facility UHS intake and discharge

In Request for Additional Information (RAI) 2.4.1-1, the staff asked the applicant to provide survey coordinates (including elevations) for the bounding areas of all ESP facility safety-related structures, including intake tunnels and piping corridors. The staff also requested that the applicant provide coordinates of existing aquifers in bounding areas, particularly perched aquifers. In response to RAI 2.4.1-1, the applicant provided an updated figure to replace Figure 1.2-4 in Chapter 1 of the site safety analysis report (SSAR). The applicant stated that this figure shows the approximate location of safety-related structures, along with a grid system overlaid on the figure.

The applicant indicated that the safety-related structures for the ESP facility are the intake structures, the essential service water cooling towers, and some other structures that will be located within the ESP facility powerblock area. The applicant stated that the final sizes and locations of the safety-related structures will be determined after the selection of a reactor during the combined license (COL) application and construction phase and that no survey coordinates are established at the ESP stage.

The applicant stated that the location of the ESP facility's normal and UHS intake structures is approximately 65 ft south of the existing CPS intake structures. The applicant selected this location to route the ESP facility piping without disturbing the CPS shutdown cooling water piping that runs from the CPS UHS. The CPS piping exits to the east of the intake structures. The CPS nonsafety service water discharge and fire protection discharge exit near the north end and then turn northeast. The circulating water discharge piping exits the intake structures south of the service water pipe as a group of three pipes that combine into a single pipe, which then turns northeast to the turbine building. The circulating water piping for the abandoned CPS

Unit 2 is located south of the CPS Unit 1 circulating water piping and follows the latter path. The shutdown service water piping exits the CPS intake structure near its south end, then turns southeast and continues for 250 ft before turning east and then north to the CPS diesel generator and heating, ventilation, and air conditioning building. Two trains of shutdown service water and a fire protection line follow this path. The shutdown service water return lines are located above the supply lines, following the same path as the supply lines to about 175 ft, where the supply lines turn east, then southwest, and finally slope downward to the discharge location in the CPS submerged UHS pond at an elevation of 675 ft MSL.

The applicant stated that the piping for the ESP facility would be routed in a manner similar to the existing CPS piping, with an expected horizontal distance of 50 ft maintained between the two sets of piping. The applicant stated that the ESP facility piping would be located south of the existing CPS piping and would be routed a sufficient distance south before it turned east in order to provide adequate clearance and cover where it passed over the sloping CPS discharge piping to the submerged UHS pond. The applicant stated that the ESP facility piping elevation would be selected to provide a vertical clearance of 3 ft 9 inches (in.) between itself and the existing CPS discharge piping. After crossing the existing CPS discharge piping, the ESP facility piping would continue east to the two cooling towers to provide makeup water. The applicant stated that the location and elevation of the ESP facility piping would not be established until after the pipe diameters were determined based on the selection of the reactor(s) for the ESP facility. The applicant stated that the ESP facility piping would include pipes for the makeup water supply to the NHS tower, the fire protection supply, and two trains of makeup water to the UHS cooling towers for the ESP facility.

The applicant stated that SSAR Section 2.4.13 discusses the regional and local ground water systems. The applicant stated that the ground water beneath the ESP site occurs in upper glacial deposits (Wisconsinan) and in the underlying Illinoian and Kansan tills. The applicant stated that, since these deposits are regional and not limited to any specific area within the ESP site, no specific coordinates delineate the aquifers underlying the ESP site. The applicant provided measured water levels at the ESP site obtained from borings and piezometers recently installed at the ESP site.

In RAI 2.4.1-2, the staff requested that the applicant identify any limits on plant operation resulting from either water supply or intake water temperature for the ESP facility (e.g., the need to derate or shut down the reactors if intake temperature were to exceed a certain threshold). The staff also requested that the applicant estimate the frequency and duration of these operating limits. In response to RAI 2.4.1-2, the applicant stated that limits on plant operation resulting from water level and temperature are usually based on the volume and temperature of water in the UHS. The applicant noted that, since the design of the power station has not yet been finalized and the related safe-shutdown analysis has not yet been performed, it has not identified any operating limits resulting from water level and temperature. The applicant stated that these analyses will be performed as part of the design certification of the power plant or during COL application.

Section 2.4.11.5 of the SSAR stated that a plant shutdown would be initiated if the water surface elevation in Clinton Lake were to fall to an elevation of 677 ft MSL. The applicant stated that this shutdown water surface elevation is not based on any safety analysis or related to the volume of water required in the submerged UHS pond. This water surface elevation is the minimum required for continued supply of normal cooling water for power generation. The applicant stated that this minimum water surface elevation is based on an as yet unfinished design of the ESP facility intake structures. The applicant also noted that the intake structures may be designed to operate with a lower water surface elevation in Clinton Lake. The applicant carried out simulations of water surface elevations in Clinton Lake using 24 years of meteorological records since the construction of Clinton Dam. The applicant found that water surface elevations in Clinton Lake did not fall to an elevation of 677 ft MSL, even with both the CPS Unit 1 and the ESP facility operating at 100-percent power. SSAR Section 2.4.11.3 included the lake drawdown analysis under a 100-year drought, which indicates that the minimum water surface elevation in Clinton Lake would be 681.4 ft MSL, 4.4 ft above the shutdown level of 677 ft MSL.

The applicant stated that thermal modeling for the ESP facility indicates that essentially all excess heat from the facility is dissipated to the atmosphere while the water is circulating back to the plant intake. The applicant also noted that ambient weather conditions directly affect intake temperatures more than plant operations. The water drawn directly from Clinton Lake for the ESP facility would be a small fraction of the total circulating flow through the cooling tower(s) and, thus, would have a minor impact on the temperature of water in the cooling tower basin. The applicant also indicated that the ESP facility would be capable of adding cooling tower makeup water to the inlet side of the cooling towers, thereby cooling the facility to the design temperature. The applicant stated that for these reasons no unit derating or shutdown of the ESP facility would occur because of elevated temperature of the makeup water. The applicant also stated that, since a safety analysis for the safe shutdown of the ESP facility has not yet been carried out, it has not made any assumptions regarding maximum water temperatures.

In RAI 2.4.1-3, the staff requested that the applicant provide references confirming that there are no existing dams, and that none are proposed upstream of Clinton Lake, that might affect the availability of water to the ESP site. In response to RAI 2.4.1-3, the applicant revised SSAR Section 2.4.1.2 to add information regarding current dams upstream and downstream of Clinton Lake to support its statement that these dams could not affect the availability of water at the ESP site.

The applicant stated that, with respect to future dams, a representative of the Illinois Department of Natural Resources (IDNR), Office of Water, Division of Water Resources Management, Dam Safety Section, advised that there are no recent or pending permits for recreational or water supply dams upstream of Clinton Lake.

The applicant revised SSAR Section 2.4.1.2 to state that no reservoirs or dams upstream or downstream from Clinton Lake exist that could affect the availability of water to Clinton Lake. The applicant identified four recreational dams, two on the North Fork of Salt Creek upstream of Clinton Lake and two downstream of Clinton Lake. The applicant also stated that, because these dams were constructed for recreational purposes and have only limited storage capacities, water is not withdrawn from the watershed. The applicant also noted that the portion of Salt Creek downstream from Clinton Lake is not a likely candidate for changes that would result in additional demand, since the flow in the creek is often low for long periods of time.

In RAI 2.4.1-4, the staff requested that the applicant provide information regarding proposed land use changes that might result in increased bed load in the tributaries upstream of Clinton Lake or sediment deposition in the submerged UHS pond. In response to RAI 2.4.1-4, the applicant stated that it had no information regarding proposed land use changes upstream of

Clinton Lake. The applicant further stated that the land upstream of Clinton Lake and the CPS submerged UHS pond is currently used primarily for agriculture. The maximum expected sediment load to the tributaries originates in early spring when soils are exposed and planting has not yet begun. The applicant explained that future development will tend to increase the impervious area within the watershed and decrease the amount of soil erosion and subsequent delivery of sediment to tributaries.

In RAI 2.4.1-5, the staff asked the applicant to provide copies of references for the estimates of runoff and mean lake evaporation expressed as percentages of rainfall in SSAR Table 2.4-2. In response to RAI 2.4.1-5, the applicant included copies of data files for evaporation (1963 to 2002) and rainfall (1910 to 2002) obtained from the Midwest Regional Climate Center.

2.4.1.2 Regulatory Evaluation

Table 1.5-1 of the SSAR shows the applicant's conformance to U.S. Nuclear Regulatory Commission (NRC) regulatory guides (RGs). In RAI 1.5-1, the staff asked the applicant to provide a comprehensive listing of NRC regulations applicable to its ESP SSAR. In its response to this RAI, the applicant indicated that Review Standard (RS)-002, Attachment 2, "Processing Applications for Early Site Permits," identifies the NRC regulations applicable to its ESP SSAR. Section 2.4 of RS-002, Attachment 2, describes the methods of review and the applicable acceptance criteria that the staff uses to develop its findings and conclusions related to the hydrologic aspects of site characterization for an ESP. Although the applicant did not indicate how the individual sections of SSAR Section 2.4 address the hydrology-related site suitability criteria in RS-002, Attachment 2, the staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance, as identified below.

Section 2.4.1 of RS-002, Attachment 2, provides the review guidance used by the staff to evaluate this SSAR section. The SSAR should address Title 10 of the *Code of Federal Regulations*, (10 CFR) Part 52, "Early Site Permits; Standard Design Certification; and Combined Licenses for Nuclear Power Plants," and 10 CFR Part 100, "Reactor Site Criteria," as they relate to identifying and evaluating the hydrologic features of the site. The regulations in 10 CFR 52.17(a) and 10 CFR 100.20(c) require the NRC to take into account the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability for a nuclear power reactor. In addition, 10 CFR 100.20(c) addresses the hydrologic characteristics of a proposed site that may affect the consequences of radioactive material escaping from the facility. Factors important to hydrologic radionuclide transport, described in 10 CFR 100.20(c)(3), should be obtained from onsite measurements. The staff evaluated SSAR Section 2.4.1 in light of these requirements.

To satisfy the hydrologic requirements of 10 CFR Parts 52 and 100, the applicant's SSAR should describe the surface and subsurface hydrologic characteristics of the site and region. The applicant should describe in detail sufficient to assess the acceptability of the site and the potential for those characteristics to influence the design of the structures, systems, and components (SSCs) of a nuclear power plant(s) (or a facility falling within a plant parameter envelope (PPE)) that might be constructed on the proposed site.

Meeting this guidance provides reasonable assurance that the hydrologic characteristics of the site and potential hydrologic phenomena would pose no undue risk to the type of facility (or facility falling within a PPE) proposed for the site. Further, it provides reasonable assurance that such a facility would not pose an undue risk of radioactive contamination to surface or subsurface water from either normal operations or as the result of a reactor accident.

To determine whether the applicant met the requirements of the hydrologic aspects of 10 CFR Parts 52 and 100, the staff used the following specific criteria.

Section 2.4.1 of the SSAR should form the basis for a hydrologic engineering analysis with respect to subsequent sections of the ESP application. Therefore, completeness and clarity are of paramount importance. Maps should be legible and adequate in coverage to substantiate applicable data. Site topographic maps should be of good quality and of sufficient scale to allow independent analysis of preconstruction drainage patterns. The SSAR should provide data on surface water users, their location with respect to the site, type of use, and quantity of surface water used. Inventories of surface water users should be consistent with regional hydrologic inventories reported by applicable Federal and State agencies. The description of the hydrologic characteristics of streams, lakes, and shore regions should correspond to those of the U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), Soil Conservation Service (SCS), U.S. Army Corps of Engineers (USACE), or appropriate State and river basin agencies. The SSAR should describe all existing or proposed reservoirs and dams (both upstream and downstream) that could influence conditions at the site. Applicants may obtain such descriptions from reports of the USGS, U.S. Bureau of Reclamation (USBR), USACE, and others. Generally, reservoir descriptions of a quality similar to those contained in pertinent data sheets of a standard USACE hydrology design memorandum are adequate. The SSAR should provide tabulations of drainage areas, types of structures, appurtenances, ownership, seismic and spillway design criteria, elevation-storage relationships, and short- and long-term storage allocations.

2.4.1.3 Technical Evaluation

On May 11, 2004, the staff conducted a site visit in accordance with the guidance provided in Section 2.4.1 of RS-002, Attachment 2. The staff used information from the site visit, digital maps, and streamflow data from the USGS and independently verified the hydrologic description provided in SSAR Section 2.4.1. The applicant provided information, including maps, charts, and data from Federal, State, and regulatory bodies, describing the hydrologic characteristics and water use in the vicinity of the ESP site.

The staff verified the surface area of Clinton Lake using the USACE major dams map layer. This map layer dataset lists the surface area of Clinton Lake as 4895 ac.

In SSAR Section 2.4.1.2, the applicant stated that the catchment area of Salt Creek above Clinton Dam is about 296 square miles (mi^2). The staff manually delineated the watershed draining into Clinton Lake using USGS topographic maps (Figure 2.4-4 of this SER). The staff determined the area of the manually delineated watershed as 289.2 mi^2. The staff estimated the catchment area of Salt Creek above Clinton Dam to be approximately 2.4 percent less than that reported by the applicant.

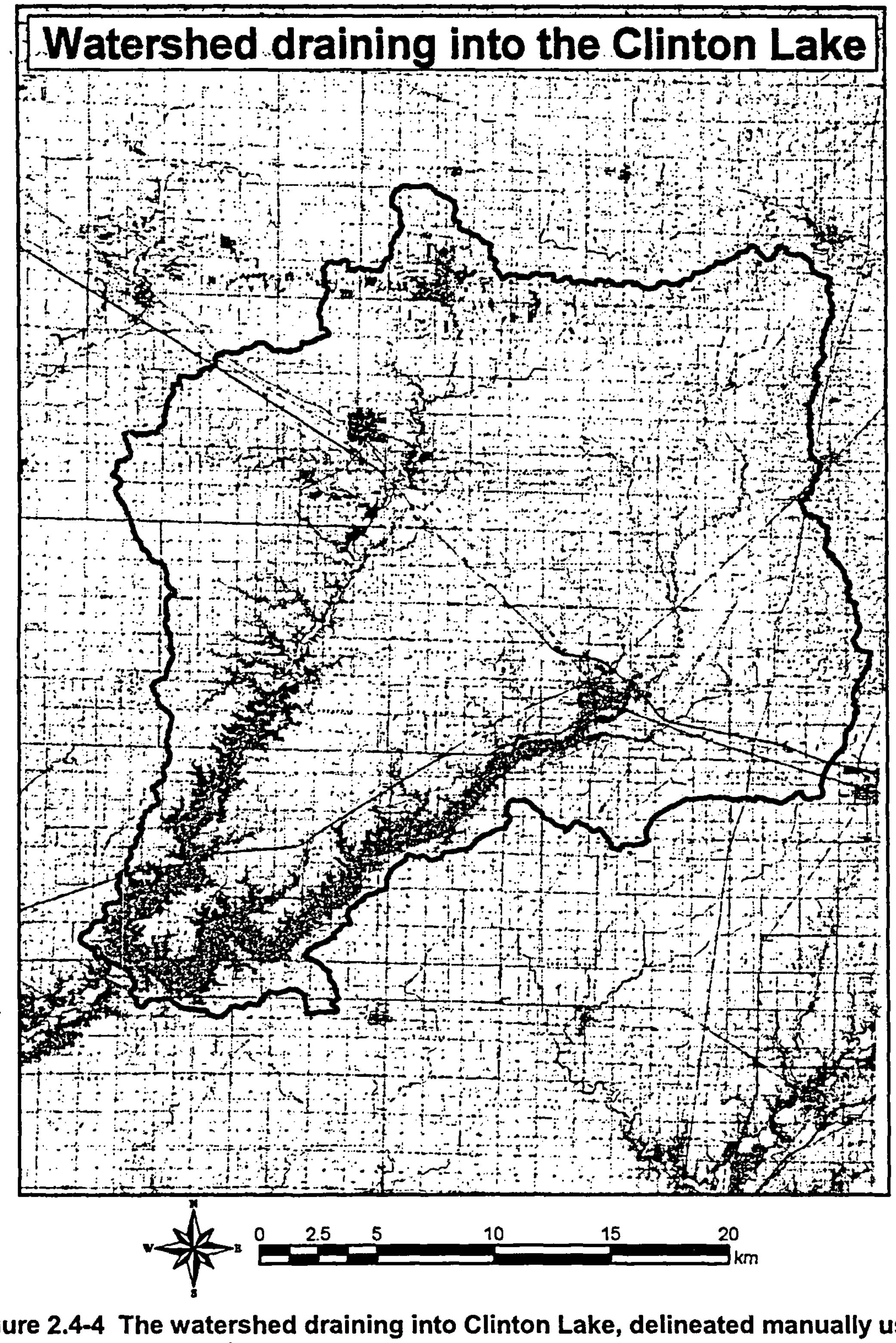


Figure 2.4-4 The watershed draining into Clinton Lake, delineated manually using topographic contours

The staff determined that the USGS has two streamflow gauges downstream of Clinton Dam and that no gauges are located upstream of the dam. The longest streamflow record exists at Salt Creek near USGS Gauge 05578500 near Rowell, Illinois, approximately 12 miles downstream from the dam. The streamflow measured at this gauge includes the release from Clinton Lake, as well as runoff from an additional 46-mi^2 watershed downstream of Clinton Dam. The streamflow record at this gauge extends back to October 1942. Another streamflow gauge, USGS gauge 00579000 at Salt Creek near Kenney, Illinois, located approximately 18.6 miles downstream from the dam, was recorded from April 1908 through September 1912.

The staff determined that the upstream tributary inflow data are too limited to allow estimation of low-water conditions and historical flood frequency at the ESP site. Consequently, the staff used an empirical approach to estimate these parameters, as more fully discussed in Sections 2.4.2 and 2.4.11 of this SER.

In RAI 2.4.1-1, the staff requested that the applicant provide additional information on survey coordinates (including elevations) for the bounding areas of all ESP facility safety-related structures, including intake tunnels and piping corridors. The staff requested that the applicant provide a layout of the intake tunnel and piping corridor from the lake to the ESP facility to determine the extent to which the COL applicant should address the layout as an interface item. The staff also asked for the locations of existing aquifers in the bounding areas, particularly perched aquifers. Although the applicant provided adequate information regarding the areal coordinates of the ESP site, it provided no information on the elevations required to define the bounding volume of the disturbed subsurface material. Therefore, the staff determined that the applicant needed to define the extent of the vertical disturbance and the bounding elevations of all SSCs. Additionally, the staff determined that SSAR Figure 1.2-4 did not identify either the elevations or the areal locations of the safety-related piping corridors. Since the intake pumps for the ESP facility UHS makeup water are safety-related structures, the staff determined that the applicant needed to state whether it covers these through the site grade specified in the PPE or proposes separate criteria for these structures. This was **Open Item 2.4-1** of the draft safety evaluation report (DSER).

In response to DSER Open Item 2.4-1, dated April 26, 2005, the applicant stated that the bounding foundation embedment is 140 ft below grade. The applicant also stated that the specific vertical disturbance and elevations of each SSC depend on the chosen reactor design and therefore have not yet been determined. The applicant explained that at 140 ft below grade, the foundation basemat will rest in Illinoian glacial till, which is considered very good foundation material. The applicant stated that any excavation below 140 ft from site grade will not be significant and will only be required for purposes such as leveling.

The applicant stated that the bounding elevation for structures within the powerblock is 234 ft above grade, and the tallest structure for the ESP facility would be a natural draft cooling tower with a bounding elevation of 550 ft above grade, if such a tower were to be included in the reactor design selected for the ESP site.

The applicant stated that the UHS piping has also not been designed at the ESP stage because its need is dependent on whether the reactor design chosen for the facility requires a UHS. The applicant stated that its response to RAI 2.4.1-1 provides a general description of the location of UHS piping, which will be installed between the minimum elevation of the CPS shutdown service piping (635 ft MSL) and the plant grade (735 ft MSL). The applicant explained that the separation between the existing CPS piping and the ESP facility piping will be determined by the COL applicant and CPS management.

The applicant stated that if a UHS were to be required by the selected ESP facility reactor design, a UHS makeup water structure would also be required and would be built at the edge of Clinton Lake, approximately 65 ft south of the existing CPS intake facility structure. Therefore, the site grade of 735 ft MSL is not pertinent for the ESP facility's UHS makeup water intake structure. The applicant stated that it expects the bottom of the ESP facility UHS makeup water intake structure to be located at an elevation of 657.5 ft MSL. The final elevation of the basemat will also depend on the submergence requirement of selected intake pumps and the elevation of the inlet, which is between 670 ft MSL and 697 ft MSL. The applicant stated that the ESP facility UHS makeup water intake structure will be subject to probable maximum flood (PMF) in Clinton Lake's watershed and will be designed to protect safety-related equipment located within it.

Based on the applicant's response to DSER Open Item 2.4-1, the staff determined that the applicant provided sufficient details regarding the vertical extent of the disturbance and the bounding elevations of all SSCs that may be required and constructed for the ESP facility. The applicant does not have a specific reactor design at the ESP stage. Therefore, further details regarding safety-related piping for the ESP facility are not available. The staff will evaluate the safety of the ESP facility piping corridors during the COL stage, in accordance with applicable NRC regulations and regulatory guidance. The UHS makeup water intake structure, if the selected ESP facility reactor design were to require one, would be designed to protect it from PMF in the Clinton Lake watershed. The staff will also evaluate the safety of the ESP facility UHS makeup water intake structure during the COL stage, in accordance with applicable NRC regulations and regulatory guidance. Based on this review, the staff has determined that the COL or construction permit (CP) applicant needs to ensure that the ESP facility intake piping is installed with adequate clearance from the CPS facility piping. This is **COL Action Item 2.4-1.** On the basis of COL Action Item 2.4-1, the staff considers Open Item 2.4-1 to be resolved.

In response to RAI 2.4.1-1, the applicant stated that it expects the horizontal clearance between the existing CPS piping and the new ESP facility piping to be 50 ft. The staff determined that this proposed horizontal clearance is acceptable. The staff had planned to include this proposed horizontal clearance of 50 ft as DSER Permit Condition 2.4-1. The staff had also planned to include a minimum vertical clearance equal to the larger of 6.6 ft or three times the diameter of the pipes as DSER Permit Condition 2.4-2. However, based on a review of the applicant's response to DSER Open Item 2.4-1 above, the staff determined that DSER Permit Conditions 2.4-1 and 2.4-2 are not necessary because COL Action Item 2.4-1 is sufficient to ensure that the ESP facility intake piping will be installed with adequate clearance from the CPS facility piping.

In RAI 2.4.1-2, the staff asked the applicant to identify any limits on plant operation for the ESP facility resulting from either water supply or intake water temperature. The staff requested that the applicant indicate the total service flow rate needed for the existing unit with once-through cooling systems and the integrated cooling flow demand for all units to determine whether sufficient margin exists in the available water flow from the lake, accounting for any uncertainties associated with water and land use changes in the vicinity of the plant. It might become necessary to derate or shut down the reactors if the intake temperature were to exceed a certain threshold. The staff also requested the applicant to estimate the frequency and duration of these operating limits. The staff determined that the applicant's description of the ESP facility UHS system was insufficient. Therefore, the staff requested that the applicant provide a schematic representation of the complete ESP facility UHS system, including the intake, piping, any potential storage basins, the UHS cooling loop, and the cooling tower(s), clearly showing all components and water flow, including discharges through these components.

In response to the RAI, the applicant stated that the ESP facility UHS system will have the capability to add makeup water to the inlet side of the cooling tower(s). It was not clear to the staff whether the PPE makeup flow rate, an average of 1.24 cubic feet per second (cfs) or 555 gallons per minute (gpm) and a maximum of 3.11 cfs or 1400 gpm, at the maximum inlet temperature of 95 °F, would be sufficient to remove all waste heat from the UHS cooling tower(s). Therefore, the staff determined that the applicant needed to provide a schematic representation of the complete UHS system for any future facility on the ESP site, including the intake, piping, any potential storage basins, the UHS cooling loop, and the cooling tower(s), clearly showing all components and water flow, including discharges through these components. In addition, the staff determined that the applicant needed to demonstrate that the PPE makeup flow rate, an average of 555 gpm and a maximum of 1400 gpm, at the maximum inlet temperature of 95 °F, would be sufficient to remove all waste heat from the UHS cooling tower(s). In addition, the applicant needed to demonstrate that there would be no limits on plant operation caused by limited water supply or elevated water temperatures at the UHS intake for any facility constructed on the ESP site. This was DSER Open Item 2.4-2.

In response to DSER Open Item 2.4-2, in its submission to the NRC dated April 26, 2005, the applicant stated that SSAR Figure 3.2-1 shows a schematic representation of the complete UHS system, if one were to be required for the ESP facility, with its major components and the direction of water flow in the system, with the exception of the blowdown. The applicant stated that the design of the UHS depends on the reactor design yet to be chosen for the ESP facility, and the purpose of the conceptual design provided in the SSAR is to provide a bounding value for possible UHS makeup water needs. The applicant stated that each mechanical draft cooling tower that is part of a UHS will have a basin to provide makeup water to the emergency service water (ESW) pumps. The depth of the basin will depend on the requirements of the selected ESW pumps. The applicant stated that the normal ESW flow is 26,125 gpm, with a maximum of 52,250 gpm. The normal blowdown from the cooling tower will be 144 gpm, with a maximum of 700 gpm. The applicant stated that the total normal makeup flow including the blowdown is 555 gpm, with a maximum of 1400 gpm.

The applicant explained that the reactor suppliers provide makeup flow and evaporation rates from the cooling tower. The PPE table (SSAR Table 1.4-1) provides the bounding values. Blowdown is used to correct the concentration of impurities in the water. The applicant stated that the CPS UHS maximum temperature is 95 °F. Therefore, makeup to the ESP facility UHS cooling tower will not exceed the required UHS cold water temperature. The applicant stated that the capability of the flow rate to remove all waste heat is a design issue and will be reviewed at the COL stage. The applicant revised SSAR Sections 2.4.11.5 and 2.4.11.6 to address issues raised by DSER Open Item 2.4-2.

Based on the applicant's response to DSER Open Item 2.4-2, the staff determined that the detailed design of the ESP facility's UHS system is not yet completed because it depends on the type of reactor selected for the ESP facility. Therefore, issues raised in DSER Open

Item 2.4-2 cannot be addressed until the COL stage when a detailed design of the UHS system is performed, if the selected reactor design type requires one. The staff will review the design of the ESP facility's UHS, if one were to be required by the selected reactor type, including its capacity to remove all waste heat under the most critical scenario in accordance with applicable NRC regulations and regulatory guidance at the COL stage. The staff determined that PPE values of makeup flow rate (555 gpm; item 3.3.9 in Table 1.4-1 of the SSAR) and maximum inlet temperature to the CCW heat exchanger (95 °F; item 3.2.1 in Table 1.4-1 of the SSAR), along with the site characteristic values provided in Table 2.3.1-6 of this SER, relate to maximum air temperature and maximum humidity and are important parameters that should be used in the design of the UHS cooling towers, if the selected reactor type for the ESP facility were to require a UHS. This is **COL Action Item 2.4-2.** On the basis of COL Action Item 2.4-2, the staff considers DSER Open Item 2.4-2 resolved.

In RAI 2.4.1-3, the staff requested that the applicant provide references confirming that no dams exist and that none are proposed upstream of Clinton Lake that might affect the availability of water for the ESP site. In response to RAI 2.4.1-3, the applicant stated that it will revise its application to mention the existence of four recreational dams, two on the North Fork of Salt Creek upstream of Clinton Lake and two downstream of Clinton Lake. The applicant provided information related to the construction date, dam height, and reservoir storage capacities of these dams. The applicant also stated that, because of the limited storage capacities of these reservoirs, water is not withdrawn from the watershed. The staff disagrees with the applicant in this assessment. Based on information provided by the applicant, the volumes of impoundments upstream of the Clinton lake are small enough to be negligible. Runoff from the Clinton Lake watershed feeds the reservoirs behind these dams and provides the water stored in these reservoirs.

However, the staff determined that the two reservoirs upstream of Clinton Lake have a maximum combined storage capacity of 194.1 million ft^3 or 4446 ac-ft. This volume is small compared to the volume of Clinton Lake (at a normal water surface elevation of 690 ft MSL, Clinton Lake has a volume of 74,200 ac-ft), and the effect of a flood wave resulting from a breach of these two dams coincident with a PMF event in the Clinton Lake watershed is not significant. Section 2.4.4 of this SER presents an analysis and evaluation of the effects of a failure of the two upstream dams. Based on this evaluation, the staff determined that the applicant's response to RAI 2.4.1-3 is satisfactory.

In RAI 2.4.1-4, the staff requested that the applicant provide information regarding proposed land use changes in the watershed upstream of Clinton Lake. These changes might result in increased bed load in the tributaries upstream of Clinton Lake and increased sediment deposition in the submerged UHS pond. In response to RAI 2.4.1-4, the applicant stated that it did not have any information regarding proposed land use changes upstream of Clinton Lake. The staff determined that, for a site suitability evaluation, the applicant needed to provide an authoritative source that could include State or county planning officials who can either provide details of a development plan in the Clinton Lake watershed or verify the absence of such a plan. This was DSER Open Item 2.4-3.

In response to DSER Open Item 2.4-3, the applicant stated, in its submission to the NRC dated April 4, 2005, that it contacted the DeWitt County Planning and Zoning Office to obtain information regarding development plans in the Clinton Lake watershed. The applicant stated that the administrator of the DeWitt County Planning and Zoning Office referred to a

Comprehensive Land Use Plan dated 1992 that is out of date and out of print. The administrator also indicated that no current plans exist to update this land use plan. According to the administrator, the county experienced a 7-percent decline in population from 1980 to 2000. Over the latter half of this period, though, there was a 1.2-percent increase in population. The administrator also provided the applicant with information related to a 40-ac residential development in Farmer City, with a 20-year plan for additional development of up to 217 ac. The applicant also contacted the acting administrator of Farmer City and confirmed the existence of an ongoing 40-ac development and another planning concept for a 200-ac commercial-industrial development project north of Farmer City.

Based on the applicant's response to DSER Open Item 2.4-3, the staff determined that the applicant provided sufficient information from authoritative sources to resolve its concerns expressed in DSER Open Item 2.4-3. Therefore, the staff considers DSER Open Item 2.4-3 resolved.

In response to RAI 2.4.1-4, the applicant also stated that increased impervious area within the Clinton Lake watershed associated with future development will reduce soil erosion and sediment discharge to tributaries. The staff disagreed with the applicant in this assessment. An increase in impervious area is likely to increase the volume of surface runoff, as well as decrease the time required to reach peak runoff in the watershed. Because of quicker and greater runoff, it is more likely that soil erosion will increase, not decrease. Should the resulting increase in soil erosion decrease the volume of stored water in the submerged UHS pond, the staff would have to examine the adequacy of the submerged UHS pond capacity. Therefore, the staff determined that the applicant needed to provide additional justification for its conclusion that an increase in impervious area will not increase soil erosion. This was DSER Open Item 2.4-4.

In response to DSER Open Item 2.4-4, the applicant stated, in its submission to the NRC dated April 4, 2005, that sediment delivery rates from agricultural land are extremely variable and tend to be high in areas with fine-grained soil on sloping land, which are exposed to the direct impact of precipitation. The applicant stated that sediment delivery from urban land is also variable. Sources of sediment in urban lands may be fewer because of land cover, but urban drainage systems may be more efficient at delivering sediment to natural drainages (streams). The applicant stated that sediment delivery rates from both agricultural, as well as urban lands, depend on erosion control practices.

The applicant stated that stream bank erosion increases with a rise in peak flow rates and volumes. Since both agricultural and urbanization changes may increase runoff volume over native conditions, the applicant concluded that there may be some increase in sediment production. In its conversation with the applicant, the DeWitt County Administrator for Planning and Zoning indicated that new urban development incorporates storm water best management practices, including storm water detention, vegetated buffers, and construction erosion control. The applicant concluded that it is difficult to definitively establish whether an increase in urban land use will lead to an increase or decrease in soil erosion. The applicant stated that in either case, the impact would be small because the long-term potential development in the watershed amounts to less than 0.5 percent of the watershed area.

The staff reviewed the additional information provided by the applicant in its response to Open Item 2.4-4 and concluded that, based on the authoritative information included in the applicant's response, new development in the watershed for the foreseeable future is approximately 250 ac, or about 0.14 percent of the area of the Clinton Lake watershed (289.2 mi^2 or 185,092 ac). In addition, the staff concluded that since new development projects use storm water best management practices, the likely increase in sediment delivery to natural drainages in the watershed is small because of the relatively small size of the areas affected by development as compared to the overall size of the watershed. Therefore, the staff considers DSER Open Item 2.4-4 resolved.

In RAI 2.4.1-5, the staff requested that the applicant provide copies of references for the estimates of runoff and mean lake evaporation expressed as percentages of rainfall in SSAR Table 2.4-2. In response to RAI 2.4.1-5, the applicant provided evaporation and rainfall data obtained from the Midwest Regional Climate Center. The staff determined that the applicant's response is satisfactory.

2.4.1.4 Conclusions

As discussed above, the applicant provided sufficient information pertaining to the identification and evaluation of the general hydrologic characteristics of the site, including descriptions of rivers, streams, lakes, water-control structures, and users of these waters. SSAR Section 2.4.1 conforms to Section 2.4.1 of RS-002, Attachment 2, with regard to this objective.

The review guidance in Section 2.4.1 of RS-002, Attachment 2, provides that the SSAR should address the requirements of 10 CFR Part 52 and 10 CFR Part 100 as they relate to identifying and evaluating the hydrologic features of the site. Although the applicant did not specifically address the above regulations in SSAR Section 2.4.1, the staff concludes that, by conforming to Section 2.4.1 of RS-002, Attachment 2, the applicant has met the requirements for general hydrologic descriptions with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c).

2.4.2 Floods

Clinton Lake was created to provide a reliable supply of cooling water for CPS. The watershed that drains into Clinton Lake has an area of approximately 289.2 mi^2. Clinton Dam is located about 1200 ft downstream from the confluence of the North Fork of Salt Creek with Salt Creek. Clinton Lake has two arms. These arms extend approximately 14 miles on the North Fork of Salt Creek and approximately 8 miles on Salt Creek, respectively.

2.4.2.1 Technical Information in the Application

SSAR Section 2.4.1.1 states that Clinton Lake significantly attenuates floodflow downstream from the dam and that no flows exceeding 10,000 cfs have been recorded at the Rowell streamflow gauge since the construction of the dam.

The applicant analyzed 22 years of flood data (January 1978 to September 2000) recorded at the Rowell gauge. SSAR Figure 2.4-5 shows the applicant-estimated peak flood frequency curve, and SSAR Table 2.4-4 presents peak flows at the gauge and Clinton Dam for various recurrence intervals. The applicant estimated peak flows at Clinton Dam by prorating peak flows at the gauge using the ratio of drainage area at the dam to that at the gauge. In SSAR Section 2.4.1.2, EGC stated that the catchment area of Salt Creek above Clinton Dam is 296 mi^2, and the drainage area at the Rowell gauge is 335 mi^2. The applicant estimated a mean annual flood of 3600 cfs at the gauge, corresponding to a recurrence interval of 2.33 years. The applicant also estimated that the maximum discharge of 7810 cfs recorded on April 13, 1994, had a recurrence interval of 25 years. The applicant further stated that, because of the presence of Clinton Dam, the 10-year recurrence interval floodflow at the Rowell gauge is reduced from 11,400 cfs to 6,200 cfs, and the 100-year recurrence interval floodflow is reduced from 29,900 cfs to 10,400 cfs.

In SSAR Section 2.4.2.2, the applicant stated that the hydraulic design of the dam and the lake is based on a PMF with a standard project flood (SPF) as its antecedent condition. The applicant used an SPF equal to 50 percent of the PMF. The SPF occurred 3 days before the PMF. This flood sequence was routed through Clinton Lake using the USACE Spillway Rating and Flood Routing (SPRAT) computer program. The applicant estimated the PMF water surface elevation in the lake to be 708.8 ft MSL. The applicant provided a freeboard of 3 ft to determine a top elevation of Clinton Dam of 711.8 ft MSL.

SSAR Section 2.4.2 states that the applicant obtained the probable maximum precipitation (PMP) using Hydrometeorological Report (HMR) 33, "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24, and 48 Hours," issued 1956. The current standards, however, are American National Standards Institute (ANSI)/American Nuclear Society (ANS)-2.8-1992, "American National Standard for Determining Design Basis Flooding at Power Reactor Sites," issued July 1992; HMR 51, "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," issued June 1978; and HMR 52, "Application of Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," issued August 1982. In RAI 2.4.2-1, the staff requested that the applicant explain why it did not use the current standards. The staff also requested that the applicant explain why an estimate based on HMR 33 is conservative relative to an estimate based on HMRs 51 and 52. In response to RAI 2.4.2-1, the applicant stated that it took the 48-hour PMP directly from the CPS updated safety analysis report (USAR). The applicant further stated that it originally obtained or derived the PMP information in the CPS USAR from HMR 33. The applicant conceded that more recent procedures than those provided in HMR 33 are available for determining the PMP. The applicant stated that it updated the PMP information in the SSAR using four reports directly relating to estimating the PMP at a given location. The applicant provided brief descriptions of HMRs 33, 51, 52, and 53, "Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates," issued April 1980.

The applicant stated that the 48-hour, all-season PMP based on HMR 33, and estimated for the 296 mi^2, drainage area is 25.2 in. The corresponding 24-hour, all-season PMP, also obtained from HMR 33, is 22.6 in. The applicant used the procedure outlined in HMR 33 to estimate the 24- and 48-hour all-season PMP for a drainage area of 200 mi^2 and then adjusted it by a scaling factor of 0.94 for the Clinton Lake drainage area of 296 mi^2.

The applicant obtained 24- and 48-hour all-season PMP values for a drainage area of 200 mi^2 from HMR 51. It reported the all-season PMP values corresponding to these two durations as 25 in. and 28 in., respectively. The applicant then applied the same scaling factor recommended by HMR 33 to the PMP values derived from HMR 51 and reported these area-adjusted values as 23.5 in. for the 24-hour all-season PMP and 26.3 in. for the 48-hour PMP.

In RAI 2.4.2-2, the staff requested that the applicant describe likely changes to both upstream land use and downstream water demand that could alter either the intensity or frequency of flood and low-flow conditions. In response to RAI 2.4.2-2, the applicant stated that a shift in upstream land use to a more impervious watershed would tend to generate more runoff from the same amount of precipitation and decrease the duration of low flows because more water would be available to the lake. The applicant stated that no change in the 100-year flood level is expected because of the lake's large flow attenuation capacity. The applicant also stated that water demand in Salt Creek is not likely to increase since the flow in the creek is low for long periods of time.

In RAI 2.4.2-3, the staff requested that the applicant document any historical hillslope failures in the watershed. The staff also requested the applicant analyze the ability of a hypothetical hillslope failure to impact the ESP facility. Hillslope failure could result in a water wave that might run up the bank near the ESP site and potentially affect its safety. The staff requested that the applicant estimate the maximum terminal height of such a hypothetical wave. In response to RAI 2.4.2-3, the applicant stated that, as discussed in Appendix A to SSAR Section 5.1.3.5, no landslides are documented for DeWitt County. The applicant also noted that, according to the Illinois State Geological Survey map of classified known landslides in Illinois, landslide potential at the ESP site is low and hillslopes near the ESP site on Clinton Lake have been very stable for the past 30 years. If a landslide were to occur on these slopes, the applicant estimated that such a hypothetical hillslope failure would generate a maximum wave height of 0.4 ft.

In RAI 2.4.2-4, the staff requested that the applicant document any seismically induced seiches in Clinton Lake. In response to RAI 2.4.2-4, the applicant stated that it performed a literature search to determine whether any seismically induced seiches had occurred in Clinton Lake or other lakes in the area. The applicant found that the occurrence of seiches and other seismic activity is extremely rare in the noncoastal Midwest, and it did not identify any seismically induced seiches in Clinton Lake. The applicant also stated that CPS personnel did not report any seiches in Clinton Lake during the 4.5-magnitude earthquake in June 2004.

In RAI 2.4.2-5, the staff requested that the applicant demonstrate that drainage capacity at the existing grade is sufficient to accommodate local intense precipitation. If the capacity is not sufficient, the staff asked the applicant to describe any active safety-related drainage systems that it would install for the ESP facility. In response to RAI 2.4.2-5, the applicant stated that the proposed plant site drains to the southeast, and there are no significant internally drained areas that might result in accumulation of stormwater during local intense precipitation. The applicant stated that the proposed ESP buildings and site drainage components would also direct drainage in the southeast direction. The applicant would design the ESP facility so that local intense precipitation would not inundate any building or critical plant facility. The applicant stated that the ESP facility design might incorporate drainage features such as raised building entrance points, surface drains, subsurface drainage pipes, and surface drainage channels to Clinton Lake.

The applicant has not designed site drainage at the ESP facility because portions of this system will depend upon the reactor(s) design selected for the ESP facility. The nominal grade elevation of 735 ft MSL provides more than 20 ft of elevation difference for drainage between the site grade and maximum flood water elevation in Clinton Lake. The applicant stated that this elevation difference is large enough to allow the design of a drainage system to handle maximum site precipitation without requiring any active components.

In Revision 4 of the SSAR, the applicant revised the maximum rainfall rate site characteristic to reflect information contained in HMR 52. The revised maximum rate for the 1-hr PMP is 18.15 in. and for the 5-minute PMP is 6.08 in. The applicant stated that these local PMP values will be used to mitigate impacts of local site flooding based on grading and drainage design at the COL stage.

The applicant stated in Revision 4 of SSAR Section 2.4.2.2 that the maximum water surface elevation (excluding the effects of coincident wind, storm surge, and seiche activity) that could be expected for Clinton Lake is 709.8 ft MSL. This elevation is based on flood calculations using a cumulative PMP depth of 27.8 in. The postulated PMP was preceded by a standard project storm (SPS) equal to 40 percent of the PMP depth. Methods for computing the maximum water elevation are discussed more fully in Section 2.4.3 of this SER and references to previous application of the USACE SPRAT computer program have been removed. The applicant stated that all safety related structures at the ESP facility will either be above the maximum combined effects Clinton Lake water surface elevation (716.5 ft MSL) or be designed to withstand the effects of inundation.

2.4.2.2 Regulatory Evaluation

SSAR Table 1.5-1 describes the applicant's conformance to the NRC RGs. In RAI 1.5-1, the staff requested that the applicant provide a comprehensive listing of the NRC regulations applicable to its ESP SSAR. In its response to this RAI, the applicant indicated that RS-002, Attachment 2, identifies the applicable NRC regulations. Section 2.4 of RS-002, Attachment 2, describes the methods of review and the applicable acceptance criteria that the staff uses to develop its findings and conclusions related to the hydrologic aspects of site characterization for an ESP. Although the applicant did not indicate how the individual sections of SSAR Section 2.4 address the hydrology-related site suitability criteria in RS-002, Attachment 2, the staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance, as identified below.

Section 2.4.2 of RS-002, Attachment 2, provides the review guidance used by the staff in evaluating this SSAR section. The acceptance criteria address 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the hydrologic features of the site. The regulations at 10 CFR 52.17(a) and 10 CFR 100.20(c) require the NRC to take into account the site's physical characteristics (including seismology, meteorology, geology, and hydrology) when determining its acceptability to host a nuclear reactor(s).

To satisfy the hydrologic requirements of 10 CFR Parts 52 and 100, the applicant's safety assessment should describe the surface and subsurface hydrologic characteristics of the site and region and contain an analysis of the PMF. The applicant should describe in detail sufficient to assess the acceptability of the site and to assess the potential for those characteristics to influence the design of plant SSCs important to safety. Meeting this requirement provides reasonable assurance that the hydrologic characteristics of the site and potential hydrologic phenomena would pose no undue risk to the type of facility proposed for the site.

In those cases for which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility(s) for comparison with the hydrologic characteristics of the site. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting the limiting parameters from among the group. Important PPE parameters for safety assessment include, but are not limited to, precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami and maximum allowable ground water level).

To determine whether the applicant met the requirements related to the hydrologic aspects of 10 CFR Parts 52 and 100, the staff used the following specific criteria in RS-002, Attachment 2:

- For SSAR Section 2.4.2.1, the potential flood sources and flood response characteristics of the region and site identified by the staff's review (described in the review procedures) are compared to those of the applicant. If similar, the applicant's conclusions are accepted. If, in the staff's opinion, significant discrepancies exist, the staff will request that the applicant provide additional data, reestimate the effects on a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site, or revise the applicable flood design bases, as appropriate.

- For SSAR Section 2.4.2.2, the applicant's estimate of controlling flood levels is acceptable if it is no more than 5 percent less conservative than the staff's independently determined (or verified) estimate. If the applicant's safety assessment estimate is more than 5 percent less conservative, the applicant should fully document and justify its estimate of the controlling level, or the applicant may accept the staff's estimate.

- For SSAR Section 2.4.2.3, the applicant's estimates of local PMP and the capacity of site drainage facilities (including drainage from the roofs of buildings and site ponding) are acceptable if the estimates are no more than 5 percent less conservative than the corresponding staff's assessment. Similarly, the applicant should base its conclusions upon conservative assumptions of storm and vegetation conditions likely to exist during storm periods when relating to the potential for any adverse effects of blockage of site drainage facilities by debris, ice, or snow. If a potential hazard does exist (e.g., the elevation of ponding exceeds the elevation of plant access openings), the applicant should document and justify the local PMP basis.

The staff uses appropriate sections of the following documents to determine the acceptability of the applicant's data and analyses in meeting the requirements of 10 CFR Parts 52 and 100. RG 1.59, Revision 2, "Design Basis Floods for Nuclear Power Plants," issued August 1977, provides guidance for estimating the design-basis flooding considering the worst single phenomenon and combinations of less severe phenomena. The staff uses publications by USGS, NOAA, SCS, USACE, applicable State and river basin authorities, and other similar agencies to verify the applicant's data relating to hydrologic characteristics and extreme events in the region. Sections 2.4.3 through 2.4.7 of RS-002, Attachment 2, discuss methods of analysis to determine the individual flood-producing phenomena.

2.4.2.3 Technical Evaluation

The staff obtained historical flows from USGS streamflow records for the Rowell gauge. The streamflow record at this gauge extends back to May 1908. The maximum observed peak discharge at Rowell before the construction of Clinton Dam was 24,500 cfs, recorded on May 16, 1968. The maximum observed peak discharge at Rowell after the construction of Clinton Dam was 7810 cfs, recorded on April 13, 1994.

Using historical data, the staff estimated peak annual discharge corresponding to several return periods at the Rowell gauge. The staff estimated pre-dam floods using peak annual discharge data from 1943 to 1977 and post-dam floods using data from 1977 to 2000. The staff used the procedure, "Guidelines for Determining Flood Flow Frequency," issued in 1981, recommended by the Water Resources Council (WRC), to determine the floods corresponding to recurrence intervals of 2.33, 10, 25, 50, and 100 years. The staff estimated the pre-dam and post-dam floods, which are included in Table 2.4-1 of this SER. The staff obtained information regarding the floods at the Clinton Dam corresponding to the same recurrence intervals by prorating the estimated floods at the Rowell gauge by the ratio of drainage area at the dam to that at the gauge (748.9 square kilometers (km^2)/867.6 km^2 = 0.8632).

Table 2.4-1 Pre-Dam and Post-Dam Floods Corresponding to Several Return Periods Estimated According to NRC Guidelines

Recurrence Interval (year)	Pre-Dam Floods		Post-Dam Floods	
	Rowell Gauge cfs	Clinton Dam cfs	Rowell Gauge cfs	Clinton Dam cfs
2.33	4,250	3,669	3,456	2,983
10	11,016	9,509	6,247	5,392
25	17,447	15,060	7,920	6,836
50	22,503	19,424	8,960	7,734
100	29,151	25,162	10,065	8,688

The staff estimated a post-dam mean annual flood of 2983 cfs and 25-year and 100-year floods of 6836 cfs and 8688 cfs, respectively. The 10-year and 100-year floods at the dam decreased from 9,509 cfs and 25,151 cfs, respectively, to 5,392 cfs and 8,688 cfs, respectively, after the construction of Clinton Dam.

According to HMR 52, local intense precipitation at the ESP site is equivalent to short-duration, 1-mi^2 PMP. The staff used HMR 52 guidelines to estimate 1-hour, 1-mi^2 PMP depth for the ESP site. Table 2.4-2 of this SER, Column 2, lists the multiplication factors recommended in HMR 52 that are applied to 1-hour, 1-$minute^2$ PMP depth to estimate the PMP depths for other durations. Column 3 lists the staff's estimated PMP depths corresponding to these durations.

Table 2.4-2 Local Intense Precipitation (1-mi^2 PMP) at the Early Site Permit Site

Duration	Multiplier to 1-hour PMP depth	PMP depth in inches
5 min	0.335	6.08
15 min	0.528	9.58
30 min	0.759	13.78
1 hour	1.000	18.15
6 hours	1.493	27.10

The applicant used HMR 33 to estimate the PMP for watershed drainage into Clinton Lake; however, the current standards are HMRs 51 and 52. Section 2.4.3 of this SER describes the staff's independent PMP estimation for the watershed draining into Clinton Lake. In RAI 2.4.2-1, the staff requested that the applicant explain why it did not use these current standards and why an estimate based on HMR 33 is conservative relative to an estimate based on HMRs 51 and 52. In its response to RAI 2.4.2-1, the applicant described its method for estimating PMP values for Clinton Lake's drainage using HMR 51. The staff found that the applicant's procedure is inconsistent with the recommendations in HMR 51, which outline a detailed method for estimating PMP values for different durations for a desired drainage area.

The staff's independent estimates of 24-hour and 48-hour PMP values for the Clinton Lake watershed are 4.9 percent and 6.3 percent higher, respectively, than the applicant's PMP values derived using HMR 33 for the same durations, as reported in the SSAR. The staff concluded that the applicant did not show that PMP values estimated using HMR 33 are conservative when compared to PMP values estimated using HMR 51. Therefore, the applicant needed to provide a revised PMP estimate using the current criteria of HMR 51. This was DSER Open Item 2.4-5.

In response to DSER Open Item 2.4-5, the applicant stated, in its submission to the NRC dated April 4, 2005, that it agreed with the staff's independent estimate of PMP values obtained using the recommendations of HMR 51. The applicant noted that the PMF water surface elevations updated for HMR 51 PMP values would not change the ESP site from being considered a "dry site." However, the applicant conceded that the updated PMP values may be useful for assessing the impacts on site drainage during significant storm events. The applicant revised the SSAR to reflect its acceptance of the staff-estimated PMP values for the ESP site. The staff, therefore, considers Open Item 2.4-5 resolved.

In RAI 2.4.2-2, the staff requested that the applicant describe likely changes to both upstream land use and downstream water demand. Upstream land use change may lead to increased intensity and frequency of flood risk to the ESP site. An increase in downstream water demand may affect low-flow conditions.

In response to RAI 2.4.2-2, the applicant stated that likely changes in upstream land use will not appreciably alter the flood risk at the site. Since the antecedent conditions used in PMF calculations will result in saturated soil conditions, any increases in impervious surface in the basin will not have a detectable impact on the PMF flood height. However, the staff concludes that the applicant's assertion that an increase in area with impervious surface will decrease the duration of low-flow events is not adequate. Increases in impervious surface also result in a reduction in recharge and the resulting ground-water-derived baseflow. While the applicant's assertion of increased flow is correct for the long-term average flow, an increase in impervious surface area could result in a decrease in baseflow during dry periods. Therefore, the applicant needed to provide additional justification for why an increase in the area with impervious surface will decrease the duration of low-flow events. This was DSER Open Item 2.4-6.

In response to DSER Open Item 2.4-6, the applicant stated, in its submission to the NRC dated April 4, 2005, that the Clinton Lake watershed is not changing significantly. The applicant stated that the trend in long-term population is decreasing, and the trend in short-term population is flat. The applicant also stated that there is no information to support significant future changes in land use or increase in water demand upstream or downstream of the lake. The applicant stated that the long-term potential of development in land use is less than 0.5 percent of the Clinton Lake watershed.

The applicant stated that, in general, development of land use will reduce the amount of infiltration, thereby reducing the volume of water in the ground that produces baseflow during low-flow periods. Therefore, the applicant argued, the rate of flow during low-flow periods, as well as the duration of low-flow for those streams that will dry up, will be reduced. The applicant further stated that given the low rate of development in the Clinton Lake watershed and the required stormwater control practices for new development, it is reasonable to assume that no significant change in stream low-flows will occur.

The applicant explained that the State requires a minimum discharge of 5 cfs from the dam to Salt Creek downstream of Clinton Lake. To maintain this minimum discharge during dry periods, water is drawn from the large storage capacity in Clinton Lake. The applicant stated that the potential change in infiltration caused by future development is small and is not expected to significantly change the total volume of inflow to the lake. Therefore, the applicant reasoned, no significant change will occur in the ability of Clinton Lake to deliver the minimum required flow to Salt Creek downstream of the lake.

Based on the applicant's response to DSER Open Item 2.4-6, the staff determined that the change in the Clinton Lake watershed for the foreseeable future is so small (0.14 percent of the watershed area; see the staff's review of the applicant's response to DSER Open Item 2.4-4 in Section 2.4.1.3 of this SER) as compared to the overall size of the watershed, it would not result in significant changes in the duration of low-flows in the watershed. Based on the above review, the staff considers DSER Open Item 2.4-6 resolved.

In response to RAI 2.4.2-2, the applicant stated that the portion of Salt Creek downstream of Clinton Lake is not a candidate for an increase in demand. The applicant stated that Salt Creek is not a likely candidate for any diversion development because it historically has experienced extended periods of low flow. However, the staff concluded that the applicant did not provide an adequate basis for this statement. Since an increase in additional storage capacity could mitigate these low-flow periods, the staff found the applicant's response incomplete. The staff asked the applicant to provide references for projections from State or local authorities responsible for development plans in the area of concern to substantiate any prediction of future development. This was DSER Open Item 2.4-7.

In response to DSER Open Item 2.4-7, the applicant stated, in its submission to the NRC dated April 4, 2005, that it provided information on planned development for DeWitt County and

Farmer City in its responses to DSER Open Items 2.4-3 and 2.4-6. The applicant stated that no significant development is planned within the Clinton Lake watershed. The limited development currently planned will use a ground water source for its water supply.

The applicant stated that Salt Creek downstream of Clinton Lake is not a good candidate for water withdrawal since flows released from the lake can be at the minimum required rate of 5 cfs for extended periods of time and would generally not be considered sufficient to support additional development.

Based on the applicant's responses to DSER Open Items 2.4-3, 2.4-6, and 2.4-7, the staff determined that the applicant provided sufficient information to conclude that there is only limited development planned within the Clinton Lake watershed. This limited development is not likely to increase significantly the water demand on Salt Creek. Based on the above review, the staff considers DSER Open Item 2.4-7 resolved.

SSAR Section 2.4.2 did not provide sufficient information for the staff to determine the safety of the ESP site from seismically generated water waves. In RAI 2.4.2-3, the staff requested that the applicant document any historical hillslope failures in the watershed and analyze the ability of a hypothetical hillslope failure to impact the ESP facility. A hillslope failure could result in a water wave that might run up the bank near the ESP site, potentially affecting its safety. The staff requested an estimate of the maximum height of such a hypothetical wave to address these safety concerns. In response to RAI 2.4.2-3, the applicant estimated that such a wave would be less than 1 ft, although it did not explain the basis for this estimated value. The staff examined the potential for hillslope failure to induce waves in Clinton Lake in Section 2.4.6 of this SER. Except for the ESP intake structures, the staff concluded that, based on the elevation of the ESP site relative to the lake and the distance of the ESP safety facilities from the shoreline (see revised SSAR Figure 1.2-4 in the attachment to RAI 2.4.1-1), water waves induced by hillslope failure would not pose a risk to the ESP site. The inlet to the CPS screenhouse is at an elevation of 670 ft MSL, and the new ESP intake would draw water from the same bottom elevation as that of the CPS intake structures. The staff determined that the ESP intake structures would be exposed to PMF water surface elevations, although the rest of the ESP site would be dry. The CP or COL applicant should design the ESP intake structures to withstand the combined effects of PMF, coincident wind wave activity, and wind setup, as discussed further in Section 2.4.3 of this SER. This is **COL Action Item 2.4-3.**

The staff had planned to include the requirement that the COL applicant design the ESP intake structures to withstand the combined effects of PMF, coincident wind wave activity, and wind setup in DSER Permit Condition 2.4-3. However, based on the applicant's responses to DSER Open Items 2.4-1 and 2.4-2, the staff determined that the requirement of a UHS, and consequently the necessity of protecting its intake structures from flooding, is dependent on reactor design, which has not been selected at the ESP stage. Therefore, the staff determined that COL Action Item 2.4-3 is sufficient to ensure flood protection of the ESP facility's UHS intake structures, if the selected reactor design were to require one. Thus, it is not necessary to impose DSER Permit Condition 2.4-3.

SSAR Section 2.4.2 did not provide sufficient information on seismically generated seiches. In RAI 2.4.2-4, the staff requested that the applicant document any seismically induced seiches in Clinton Lake to determine whether such waves could affect the safety of the ESP site. In response to RAI 2.4.2-4, the applicant stated that it performed a search of existing literature to determine whether any seismically induced seiches had occurred in Clinton Lake or other lakes in the area. The applicant reported that seismic wave activity is extremely rare, and it did not identify any seismically induced seiche information. As an anecdotal note, the applicant stated that CPS personnel did not report any seiche activity in Clinton Lake during the magnitude 4.5 earthquake of June 2004. The staff examined the potential for seiches in Section 2.4.5 of this SER. Except for the ESP intake structures, the staff concluded that, based on the elevation of the ESP site relative to the lake and the distance of the ESP safety facilities from the shoreline (see revised SSAR Figure 1.2-4 in the attachment to RAI 2.4.1-1), seismically induced seiches did not pose a risk to the ESP site.

SSAR Section 2.4.2 did not provide sufficient information for the staff to determine whether drainage capacity at the existing grade can accommodate local intense precipitation without affecting any safety-related structures for the ESP facility. In RAI 2.4.2-5, the staff requested that the applicant demonstrate that drainage capacity at the existing grade is sufficient to accommodate local intense precipitation, or describe any active safety-related drainage systems that would be installed for the ESP facility. In response to RAI 2.4.2-5, the applicant stated that it has not yet designed site drainage at the ESP facility, since portions of this system will depend upon the reactor design selected for the ESP facility.

The applicant estimated local intense precipitation at the ESP site for a 1-hour duration to be 13.5 in. and for a 5-minute (min) duration to be 4.3 in. Table 2.4-2 of this SER shows the staff's independent estimation of local intense precipitation, which is 2 percent higher than the applicant's estimate for a 1-hour duration and 41 percent higher than its estimate for a 5-minute duration. Because of these differences, the site characteristic of local intense precipitation at the ESP site remained open. Therefore, the staff asked the applicant to address the differences between the two estimates of local intense precipitation at the ESP site for a 1-hour duration and for a 5-minute duration. This was DSER Open Item 2.4-8.

In response to DSER Open Item 2.4-8, the applicant stated, in its submission to the NRC dated April 4, 2005, that the SSAR characterizes short-term intense precipitation at the site for 1-hour and 5-minute durations on the basis of information available from the CPS USAR. The information in the CPS USAR is based on recommended procedures found in the older HMR 33. The applicant reviewed the staff's estimates of local intense precipitation for 1-hour and 5-minute durations based on the currently applicable HMR 52 and agreed with them. The applicant agreed with the staff's estimates and revised the text in SSAR Section 2.4.2.3 accordingly. The staff determined that applicant's response to DSER Open Item 2.4-8 is satisfactory, and therefore, considers DSER Open Item 2.4-8 to be resolved. The staff-estimated local intense precipitation presented in Table 2.4-2 of this SER will be included as a site characteristic for the ESP site (see Table 2.4.14-1 of this SER).

The applicant stated that a drainage system at the ESP site can be designed to handle maximum site precipitation without requiring any active components. The CP or COL applicant should demonstrate that the flooding from local intense precipitation at the ESP site can be discharged to Clinton Lake without relying on any active drainage systems that may be blocked during such an event. This is **COL Action Item 2.4-4.** The staff had planned to include this requirement as DSER Permit Condition 2.4-4. However, the staff determined that the ESP facility site grading will partially depend on the chosen reactor type, which has not been designed at the ESP stage. The staff concluded that COL Action Item 2.4-4 is sufficient to ensure the safety of the ESP facility from flooding generated by local intense precipitation. Therefore, it is not necessary to impose DSER Permit Condition 2.4-4.

2.4.2.4 Conclusions

As set forth above, the applicant provided sufficient information pertaining to identifying and evaluating floods at the site. SSAR Section 2.4.2 conforms to Section 2.4.2 of RS-002, Attachment 2, as it relates to identifying and evaluating floods at the site.

The review guidance in Section 2.4.2 of RS-002, Attachment 2, provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100. Although the applicant did not specifically address the above regulations in SSAR Section 2.4.2, the staff concludes that, by conforming to Section 2.4.2 of RS-002, Attachment 2, the applicant has met the requirements concerning floods at the site with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c). Further, the staff finds that the applicant appropriately considered the most severe flooding that has been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

2.4.3 Probable Maximum Flood on Streams and Rivers

The ESP site is approximately 40.2° N latitude and 88.8° W longitude. The watershed draining into Clinton Lake is approximately 281.5 mi^2. The area of Clinton Lake is approximately 7.6 mi^2. Flooding in the watershed will lead to increased water surface elevation in Clinton Lake.

2.4.3.1 Technical Information in the Application

In SSAR Section 2.4.3.1, the applicant stated that the watershed drainage area is 296 mi^2. It developed the PMP according to procedures outlined in HMR 33. The applicant estimated a total precipitation of 25.2 in. during the 48-hour PMP storm. The 48-hour PMP storm was temporarily distributed according to guidelines in USACE, EM 1110-2-1411, "Standard Project Flood Determinations," issued March 1965. For the PMF runoff analysis, the applicant used an antecedent 48-hour SPS equivalent to 50 percent of the PMP, followed by 3 dry days, followed by the full 48-hour PMP storm. The applicant considered the precipitation to be uniformly distributed over the entire area of the watershed.

SSAR Section 2.4.3.2 stated that soils in approximately 90 percent of the drainage area of the Clinton Lake watershed belong to Flanagan silt loam, Drummer clay loam, and Huntsville loam, which are classified in SCS soil group B. The rest belong to Sawmill clay loam. The applicant estimated an initial precipitation loss during the SPS of 1.5 in. and no initial precipitation loss during the PMP, based on communications with USACE on November 2, 1970. The applicant estimated an infiltration loss during SPS, as well as during PMP, of 0.1 inches per hour (in./h). Initial precipitation loss is the part of precipitation that is consumed by soil infiltration before runoff begins, and infiltration loss is part of the precipitation that is consumed by soil infiltration during the rest of the storm.

SSAR Section 2.4.3.3 states that the applicant estimated a synthetic unit hydrograph for Salt Creek at the Rowell gauge, as described by the Illinois Division of Waterways (IDOW) in "Unit Hydrographs in Illinois," issued in 1948 in conjunction with the USGS. The applicant estimated the unit hydrograph at Clinton Dam by prorating the unit hydrograph values at the Rowell gauge by the ratio of drainage area at the dam to that at the gauge (see SSAR Figure 2.4-10).

The applicant also estimated unit hydrographs for five subareas of the watershed draining into Clinton Lake (see SSAR Figure 2.4-11) following the same synthetic method. The applicant computed lag times for each subarea according to the method proposed by IDOW. The applicant estimated flood hydrographs corresponding to the PMP for each subarea and combined these individual flood hydrographs, considering their previously estimated lag times for their corresponding subareas, to obtain the PMF into Clinton Lake.

The applicant routed the PMF through Clinton Lake using the USACE SPRAT computer program. SSAR Figure 2.4-12 provides the spillway discharge corresponding to water surface elevation in Clinton Lake. The applicant assumed an initial water surface elevation for Clinton Lake of 690 ft MSL, which is the normal water surface elevation of the lake before arrival of the PMF. The applicant also estimated the peak PMF discharge of 112,927 cfs under natural flow conditions in Salt Creek and a peak PMF inflow into the lake of 175,615 cfs.

The applicant estimated a water surface elevation corresponding to the PMF of 708.8 ft MSL and an elevation of 711 MSL caused by a 40-mile per hour (mph) wind wave runup. The applicant used the USACE Water Surface Profiles computer program to determine a water surface elevation at the ESP site resulting from backwater effects of 708.9 ft MSL.

The applicant estimated wind wave runup at the ESP site caused by significant (33-percent exceedance) and maximum (1-percent exceedance) winds. The applicant used a fetch of 0.8 mile, a water depth of 40.5 ft, and smooth ground with a slope of 3:1 (horizontal:vertical). The applicant estimated wind wave runups of 2.95 ft and 4.85 ft for significant and maximum wind speeds, respectively. The corresponding water surface elevations at the ESP site caused by wind action coincident with the PMF are 711.95 ft MSL and 713.8 ft MSL, respectively.

The applicant estimated a significant wave height of 2.2 ft at the dam site using a maximum wind speed of 40 mph, a water depth of 58 ft, and an upstream dam slope of 3:1 (horizontal:vertical). The water surface elevation corresponding to this wind wave runup coincident with the PMF is 711 ft MSL.

In RAI 2.4.3-1, the staff requested that the applicant describe the status of the USACE SPRAT computer program referenced in SSAR Section 2.4.3.3 and any software quality assurance measures that it employed to augment use of this software in support of the ESP application. In response to RAI 2.4.3-1, the applicant stated that a significant portion of CPS dam design included preparation of a discharge rating curve. It used the SPRAT model to prepare the current discharge rating curve for the dam. The applicant stated that the presence of the ESP facility does not require revision of the discharge rating curve for the dam and, therefore, does not require use of the SPRAT model. The applicant proposed to revise the ESP application to indicate that the hydraulic modeling, including SPRAT runs and water surface profile estimations, were performed as part of the dam design and not as part of the ESP application.

In RAI 2.4.3-2, the staff asked the applicant to explain the bounding of the wave runup calculations through the examination of the combined events criteria indicated in ANSI/ANS-2.8-1992. The staff also requested that the applicant discuss coincident wave calculation and the basis for applying a 40-mph design wind. In response to RAI 2.4.3-2, the applicant stated that it had previously estimated a maximum wave runup elevation, caused by a sustained 40-mph overland wind speed acting on the PMF water surface elevation, at the dam and at the CPS site of 711 ft MSL and reported it in CPS USAR Section 2.4.2.2. Section 2.4.10 of the CPS USAR uses a 48-mph overland wind speed coincident with the PMF for design of the CPS circulating-water screenhouse. The applicant stated that use of these wind speeds did not result in any safety-related issues for CPS Unit 1, since it determined that the site grade is 22.2 ft above the wave runup water surface elevation and 27.1 ft above the PMF water surface elevation. Therefore, the applicant concluded that the CPS plant facility will not flood under any circumstances.

The applicant stated that the ESP facility site is considered to be a dry site, consistent with Condition 3 to Section 2.4.3 of RS-002, Attachment 2, and it will not be subject to flooding under any circumstances. The applicant also indicated that the operation of the ESP facility would not impact the potential for flooding at the existing dam or at the plant site. The applicant suggested that the use of any wind speed for the purpose of estimating wave runup effects on PMF water surface elevation would be inconsequential. The applicant stated that it retained the use of the 40-mph wind speed in the ESP SSAR analysis to be consistent with the CPS USAR. The applicant's review of more recent information published in ANSI/ANS-2.8-1992 indicates that a greater wind speed than that used previously in the USAR and SSAR might be appropriate. Using ANSI/ANS-2.8-1992, the applicant determined that a wind speed of 52 mph should be used to estimate wave runup coincident with the PMF water surface elevation.

The applicant stated that it performed screening analyses to conservatively estimate the impact of a 52-mph wind speed on wave runup. The applicant estimated new wave heights of 3.81 ft for significant (33-percent probability) waves and 6.39 ft for maximum (1-percent probability) waves. These new wave heights are 0.94 ft and 1.58 ft greater than those estimated in the SSAR, which were based on a 40-mph wind speed. The applicant concluded that these increases are not significant because of a more than 20-ft difference in ESP site grade and the PMF water surface elevation in Clinton Lake.

In response to RAI 2.4.3-2, the applicant revised SSAR Sections 2.4.3.6 and 2.4.10 to include this updated estimation for wave runup.

After reviewing the conclusions of the staff's initial independent bounding analysis, the applicant elected to revise its application in order to provide the staff additional information to provide a basis for the staff's conclusions as documented in this report. In Revision 4 of the application, the applicant described its revised analysis. This new analysis did not rely on the applicant's earlier baseline calculation from the CPS USAR. The staff did not accept the applicant's initial approach as the applicant was unable to find adequate documentation of this earlier analysis.

In Revision 4 of the application, the applicant described an assessment of the PMF static flood elevation height based on a unit hydrograph analysis of the 72-hour PMP. The PMP was estimated using current National Weather Service guidance for deriving a PMP for the Clinton watershed (HMRs 51, 52, and 53). The applicant presented PMF calculations using two different synthetic unit hydrograph methods with two different conceptual watershed layouts. One conceptual layout included the lake and the two drainages associated with the Salt Creek and North Fork drainages as they enter Lake Clinton. The second conceptual layout further refined the two drainages into a total of seven sub-drainages. The applicant used the USACE

Hydrologic Engineering Center (HEC) model HEC-HMS 3.0.0 computer code to estimate the variation of the lake level in response to the PMP.

The synthetic unit hydrograph method relies on estimates of lag time and precipitation losses. The applicant estimated time to peak using a relationship between drainage area and lag time developed for Illinois by the USGS (Mitchell, 1948). The applicant estimated the precipitation losses based on soil and land use data for the watershed. The most conservative estimate of hydrostatic flood elevation, due to the PMF based on results of the applicant's HEC-HMS analysis for the different synthetic unit hydrographs and conceptual layouts considered, was 709.8 ft MSL.

In Revision 4 of the application, the applicant estimated a maximum coincident wave runup of 6.4 ft based on calculations using the USACE's ACES version 1.07 code with a wind velocity of 52 mph. The applicant also estimated a probable maximum surge of 0.3 ft based on a wind velocity of 100 mph.

2.4.3.2 Regulatory Evaluation

SSAR Table 1.5-1 shows the applicant's conformance to the NRC RGs. In RAI 1.5-1, the staff asked the applicant to provide a comprehensive listing of NRC regulations applicable to its ESP SSAR. In its response to this RAI, the applicant indicated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. Section 2.4 of RS-002, Attachment 2, describes the methods of review and the applicable acceptance criteria that the staff uses to develop its findings and conclusions related to the hydrologic aspects of site characterization for an ESP. Although the applicant did not indicate how the individual sections of SSAR Section 2.4 address the hydrology-related site suitability criteria in RS-002, Attachment 2, the staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance, as identified below.

Section 2.4.3 of RS-002, Attachment 2, provides the review guidance used by the staff in evaluating this SSAR section. The acceptance criteria address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the hydrologic features of the site. The regulations in 10 CFR Parts 52 and 100 require the NRC to take into account a site's physical characteristics (including seismology, meteorology, geology, and hydrology) when determining the site's acceptability for a nuclear reactor(s).

To satisfy the hydrologic requirements of 10 CFR Parts 52 and 100, the SSAR should describe the hydrologic characteristics of the site and region and contain a PMF analysis. The applicant should describe in detail sufficient to assess the site's acceptability and the potential for those characteristics to influence the design of SSCs important to safety for a nuclear power plant(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site. Meeting this guidance provides reasonable assurance that any hydrologic phenomena of severity, up to and including the PMF, would pose no undue risk to the type of facility proposed for the site.

In those cases for which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting limiting values of the relevant parameters.

Specific criteria apply to the requirements regarding the hydrologic aspects of 10 CFR Parts 52 and 100.

The PMF, as defined in RG 1.59, has been adopted as one of the conditions to be evaluated in establishing the applicable stream and river flooding design basis referenced in General Design Criteria (GDC) 2, "Design Bases for Protection against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants, to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." PMF estimates are needed for all adjacent streams or rivers and site drainage (including the consideration of PMP on the roofs of safety-related structures). The staff uses one of the following three conditions as criterion for accepting the applicant's PMF-related design basis:

(1) The elevation attained by the PMF (with coincident wind waves) establishes a necessary protection level to be used in the design of the facility.

(2) The elevation attained by the PMF (with coincident wind waves) is not controlling; the design-basis flood protection level is established by another flood phenomenon (e.g., the probable maximum hurricane).

(3) The site is "dry"; that is, the site is well above the elevation attained by a PMF (with coincident wind waves).

When Condition 1 is applicable, the staff assesses the flood level. It may make the assessment independently from basic data by detailed review of the applicant's analyses or by comparison with estimates made by others that have been reviewed in detail. The applicant's estimates of the PMF level and the coincident wave action are acceptable if the estimates are no more than 5 percent less conservative than the staff estimates. If the applicant's estimates of discharge are more than 5 percent less conservative than the staff's, it should fully document and justify its estimates or accept the staff estimates.

When either Condition 2 or 3 applies, the staff analyses may be less rigorous. For Condition 2, acceptance is based on the protection level estimated for another flood-producing phenomenon exceeding the staff estimate of PMF water levels. For Condition 3, the staff expects that the site grade should be well above the staff-assessed PMF water levels. The evaluation of the adequacy of the margin (difference in flood and site elevations) is generally a matter of engineering judgment based on the confidence in the flood-level estimate and the degree of conservatism in each parameter used in the estimate.

The staff used the appropriate sections of several documents to determine the acceptability of the applicant's data and analyses. RG 1.59 provides guidance for estimating the PMF design basis. The staff also used publications by NOAA and USACE to estimate PMF discharge and water level condition at the site, as well as coincident wind-generated wave activity.

2.4.3.3 Technical Evaluation

In its evaluation, the staff performed an independent analysis to verify the applicant's PMF analysis. The staff determined the PMP using HMRs 51 and 52 and ANSI/ANS-2.8-1992. HMR 51 gives a set of charts showing the PMP depths for durations of 6, 12, 24, 48, and 72 hours corresponding to drainage areas of 10, 200, 1,000, 5,000, 10,000, and 20,000 mi^2.

Using these charts, the staff determined PMP depths for drainage areas of 10, 200, 1000, and 5000 mi^2 for all durations given in Table 2.4-3 of this SER.

Using the values in Table 2.4-3, the staff prepared depth-area-duration curves following the guidelines of HMR 51 to bracket the drainage area of the Clinton Lake watershed. Figure 2.4-5 of this SER shows these depth-area-duration curves. Using Figure 2.4-5 of this SER to determine the PMP depth values corresponding to a Clinton Dam drainage area of 289.2 mi^2, the staff constructed Table 2.4-4 of this SER.

Table 2.4-3 PMP Values in Inches near the Clinton Dam Drainage Area

	Duration (hour)				
Area (mi^2)	6	12	24	48	72
10	27.2	31.7	33.5	37.0	38.8
200	19.4	23.5	25.0	28.2	29.9
1000	14.0	17.5	19.5	22.3	24.3
5000	8.9	11.9	13.6	16.6	18.1

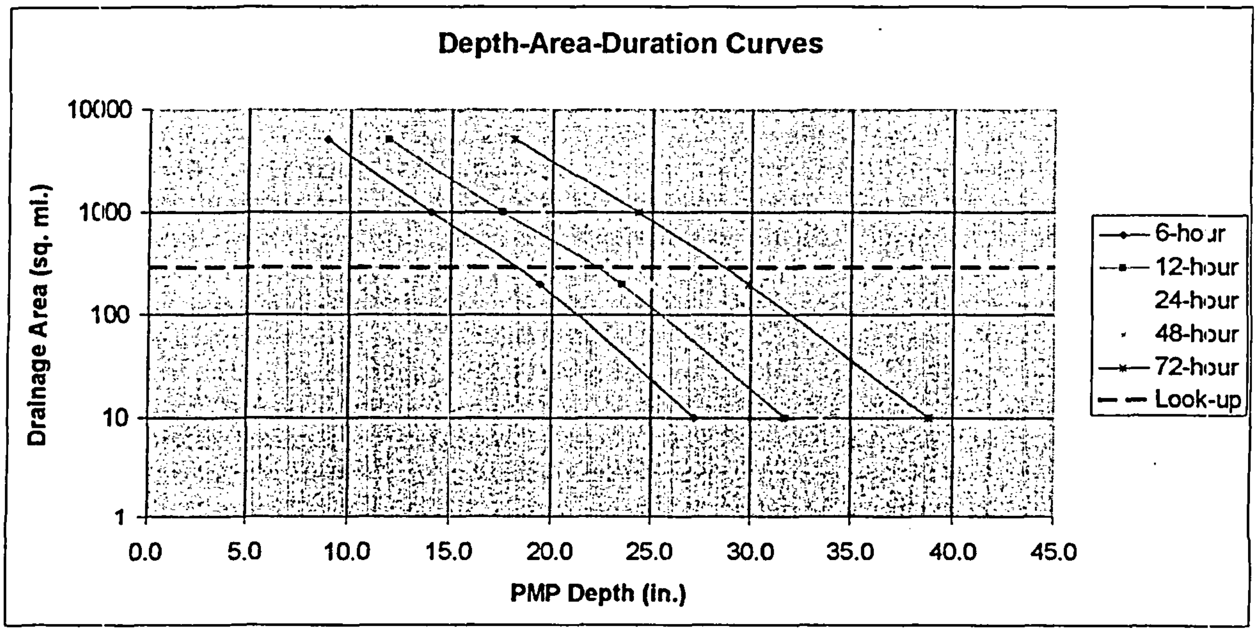


Figure 2.4-5 Depth-area-duration curves prepared for bracketing Clinton Dam drainage. The dotted horizontal line corresponds to a drainage area of 289.2 mi^2, equal to that of the Clinton Dam drainage area.

Table 2.4-4 PMP Depth-Duration Values in Inches for the Clinton Dam Drainage Area

	Duration (hour)				
Clinton Lake PMP	6	12	24	48	72
289.2 mi^2	18.2	22.1	23.7	26.8	28.7

The staff used HMR 52 and ANSI/ANS-2.8-1992 to provide guidelines for distributing the PMP depths in time to create storm sequences during the PMP event. According to these guidelines, the staff computed incremental PMP depths corresponding to all 6-hour durations during the 72-hour PMP (column 2 of Table 2.4-5 of this SER). The staff grouped the incremental depths into three 24-hour periods in descending order (column 3 of Table 2.4-5 of this SER). The staff rearranged the PMP depths within each 24-hour group according to guidelines given by ANSI/ANS-2.8-1992 (column 4 of Table 2.4-5 of this SER). Finally, the staff rearranged column 4 according to the guidelines in ANSI/ANS-2.8-1992 to create the time distribution of the PMP storm over the Clinton Dam drainage area (column 5 of Table 2.4-5 of this SER).

Table 2.4-5 Time Distribution of PMP for the Clinton Dam Drainage Area

6-hour Period	Depth (in.)	Group No.	ANSI/ANS-2.8-1992 Rearrange	Time Distribution for PMP (in.)	Time (h)
1	18.16	1	0.79	0.79	6
2	3.95		3.95	0.79	12
3	0.79		18.16	0.79	18
4	0.79		0.79	0.79	24
5	0.79	2	0.79	0.79	30
6	0.79		0.79	3.95	36
7	0.79		0.79	18.16	42
8	0.79		0.79	0.79	48
9	0.46	3	0.46	0.46	54
10	0.46		0.46	0.46	60
11	0.46		0.46	0.46	66
12	0.46		0.46	0.46	72

The staff independently verified the maximum hydrostatic (stillwater) elevation associated with a PMF at the ESP site. Since certain historical data (e.g., gauged inflows, observed lake elevations, etc.) were not available, multiple approaches were employed to provide a conservative basis.

The staff performed three analyses to estimate the water surface elevation of Clinton Lake near the ESP site during the PMF event. The first analysis bounded the water surface elevation by conservatively assuming no loss and instantaneous translation of the PMP into the lake. This bounding analysis was used to clearly establish that the site would remain dry. The second and third analyses refined the maximum water surface elevation estimate by relaxing some of the conservatism in the bounding analysis. These analyses were used to establish the site characteristic for the proposed ESP site intake structure and associated systems that may be placed below site grade.

The initial bounding analysis performed by staff conservatively estimated runoff by assuming that all watershed runoff instantaneously entered Clinton Lake. In this analysis, the runoff for each 6 hour duration during the PMP (Table 2.4-5) was computed by multiplying the PMP depth by the area of Clinton Dam's drainage. An infiltration loss rate of 0.0 in/hr was assumed to maximize the flood generated by the PMP storm. Based on these assumptions, runoff entering Clinton Lake had a peak discharge of 571,314 cfs.

The staff assumed instantaneous translation of the inflow wave through Clinton Lake using level pool routing and the stage-storage curve provided by the applicant (SSAR Figure 2.4 12). The stage-storage relationship was extended beyond elevation 708 ft MSL by extrapolation using the slope of the stage-storage curve.

The applicant provided the spillway rating curve for the Clinton Dam (SSAR Figure 2.4 12) that listed total combined discharge from service and auxiliary spillways corresponding to water surface elevations ranging from 690 ft MSL to 710 ft MSL. The staff extended this stage-discharge relationship above elevation 710 ft MSL by extrapolation using the slope of the stage-discharge relationship at elevation of 710 ft MSL. At elevations above the top of the dam, the staff assumed that water would spill along the entire dam face; the staff used a weir equation to compute the resulting discharge.

Results generated from the conservative, instantaneous translation, level pool routing method produced the reservoir inflow-outflow sequence shown in Figure 2.4-6 of this SER. Figure 2.4-7 of this SER shows the corresponding reservoir water surface elevations. The staff estimated the maximum hydrostatic (stillwater) water surface elevation using this extremely conservative and bounding approach to be 712.2 ft MSL.

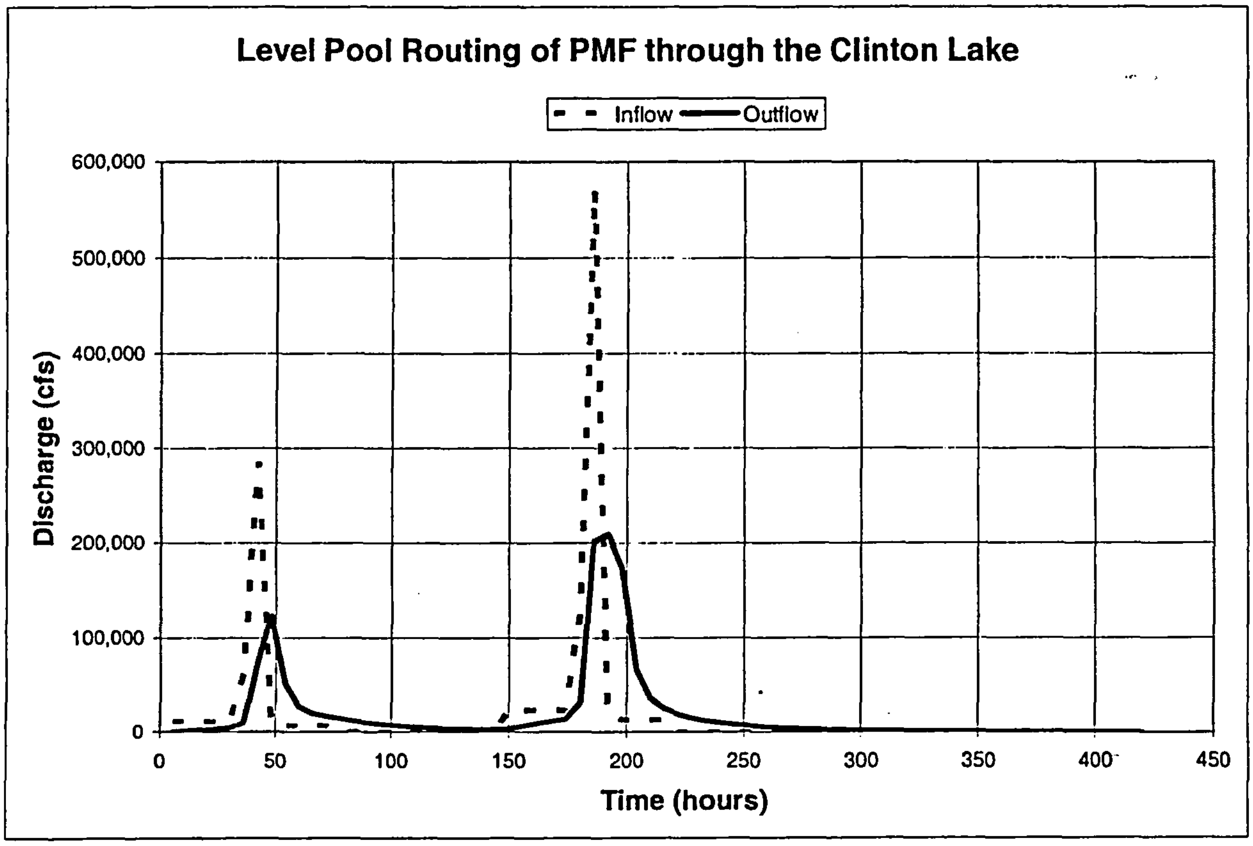


Figure 2.4-6 Inflow and outflow from Clinton Lake during the PMF event calculated using the instantaneous-translation level-pool routing method

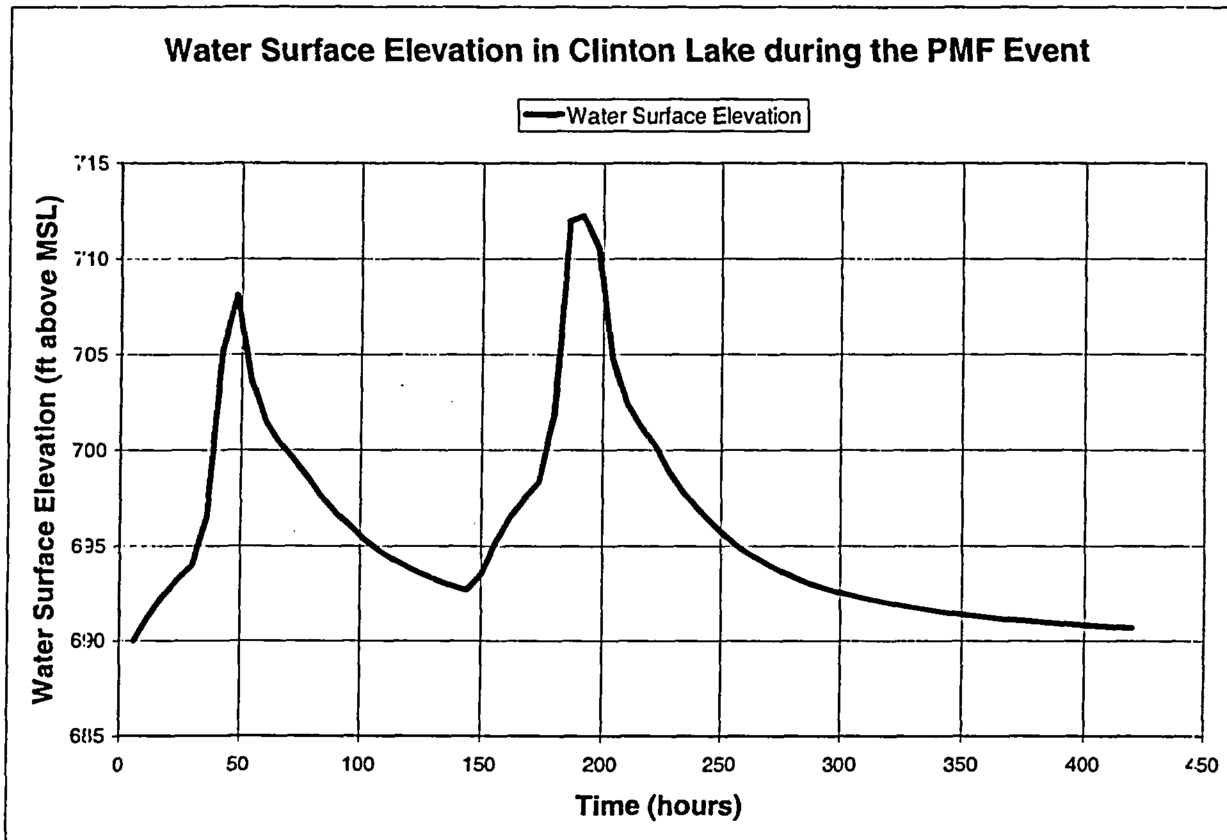


Figure 2.4-7 Water surface elevation in Clinton Lake during the PMF event calculated using the instantaneous-translation level-pool routing method

A second analysis was performed by staff using the HEC-HMS Version 3.0.0 computer code. The watershed was divided into eight sub-areas (Clinton Lake plus seven sub-basins) in the same manner as Revision 4 of the SSAR and with the following sub-areas: 1) Salt Creek headwater = 126.8 mi^2, 2) Salt Creek local area northeast = 5 mi^2, 3) Salt Creek local area northwest = 16.3 mi^2, 4) Salt Creek local area southeast = 6.2 mi^2, 5) Salt Creek local area southwest = 8.2 mi^2, 6) North Fork headwater = 111 mi^2, 7) North Fork local area = 15 mi^2, and 8) Clinton Lake area = 7.6 mi^2. The basins were connected together in the model so that outflow from the basins immediately entered the lake. This is a conservative assumption since the flow is not routed.

The Clinton Lake inflow hydrograph was estimated using the unit hydrograph approach. Synthetic unit hydrographs were developed to determine the runoff from each sub-basin area. The storm hydrograph entering Clinton Lake was computed based on two-hour unit hydrographs for each sub-basin. An antecedent storm equal in volume to 50% of the PMP, followed by three days of no rainfall, and followed by the full PMP volume (Table 2.4-5) was applied to the Clinton Lake watershed. In addition, the PMP used in the staff's analysis had a total volume of 28.7 in., which is more conservative compared to the applicant's value of 27.8 in.

One of the key parameters in the synthetic unit hydrograph method is the lag time. Values of lag times used by the applicant were based on limited published watershed data. The lag times used by the applicant and the staff ('standard lag' Table 2.4-6) in the HEC-HMS model were as follows: 1) Salt Creek headwater = 12.3 hrs, 2) Salt Creek local area northeast = 1.1 hrs, 3) Salt Creek local area northwest = 2.6 hrs, 4) Salt Creek local area southeast = 1.4 hrs, 5) Salt Creek local area southwest = 1.7 hrs, 6) North Fork headwater = 11.3 hrs, and 7) North Fork local area = 2.5 hrs. The selected lag values approximate those developed in Mitchell (1948) and the CPS USAR, although for the present analysis seven watershed sub-areas were used so corresponding values are not directly comparable. Since recent direct field data are not available, the lag time values are subjective. The staff appreciates the empirical nature of these coefficients and of the SCS method in general, which is generally not advised for use for areas larger than 2,000 ac (NOAA, 2006). To test the overall range of Clinton Lake PMF water surface elevations, the staff varied the lag time by shortening and increasing the lag time by 10 percent. Maximum Clinton Lake PMF water surface elevations are shown in Table 2.4-6 for these scenarios.

A second key parameter in the PMF computation method is the infiltration loss. The staff evaluated model sensitivity by reducing the constant loss parameter used by the applicant (0.1 in/hr) first by half (0.05 in/hr) and then eliminating infiltration altogether (0.0 in/hr loss). Computed time series of Clinton Dam outflow and Clinton Lake water surface elevation during the storm event are shown in Figure 2.4-8 and Figure 2.4-9, respectively. The maximum Clinton Lake PMF water surface elevations for this range of infiltration loss parameter values are shown in Table 2.4-6.

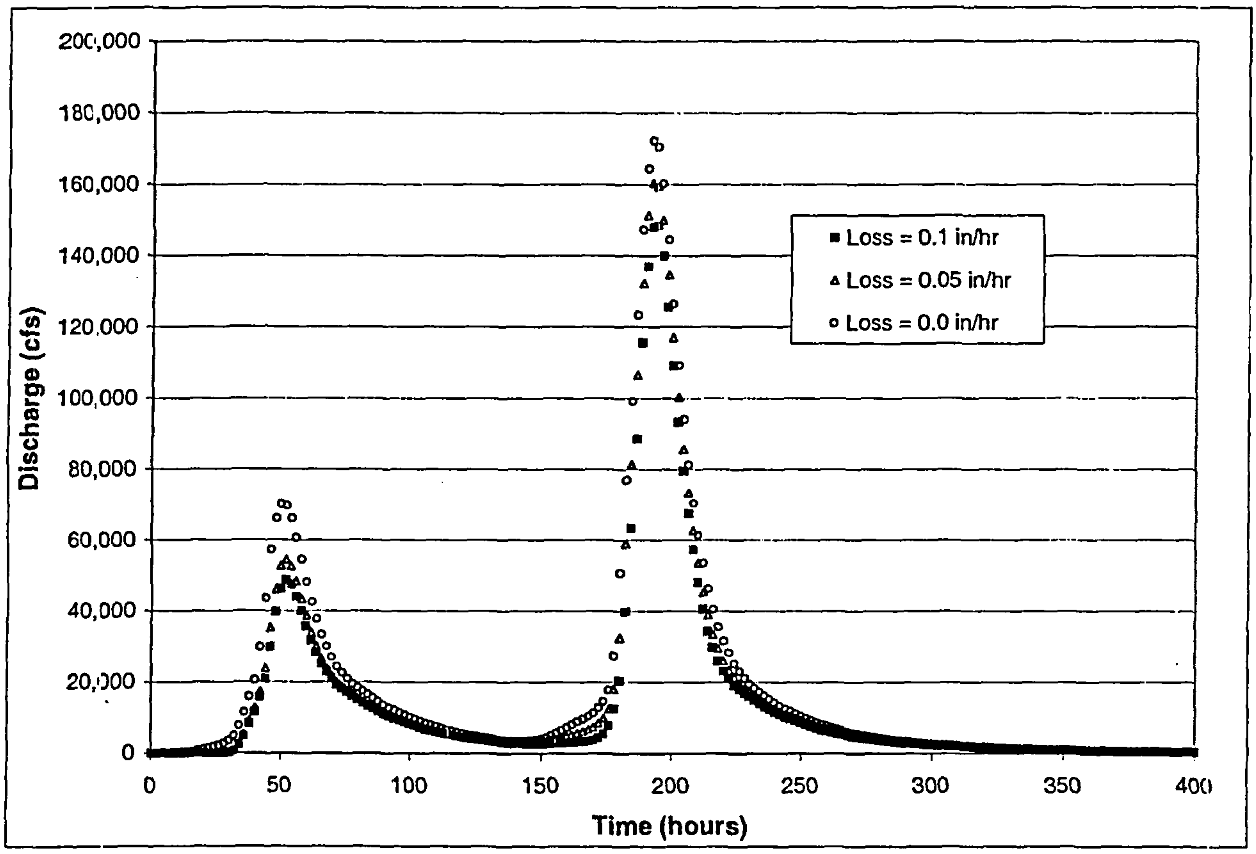


Figure 2.4-8 Inflow and outflow Hydrographs for Clinton Lake during the PMF event using the HEC-HMS model and the seven sub-basins + lake method

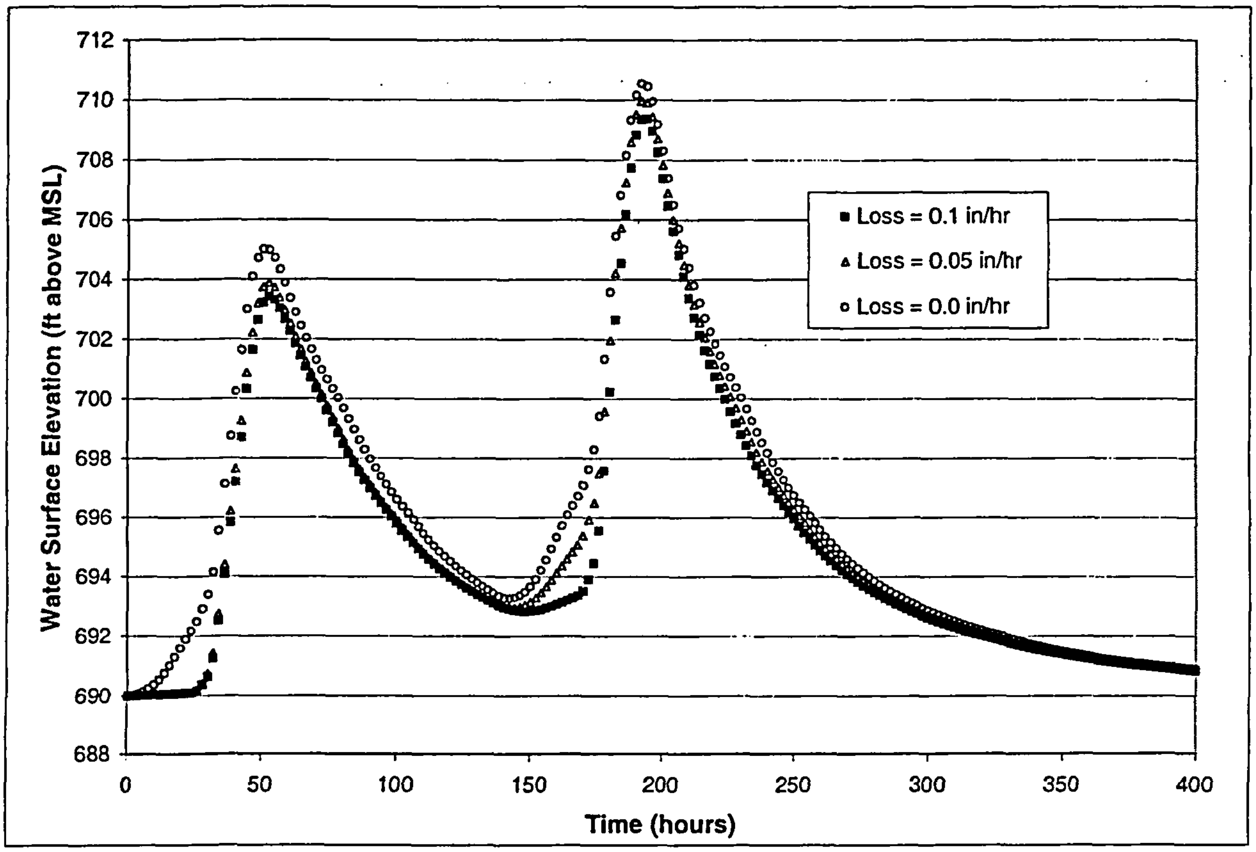


Figure 2.4-9 Water surface elevation of Clinton Lake during the PMF event using the HEC-HMS model and the seven sub-basins + lake method

The third analysis examined by staff also utilized HEC-HMS; however the watershed was divided into five sub-basins. Unit hydrographs following Mitchell (1948) and discussed in the CPS USAR were used. These unit hydrographs were made more conservative by shortening the time to peak by 33% and increasing the peak discharge by 20%. The Clinton Lake watershed was subjected to the same 50 percent PMP volume antecedent storm followed by the full PMP volume (Table 2.4-5) as the second analysis. For this analysis, the initial loss and constant loss rate were both set to zero. As in the second analysis, the routing from the five sub-basins to the Clinton Lake was instantaneous (no routing) and the PMP volume was 28.7 in.; both of which are conservative assumptions. The resulting maximum water surface elevation of Clinton Lake during the PMF was 710.6 ft MSL.

Results from the three analyses performed by staff are summarized in Table 2.4-6. Results from the initial bounding analysis clearly establish that the site would remain dry during the PMF event. The second and third analyses were used to establish the site characteristic for the intake structures and associated safety related systems located below site grade that might be inundated. Water surface elevation results from these analysis fell within 4% of the applicant's water surface elevation value. Based upon the consistency of the results of the various analyses, the staff finds that the applicant's value of 709.8 ft MSL for the maximum hydrostatic (stillwater) water surface elevation is reasonably conservative.

Table 2.4-6 Summary of Maximum PMF Water Surface Elevations (ft MSL) at the ESP Site

Method	Constant Infiltration Loss Rates (in/hr)		
	0.0	0.05	0.1
Instantaneous Translation	712.2		
SCS with Standard Lag	710.6	710.0	709.4
Mitchell Unit Hydrograph	710.6		

Method	Lag – 10%	Standard Lag	Lag + 10%
SCS with Loss = 0.1	709.9	709.4	709.0

The influence of coincident wind wave activity would cause an increase in the PMF water surface elevation. The staff conservatively estimated the probable maximum windstorm (PMWS), as defined by ANSI/ANS 2.8-1992, to be equivalent to 100 mph. This conservative wind velocity is based upon the location of the site, which is within 150 mi of the Great Lakes. The staff estimated wave heights using the method outlined in the Coastal Engineering Manual with a site-specific fetch of 1.2 mi. The resulting significant (average height of the one-third highest waves) wave height is 3.9 ft, and the 1-percent maximum (average height of the largest 1 percent of all waves) wave height is 6.6 ft. Therefore, staff find that the applicant's value of 6.4 ft is reasonable.

A further increase of water surface elevation may result from storm surge, as discussed more fully in Section 2.4.5 of this SER. Storm surge would result in an additional increase in water surface elevation of 0.3 ft. Combining the effects of PMF (elevation 709.8 ft MSL), coincident wind wave activity (6.4 ft), and storm surge (0.3 ft), the staff estimated a resulting maximum water surface elevation at the ESP site of 716.5 ft MSL. The staff, therefore, determined that the ESP site, excluding the ESP intake structures, is safe from flooding during a PMF event. For the ESP intake structure, the COL applicant needs to design the intake structures to withstand the combined effects of PMF, coincident wind wave activity, and wind setup of a water surface elevation of 716.5 ft MSL. COL Action Item 2.4-3, discussed in Section 2.4.2.3 of this SER, states this.

In response to RAI 2.4.3-1, the applicant stated that the presence of the ESP facility does not require that the discharge rating curve for the dam be revised and, therefore, does not require use of the SPRAT model. The applicant revised the ESP application to remove reference to the hydraulic modeling. The staff determined that the applicant's response to RAI 2.4.3-1 is satisfactory.

With respect to the effects of wind speed on PMF water level elevation, the applicant stated in response to RAI 2.4.3-2 that use of these wind speeds did not result in any safety-related issues for CPS Unit 1 since the site grade was determined to be 22.2 ft above the wave run-up water surface elevation and 27.1 ft above the PMF water surface elevation. As such, the applicant determined that the CPS plant facility could not flood under any circumstances. The staff determined that the applicant's response to RAI 2.4.3-2 is satisfactory.

2.4.3.4 Conclusions

As set forth above, the applicant provided sufficient information pertaining to the identification and evaluation of PMFs on streams and rivers at the site. SSAR Section 2.4.3 conforms to Section 2.4.3 of RS-002, Attachment 2, with regard to this objective.

Section 2.4.3 of RS-002, Attachment 2, provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating PMFs on streams and rivers at the site. Although the applicant did not specifically address the above regulations in SSAR Section 2.4.3, the staff concludes that, by conforming to Section 2.4.3 of RS-002, Attachment 2, it has met the requirements to identify and evaluate PMFs on streams and rivers at the site with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c). Further, the staff finds that the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area in establishing the stream and river design-basis flood, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

2.4.4 Potential Dam Failures

2.4.4.1 Technical Information in the Application

In SSAR Section 2.2.4, the applicant stated that no other dams exist either upstream or downstream of Clinton Dam. The applicant also indicated that failure of Clinton Dam will not result in a loss of water from the submerged UHS pond.

2.4.4.2 Regulatory Evaluation

SSAR Table 1.5-1 shows the applicant's conformance to the NRC RGs. In RAI 1.5-1, the staff requested that the applicant provide a comprehensive listing of the NRC regulations applicable to its ESP SSAR. In its response to this RAI, the applicant indicated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. Section 2.4 of RS-002, Attachment 2, describes the methods of review and the applicable acceptance criteria that the staff uses to develop its findings and conclusions related to the hydrologic aspects of site characterization for an ESP. Although the applicant did not indicate how the individual sections of SSAR Section 2.4 address the hydrology-related site suitability criteria in RS-002, Attachment 2, the staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance, as identified below.

Section 2.4.4 of RS-002, Attachment 2, provides the review guidance used by the staff in evaluating this SSAR section. The acceptance criteria are based on meeting the requirements of the following regulations:

- 10 CFR Parts 52 and 10 100 as they relate to evaluating the hydrologic features of the site
- 10 CFR 100.23 as it relates to establishing the design-basis flood caused by a seismic dam failure

The regulations at 10 CFR 52.17(a) and 10 CFR 100.20(c) require that the NRC take into account the site's physical characteristics (including seismology, meteorology, geology, and hydrology) when determining its acceptability to host a nuclear reactor(s).

The regulations at 10 CFR Parts 52 and 100 are applicable to SSAR Section 2.4.4, which addresses the physical characteristics, including hydrology, the Commission considers when determining the site acceptability for a power reactor. To satisfy the hydrologic requirements of 10 CFR Parts 52 and 100, the applicant's safety assessment should describe the hydrologic characteristics of the region and contain an analysis of potential dam failures. The applicant should describe in detail sufficient to assess the site acceptability and the potential for those characteristics to influence the design of SSCs important to safety. Meeting this criterion provides reasonable assurance that the effects of high water levels resulting from failure of upstream dams, as well as those of low water levels resulting from failure of a downstream dam, will pose no undue risk to the type of facility proposed for the site.

In those cases for which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the site's hydrologic characteristics. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting the limiting values of parameters. Important PPE parameters for SSAR Section 2.4 include, but are not limited to, precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami surge level and maximum allowable ground water level).

The regulation at 10 CFR 100.23 requires consideration of geologic and seismic factors in the determination of site suitability. Pursuant to 10 CFR 100.23(c), the applicant must obtain geologic and seismic data for evaluating seismically induced floods, including failure of an upstream dam during an earthquake.

The regulation at 10 CFR 100.23 is applicable to Section 2.4.4 of RS-002, Attachment 2, because it requires investigation of seismically induced floods or low water levels that guide the Commission in its consideration of the suitability of proposed sites for nuclear power plants. RG 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Reactors—LWR Edition," issued November 1978, provides more detailed guidance on the investigation of seismically induced floods, including results for seismically induced dam failures and antecedent flood flows coincident with the flood peak. Meeting the requirements of 10 CFR 100.23 provides reasonable assurance that, given the geologic and seismic characteristics of the proposed site, a nuclear power plant(s) of a specified type (or falling within a PPE) could be constructed and operated on the proposed site without undue risk to the health and safety of the public with respect to those characteristics.

The staff used the following criteria to meet the requirements of 10 CFR Part 52, 10 CFR Part 100, and 10 CFR 100.23, as they relate to dam failures:

- The staff will review the applicant's analyses and independently assess the coincident river flows at the site and at the dams being analyzed. ANSI/ANS-2.8-1992 provides guidance on acceptable river flow conditions to be assumed coincident with the dam failure event. To be acceptable, the applicant's estimates (which may include landslide-induced failures) of the flood discharge resulting from the coincident events should be no more than 5 percent less conservative than the staff estimates. If the applicant's estimates differ by more than 5 percent, the applicant should fully document and justify its estimates or accept the staff estimates.

- The applicant should identify the location of dams and potentially "likely" or severe modes of failure. The applicant also should identify dams or embankments for the purpose of impounding water for a nuclear power plant(s) that might be constructed on the proposed site, and discuss the potential for multiple, seismically induced dam failures and the domino failure of a series of dams. Applicants should use approved models of the USACE and the Tennessee Valley Authority to predict the downstream water levels resulting from a dam breach. First-time use of other models will necessitate complete model description and documentation. The staff bases its acceptance of the model (and subsequent analyses) on staff review of model theory, available verification, and application. In cases which assume something other than instantaneous failure, the conservatism of the rate of failure and shape of the breach should be well documented. The applicant should document a determination of the peak flow rate and water level at the site for the worst possible combination of dam failures, summary analysis that substantiates the condition as the critical permutation, and a description (and the bases) of all coefficients and methods used. In addition, the applicant should consider the effects of other concurrent events on plant safety, such as blockage of the river and waterborne missiles.

- The applicant also should consider the effects of coincident and antecedent flood flows (or low flows for downstream structures) on initial pool levels. Depending upon estimated failure modes and the elevation difference between plant grade and normal river levels, it may be acceptable to use conservative, simplified procedures to estimate flood levels at the site. Where calculated flood levels using simplified methods are at or above plant grade and use assumptions which cannot be demonstrated as conservative, applicants should use unsteady flow methods to develop flood levels at the site. References 7, 13, and 14 of RS-002 are acceptable methods; however, other programs could be acceptable with proper documentation and justification. The applicant should summarize computations, coefficients, and methods used to establish the water level at the site for the most critical dam failures. Coincident wind-generated wave activity should be considered in a manner similar to that discussed in Section 2.4.3 of RS-002.

RG 1.59 provides guidance for estimating the design basis for flooding, considering the worst single phenomenon and a combination of less severe phenomena.

2.4.4.3 Technical Evaluation

The staff consulted maps published by the USGS to independently verify the applicant's statement that no other dams exist upstream of Clinton Dam. The staff found that a small impoundment called Dawson Lake, created by construction of a dam on the North Fork of Salt Creek, exists upstream of the ESP site. Dawson Lake is located approximately 17.1 miles north-northeast of the ESP site. Dawson Lake has a surface area of 152 ac, with an average depth of 9.8 ft and a storage capacity of 67.10 million ft^3 or 1541 ac-ft. The lake is mainly used for recreation.

The applicant should consider the effects of the failure of the Dawson Lake dam in SSAR Section 2.4.4. In response to RAI 2.4.1-3, the applicant added information to SSAR

Section 2.4.1.2 regarding dams upstream and downstream of Clinton Lake to support its statement that such dams could not affect the availability of water at the ESP site.

The applicant stated that, with respect to future dams, a representative of the IDNR, Office of Water, Division of Water Resources Management, Dam Safety Section, advised that there are no recent or pending permits for recreational or water supply dams upstream of Clinton Lake.

The applicant revised SSAR Section 2.4.1.2 to state that there are no existing reservoirs or dams upstream or downstream from Clinton Lake that could affect the availability of water to Clinton Lake. The applicant identified four recreational dams, two on the North Fork of Salt Creek upstream of Clinton Lake (Moraine View Dam on Dawson Lake, and Vance Lake Dam on Clyde Vance Lake) and two downstream of Clinton Lake (Weldon Springs State Park Lake Dam and Little Galilee Lake Dam).

The staff determined that the maximum combined storage capacity of the two reservoirs upstream of Clinton Lake is 4446 ac-ft. The original capacity of Clinton Lake at normal water surface elevation of 690 ft MSL, as determined by the staff using the stage-storage relationship for Clinton Lake given in CPS USAR Figure 2.4-14, is 74,200 ac-ft. The maximum combined storage capacities of the two reservoirs upstream of Clinton Lake is about 6 percent of the normal storage capacity of Clinton Lake. The staff determined, using the same stage-storage relationship for Clinton Lake, that an increase in storage by 4446 ac-ft, with an initial water surface elevation in Clinton Lake of 690 ft MSL, would result in an increase in water surface elevation of 3.1 ft. This estimate is very conservative, since it ignores water discharged over the service spillway when the water surface elevation in Clinton Lake exceeds its crest elevation of 690 ft MSL. Discharge over the service spillway reduces the water surface elevation in Clinton Lake, and the final increase in water surface elevation resulting from a breach of the two upstream dams is likely to be less than 3.1 ft.

The staff's estimate of maximum water surface elevation in Clinton Lake because of PMF, wind setup, and wave runup, as discussed in Section 2.4.3 of this SER, is 716.5 ft MSL. The staff plans to include 716.5 ft MSL as a site characteristic in any ESP that might be issued for this application. Even if the maximum water surface elevation in Clinton Lake were to be augmented by 3.1 ft because of a breach of the two upstream dams, leading to a water surface elevation of 719.6 ft MSL in Clinton Lake, the ESP site, located at 735 ft MSL, would be safe from flooding. Therefore, the staff determined that the applicant's response to RAI 2.4.1-3 is satisfactory.

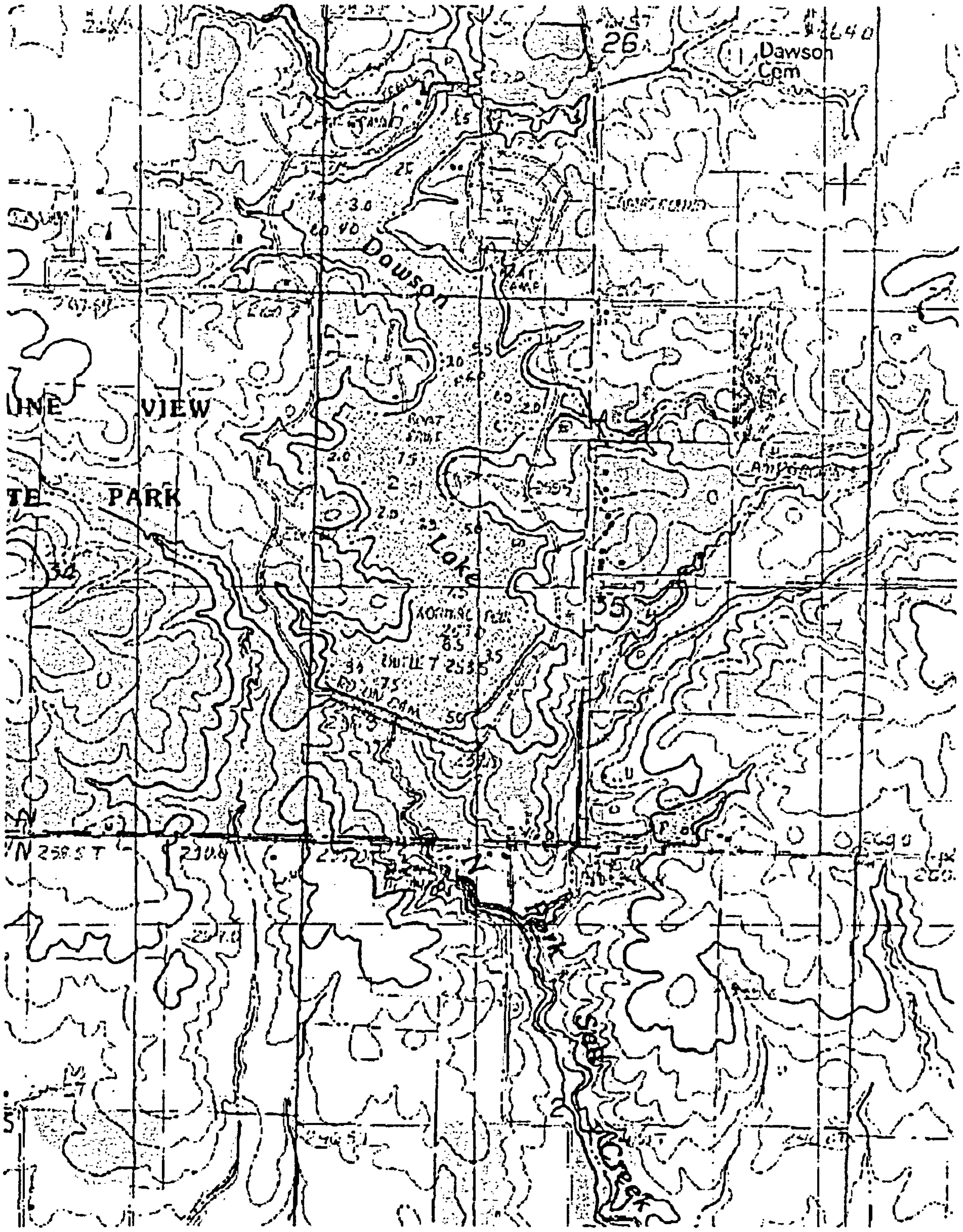


Figure 2.4-10 Dawson Lake and Dam located approximately 17.1 miles north-northeast of the ESP site. Dawson Lake is located on the North Fork of Salt Creek.

2.4.4.4 Conclusions

As set forth above, the applicant provided sufficient information pertaining to potential dam failures at the site. SSAR Section 2.4.4 conforms to Section 2.4.4 of RS-002, Attachment 2, with regard to this objective.

Section 2.4.4 of RS-002, Attachment 2, provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to the identification and evaluation of potential dam failures at the site. Although the applicant did not specifically address the above regulations in SSAR Section 2.4.4, the staff concludes that by conforming to Section 2.4.4 of RS-002, Attachment 2, it has met the requirements for potential dam failures with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c). Further, the staff finds that the applicant has considered the most severe natural phenomena that have been historically reported for the site and surrounding area in establishing the design-basis dam failure, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

2.4.5 Probable Maximum Surge and Seiche Flooding

The EGC ESP site is located on the shores of Clinton Lake, approximately 6 miles east of the city of Clinton in DeWitt County, in central Illinois at elevation 735 ft MSL.

2.4.5.1 Technical Information in the Application

The applicant stated in Revision 0 of SSAR Section 2.4.5 that there are no large bodies of water near the ESP site where significant storm surges and seiche can occur. The applicant also stated that Clinton Lake is not large enough to develop surge and seiche conditions more critical than the PMF condition. In Revision 4 of the SSAR, the applicant revised their approach to provide a higher level of conservatism, and the maximum storm surge at the site was stated as 0.3 ft. This value was computed using a wind speed of 100 mph, an effective fetch of 0.8 mi, and a water depth of 40.5 ft.

2.4.5.2 Regulatory Evaluation

SSAR Table 1.5-1 demonstrates the applicant's conformance to the NRC RGs. The staff requested, in RAI 1.5-1, that the applicant provide a comprehensive listing of the NRC regulations applicable to its ESP SSAR. In its response to this RAI, the applicant indicated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. RS-002, Attachment 2, describes the methods of review and the applicable acceptance criteria that the staff should use to develop its findings and conclusions related to the hydrologic aspects of site characterization for an ESP. Although the applicant did not indicate how it addresses the hydrology-related site suitability criteria in RS-002, Attachment 2, the staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance, as identified below.

Section 2.4.5 of RS-002, Attachment 2, provides the review guidance used by the staff in evaluating this SSAR section. The applicant must meet the requirements of 10 CFR Parts 52 and 100 as they relate to evaluating the hydrologic characteristics of the site. To determine whether the applicant met the relevant hydrologic requirements of 10 CFR Parts 52 and 100, the staff used the specific criteria in 10 CFR 52.17(a) and 10 CFR 100.20(c), which require that the site's physical characteristics (including seismology, meteorology, geology, and hydrology) be considered when determining its acceptability for a nuclear reactor(s). Further, RS-002, Attachment 2, states the following:

> To satisfy the hydrologic requirements of 10 CFR Parts 52 and 100, the applicant's safety assessment should contain a description of the surface and subsurface hydrologic characteristics of the region and an analysis of the potential for flooding due to surges or seiches. This description should be sufficient to assess the acceptability of the site and the potential for a surge or seiche to influence the design of structures, systems, and components important to safety for a nuclear power plant or plants of specified type that might be constructed on the proposed site. Meeting this requirement provides reasonable assurance that the most severe flooding likely to occur as a result of storm surges or seiches would not pose an undue risk to the type of facility proposed for the site.

In those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting the limiting values of parameters. Important PPE parameters for safety assessment identified in SSAR Section 2.4 include but are not limited to precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami surge level and maximum allowable ground water level).

If it has determined that surge and seiche flooding estimates are necessary to identify flood design bases, the staff will consider the applicant's analysis complete and acceptable if the following areas are addressed and can be independently and comparably evaluated from the applicant's submission.

- All reasonable combinations of probable maximum hurricane, moving squall line, or other cyclonic wind storm parameters are investigated, and the most critical combination is selected for use in estimating a water level.

- Models used in the evaluation are verified or have been previously approved by the staff.

- Detailed descriptions of bottom profiles are provided (or are readily obtainable) to enable an independent staff estimate of surge levels.

- Detailed descriptions of shoreline protection and safety-related facilities are provided to enable an independent staff estimate of wind-generated waves, runup, and potential erosion and sedimentation.

- Ambient water levels, including tides and sea level anomalies, are estimated using NOAA and USACE publications as described below.

- Combinations of surge levels and waves that may be critical to the design of a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site are considered, and adequate information is supplied to allow a determination that no adverse combinations have been omitted.

- At the COL stage, if the applicant elects Position 2 of RG 1.59, then it should demonstrate that the design basis for flood protection of all safety-related facilities identified in RG 1.29 is adequate in terms of the time necessary for implementation of any emergency procedures. The applicant should also demonstrate that all potential flood situations that could negate the time and capability to initiate flood emergency procedures are provided for in the less severe design basis selected.

In this section of the safety assessment, the applicant may also justify that surge and seiche flooding estimates are not necessary to identify the flood design basis (e.g., the site is not near a large body of water).

Hydrometeorological estimates and criteria for development of probable maximum hurricanes for east and Gulf Coast sites, squall lines for the Great Lakes, and severe cyclonic wind storms for all lake sites by USACE, NOAA, and the staff are used for evaluating the conservatism of the applicant's estimates of severe windstorm conditions, as discussed in RG 1.59. The USACE and NOAA criteria call for variation of the basic meteorological parameters within given limits to determine the most severe combination that could result. The applicant's hydrometeorological analysis should be based on the most critical combination of these parameters.

The staff used data from the publications of NOAA, USACE, and other sources (such as tide tables, tide records, and historical lake level records) to substantiate antecedent water levels. These antecedent water levels should be as high as the "10-percent exceedance" monthly spring high tide, plus a sea level anomaly based on the maximum difference between recorded and predicted average water levels for durations of 2 weeks or longer for coastal locations or the 100-year recurrence interval high water for the Great Lakes. In a similar manner, independent staff analysis can evaluate the storm track, wind fields, effective fetch lengths, direction of approach, timing, and frictional surface and bottom effects to ensure that the most critical values have been selected. Models used to estimate surge hydrographs that have not previously been reviewed and approved by the staff are verified by reproducing historical events, with any discrepancies in the model being on the conservative (i.e., high) side.

Criteria and methods of USACE, as generally summarized in Reference 9 of RS-002, Attachment 2, are used as a standard to evaluate the applicant's estimate of coincident wind-generated wave action and runup.

Criteria and methods of USACE and other standard techniques are used to evaluate the potential for oscillation of waves at natural periodicity.

At the COL stage, the applicant will use the criteria and methods of USACE to evaluate the adequacy of protection from flooding, including the static and dynamic effects of broken, breaking, and nonbreaking waves. RG 1.102, Revision 1, "Flood Protection for Nuclear Power Plants," issued February 1976, provides further guidance on flood protection. RG 1.125, Revision 1, "Physical Models for Design and Operation of Hydraulic Structures and Systems for Nuclear Power Plants," issued October 1978, provides guidance for using physical models in assessing flood protection.

2.4.5.3 Technical Evaluation

The staff conducted its review in accordance with Section 2.4.5 of RS-002, Attachment 2, and RG 1.59. The ESP site is located inland on the shores of Clinton Lake, formed by inundation of the North Fork of Salt Creek and Salt Creek by Clinton Dam, located approximately 1200 ft downstream of the confluence of the North Fork of Salt Creek with Salt Creek. Salt Creek flows west and joins with the Sangamon River, which in turn joins the Illinois River. The Illinois River is a tributary of the Mississippi River.

The ESP site is located at an elevation of 735 ft MSL. The staff concludes that the ESP site is not subject to storm surge from either the ocean or the Great Lakes.

The following describes the staff's independent evaluation performed to estimate seiche effects. Fetch length is one of the key parameters for determining wind setup and is generally based upon the longest straight-line distance from the site to the opposing shore. Although the site is approximately 3 miles from the dam and 10 miles from the upstream end of the reservoir, the longest straight-line distance to the opposing shore is approximately 6340 ft (see Figure 2.4-11 of this SER).

Irregular lake bathymetry and strong thermal stratification, which exists during various parts of the year, affect wind setup. An accurate determination of the wind setup that considers all of these complicating factors would require use of a multidimensional hydrodynamic and water quality model.

A simplified and conservative approach to estimate wind setup is to assume that the lake is not thermally stratified and can be represented as a uniform rectangular basin with one side equal to the fetch length. The staff assumed a uniformly distributed wind stress along the water surface in the direction of the fetch to simplify the hydrodynamic equations of motion and make it possible to obtain an analytic solution for the surface setup. As presented in N.S. Heaps (1984) the resulting solution is:

$$\zeta = \frac{CU^2 L}{h}$$

where ζ is the wind setup in ft; U is the wind speed in mph; h is the average depth of the lake in ft; L is the fetch length in ft; and C is an empirical coefficient equal to approximately 1.5×10^{-7}. The staff used a value of 6340 ft for L. Bathymetry contours (see Figure 2.4-11 of this SER) indicate that the original river level was at an elevation of approximately 660 ft MSL. Since the water depth, h, is in the denominator, a smaller depth would produce a larger (i.e., more conservative) wind setup. Therefore, the staff used the relatively conservative average water depth value of 30 ft.

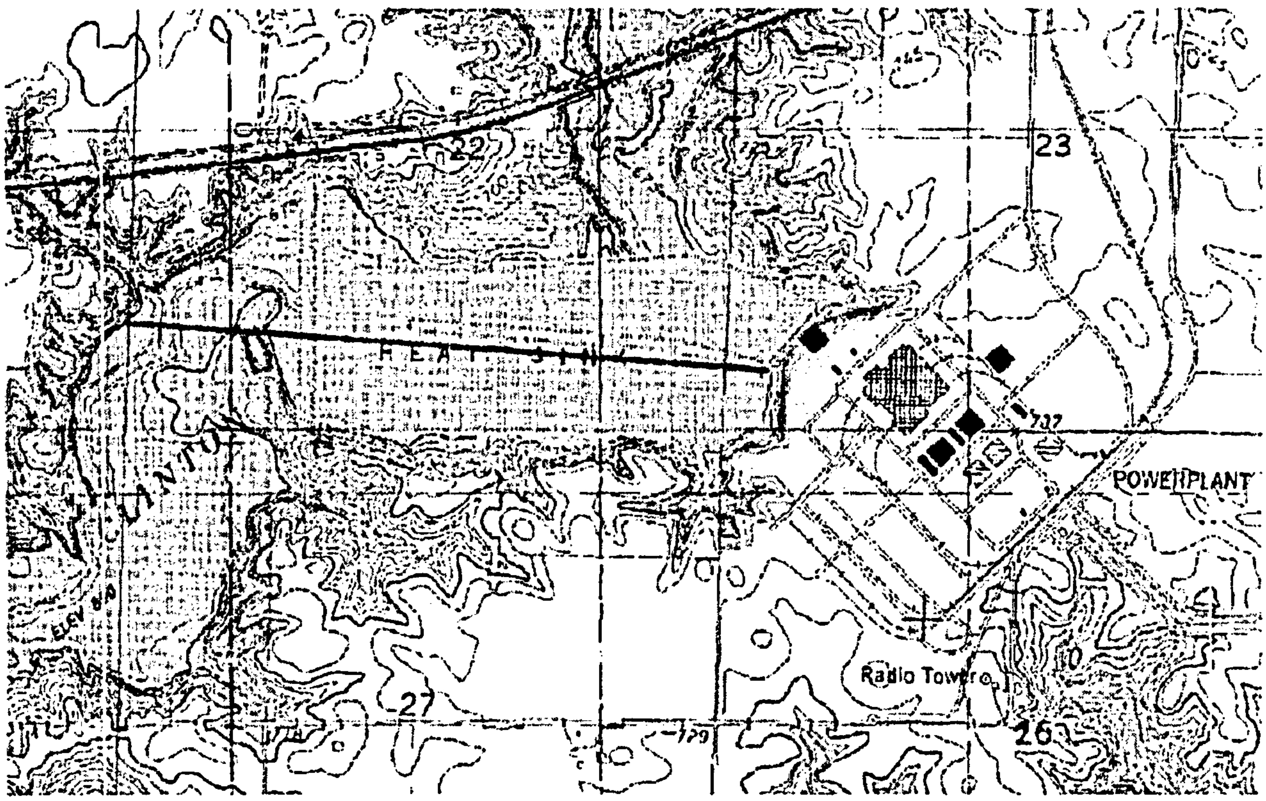


Figure 2.4-11 Clinton Power Station site and fetch length

One of the derivation assumptions in the wind setup equation above is that the wind speed is steady and uniformly blowing in the direction of maximum fetch. The staff conservatively estimated the PMWS, as defined by ANSI/ANS 2.8-1992, to be equal to a 100-mph wind. This windstorm is based upon the location of the site, which is within 150 miles of the Great Lakes. The staff used this conservative value as the steady over-water wind speed in the wind setup equation.

Using these parameters, the staff estimated the resulting wind setup as 0.3 ft. The staff combined this increase in water surface elevation at the ESP site with the water surface elevation estimated as a result of the PMF and coincident wind wave activity to estimate the maximum water surface elevation at the site in Section 2.4.3 of this SER.

The staff estimated the period of oscillation resulting from seiche, along the fetch length line shown in Figure 2.4-11 of this SER, based on the theory for free oscillation of water of uniform depth and temperature in a rectangular basin (Wilson, 1972):

$$T = \frac{2L}{\sqrt{gh}}$$

where T is the period of seiche motion in seconds; g is the acceleration resulting from gravity (32.2 feet per square second (ft/s^2)); and L and h are as defined in the equation for wind setup.

The staff estimated the resulting seiche period to be approximately 6.8 minutes. This period is significantly shorter than meteorologically induced wave periods (e.g., synoptic storm pattern frequency and dramatic reversals in steady wind direction required for wind setup). Therefore, the staff concluded that meteorologically forced resonance is not likely. The staff also concluded that seismically induced seiche is unlikely in Clinton Lake because of the large difference between the period of oscillation resulting from seiche and that of seismically induced vibrations.

2.4.5.4 Conclusions

As set forth above, the applicant provided sufficient information pertaining to the identification and evaluation of probable maximum surge and seiche flooding at the site. SSAR Section 2.4.1 conforms to Section 2.4.5 of RS-002, Attachment 2, with regard to this objective.

Section 2.4.5 of RS-002, Attachment 2, provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating probable maximum surge and seiche flooding at the site. Although the applicant did not specifically address the above regulations in SSAR Section 2.4.5, the staff concludes that, by conforming to Section 2.4.5 of RS-002, Attachment 2, it has met the requirements to identify and evaluate probable maximum surge and seiche flooding at the site with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c). In addition, the seismically induced flooding analysis reflects the most severe seismic event historically reported for the site and surrounding area (with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated). In addition, the staff concludes that the applicant partially conforms to GDC 2, insofar as that analysis defines design bases for seismically induced surge and seiche.

2.4.6 Probable Maximum Tsunami Flooding

The EGC ESP site is 6 miles east of the city of Clinton, in DeWitt County, located in central Illinois. It is adjacent to Unit 1 of the CPS on the shore of Clinton Lake, an impoundment on Salt Creek. Salt Creek flows 50 miles from the Clinton Dam to its confluence with the Sangamon River. The Sangamon River, from its confluence with Salt Creek, flows 40 miles to merge with the Illinois River north of Beardstown. The Illinois River flows 90 miles from its confluence with the Sangamon River to meet the Mississippi River near Grafton. The Mississippi River flows 1172 miles from its confluence with the Illinois River to the Gulf of Mexico (NOAA, 2004). The Gulf of Mexico is the body of open water directly downstream from Clinton Lake that is subject to seismically generated tsunamis.

2.4.6.1 Technical Information in the Application

The applicant stated in Revision 0 of SSAR Section 2.4.6 that "the site will not be subjected to the effects of tsunami flooding because the site is not adjacent to a coastal area." In Revision 3 of the SSAR, the applicant also considered the effects of a lake tsunami caused by a hillslope failure. The applicant's analysis produced a maximum tsunami height at 0.4 ft. Based on the elevation of the ESP site, the applicant concluded that landslide-induced tsunamis do not pose a risk to the site.

2.4.6.2 Regulatory Evaluation

SSAR Table 1.5-1 presents the applicant's conformance to the NRC RGs. The staff requested, in RAI 1.5-1, that the applicant provide a comprehensive listing of the NRC regulations applicable to its ESP SSAR. In its response to this RAI, the applicant indicated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. RS-002, Attachment 2, describes the methods of review and the applicable acceptance criteria that the staff uses to develop its findings and conclusions related to the hydrologic aspects of site characterization for an ESP. Although the applicant did not indicate how it addressed the hydrology-related site suitability criteria in RS-002, Attachment 2, the staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance, as identified below.

Section 2.4.6 of RS-002, Attachment 2, provides the following review guidance used by the staff in evaluating this SSAR section:

- 10 CFR Parts 52 and 100, as they relate to identifying and evaluating the hydrologic features of the site
- 10 CFR 100.23, as it relates to investigating the tsunami potential at the site

The regulations at 10 CFR 52.17(a) and 10 CFR 100.20(c) require that the site's physical characteristics (including seismology, meteorology, geology, and hydrology) be taken into account when determining its acceptability to host a nuclear reactor(s). The regulations at 10 CFR Parts 52 and 100 are applicable to Section 2.4.6 of RS-002, Attachment 2, because they address the physical characteristics, including hydrology, the Commission considers when determining the acceptability of the proposed site. To satisfy the hydrologic requirements of 10 CFR Parts 52 and 100, the applicant's safety assessment should contain a description of the hydrologic characteristics of the coastal region in which the proposed site is located and an analysis of severe seismically induced waves. The applicant should describe in detail sufficient to assess the acceptability of the site and the potential for a tsunami to influence the design of SSCs important to safety for a nuclear power plant(s) of specified type that might be constructed on the proposed site. Meeting this requirement provides reasonable assurance that the most severe flooding likely to occur as a result of a tsunami would pose no undue risk to the type of facility proposed for the site.

In those cases for which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting limiting values of parameters. Important PPE parameters for safety assessment identified in Section 2.4 include, but are not limited to, precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami surge level and maximum allowable ground water level).

The regulation at 10 CFR 100.23(c) requires that geologic and seismic factors be considered when determining suitability of the site. This regulation also requires an investigation to obtain geologic and seismic data necessary for evaluating seismically induced floods and water waves. The regulation is applicable to Section 2.4.6 of RS-002, Attachment 2, because it requires investigation of distantly and locally generated waves or tsunami that have affected or could affect a proposed site, including available evidence regarding the runup or drawdown associated with historic tsunami in the same coastal region, as well as local features of coastal topography that might modify runup or drawdown. RG 1.70 provides more detailed guidance on the investigation of seismically induced flooding.

To determine whether the applicant met the requirements of 10 CFR Parts 52 and 100, as well as 10 CFR 100.23, with respect to tsunamis and the analysis thereof, the staff used the following specific criteria:

- If it has been determined that tsunami estimates are necessary to identify flood or low-water design bases, the staff will consider the analysis complete if the following areas are addressed and can be independently and comparably evaluated from the applicant's submission:
    - All potential distant and local tsunami generators, including volcanoes and areas of potential landslides, are investigated and the most critical ones are selected.
    - Conservative values of seismic characteristics (source dimensions, fault orientation, and vertical displacement) for the tsunami generators selected are used in the analysis.
    - All models used in the analysis are verified or have been previously approved by the staff. RG 1.125 provides guidance on the use of physical models of wave protection structures.
    - Bathymetric data are provided (or are readily obtainable).
    - Detailed descriptions of shoreline protection and safety-related facilities are provided for wave runup and drawdown estimates. RG 1.102 provides guidance on flood protection for nuclear power plants.
    - Ambient water levels, including tides, sea level anomalies, and wind waves, are estimated using NOAA and Corps of Engineers publications as described below.
    - If the applicant adopts Position 2 of RG 1.59, it should show at the COL that the design basis for tsunami protection of all safety-related facilities identified in RG 1.29 is adequate in terms of the time necessary for implementation of any emergency procedures.
- The applicant's estimates of tsunami runup and drawdown levels are acceptable if the estimates are no more than 5 percent less conservative than the staff's estimates. If the applicant's estimates are more than 5 percent less conservative (based on the difference between normal water levels and the maximum runup or drawdown levels) than the staff's, the applicant should fully document and justify its estimates or accept the staff's estimates.
- This section of the safety assessment will also be acceptable if it states the criteria used to determine that tsunami flooding estimates are not necessary to identify the flood design basis (e.g., the site is not near a large body of water).

2.4.6.3 Technical Evaluation

During its independent review, the staff found that, in extreme cases along coastal areas, the shoreline water level has risen to more than 50 ft for a tsunami of distant origin and over 100 ft for tsunami waves generated near the earthquake's epicenter (NOAA, 2004). However, since the ESP site is located at an elevation of 735 ft MSL and is at a great distance from the coast and more than 93 miles from the Great Lakes, the staff concluded that the effects of even the largest ocean tsunami or a tsunami caused in the Great Lakes would not be high enough to exceed the elevation of the ESP site.

The staff also considered the potential for flooding along the shores of Clinton Lake near the ESP site that could result from a seismically induced hillslope failure. Such a wave would have the potential to cause a tsunami-like wave, as discussed in RG 1.59. The applicant's response to RAI 2.4.2-3, however, indicated that the slopes near the ESP site have been stable for the past 30 years, and that no landslides are documented for DeWitt County.

The updated SSAR Figure 1.2-4 (in response to RAI 2.4.1-1) displays the location of the essential safety-related features of the ESP site. All features, except the new intake structures, are located more than 600 ft from the shores of Clinton Lake at an elevation of 735 ft MSL, or 45 ft above the normal water surface elevation of Clinton Lake. The height of the hillslope banks directly opposite the ESP site is approximately 40 ft above the surface of the water. Waves generated from a hillslope failure on these banks would also need to transect the UHS pond and underwater dikes before reaching the ESP site, potentially removing energy from these waves as they pass over the shallow water zones. The staff therefore concluded that tsunami-like waves induced by hillslope failure do not pose a risk to the ESP site.

2.4.6.4 Conclusions

As set forth above, the applicant provided sufficient information pertaining to the identification and evaluation of probable maximum tsunami flooding at the site. SSAR Section 2.4.6 conforms to Section 2.4.6 of RS-002, Attachment 2, with regard to this objective.

Section 2.4.6 of RS-002, Attachment 2, provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating probable maximum tsunami flooding at the site. Although the applicant did not specifically address these regulations in SSAR Section 2.4.6, the staff concludes that, by conforming to Section 2.4.6 of RS-002, Attachment 2, it has met the requirements to identify and evaluate tsunami flooding with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c). Further, the staff finds that the applicant has considered the most severe natural phenomena that have been historically reported for the site and surrounding area in establishing the design bases for tsunamis, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. Therefore, the applicant partially conforms to GDC 2, insofar as that analysis defines design bases related to tsunamis.

2.4.7 Ice Effects

The EGC ESP site is located on the shore of Clinton Lake, approximately 6 miles east of the city of Clinton in Dewitt County, Illinois. Clinton Lake is an impoundment formed by construction of an earthen dam across Salt Creek about 1200 ft downstream from the confluence of the North Fork of Salt Creek with Salt Creek. The ESP site is located approximately 3.5 miles northeast of the dam.

The climate of central Illinois is typically continental, with cold winters and frequent short-period fluctuations in temperature, humidity, cloudiness, and wind direction. Alternating periods of steady precipitation (rain, freezing rain, sleet, or snow) and clear, crisp cold weather characterize winter.

2.4.7.1 Technical Information in the Application

The applicant used the USGS streamflow data measured at the Rowell gauge to identify ice formation in streams. The gauge is located approximately 12 miles downstream from the Clinton Dam. The applicant reported intermittent ice effects during the winter months. An ice jam recorded on February 11, 1959, resulted in a maximum gauge height of 24.84 ft and a peak discharge of 7500 cfs. The gauge datum was at elevation 610 ft MSL. The applicant estimated that a discharge of 7500 cfs corresponds to a gauge height of 22.14 ft and, consequently, the ice jam raised the water surface by 2.7 ft.

The applicant stated that the wintertime PMP depth in February is 13.8 in., 11.4 in. less than the 48-hour PMP depth for August of 25.2 in. The applicant concluded that the effects of an ice jam flood in combination with a wintertime PMF on the water surface in Clinton Lake would be less than that resulting from the summertime PMF.

The applicant estimated the average thickness of the ice sheet that could form on the surface of Clinton Lake as 10 in., neglecting the heat discharged into the lake during operation of any station units. The design water level of the UHS is 675 ft MSL, and the inlet to the CPS screenhouse is at elevation 670 ft MSL. The applicant stated that a water depth of 12.3 ft above the intake will be available for station operation, even under low-water conditions. The applicant concluded that the formation of a 10-in.-thick ice sheet will not block flow into the CPS screenhouse.

The applicant stated that low-flow conditions resulting from ice jams on streams upstream of the ESP site will not affect the UHS because of its submerged conditions. The applicant stated that the UHS capacity will be maintained.

The applicant stated that the only ESP facility safety-related structure exposed to the ice sheet formed on the surface of Clinton Lake would be the intake structure. The intake structure would be similar to, but considerably smaller than, the existing intake structure. The new intake would be located at the same depth as the existing intake.

The applicant described the possibility of an ice sheet formation on the surface of Clinton Lake in SSAR Section 2.4.7, but that section did not describe the possibility nor the impact of a collision of the ice sheet or a breakaway chunk of the ice sheet with the intake structure. The staff requested, in RAI 2.4.7-1, that the applicant discuss the potential for ice sheet collision impacts on the intake structure and quantify the force of this impact. In response to RAI 2.4.7-1, the applicant stated that because a potential for formation of an ice sheet that could affect the intake structure exists, it will consider ice sheet effects at the COL stage. The applicant revised SSAR Section 2.4.7 to state that the force resulting from the interaction of a moving ice sheet and a structure results from crushing, bending, buckling, splitting, or a combination of these modes. The total force on the entire structure is important in designing foundations that resist sliding and overturning. Contact forces over small areas are important for designing the internal structural members and external skin of the structure.

SSAR Section 2.4.7 stated that the expected average thickness of an ice sheet that may form on the surface of Clinton Lake is 10 in. The staff requested, in RAI 2.4.7-2, that the applicant explain how it estimated the ice sheet thickness identified in SSAR Section 2.4.7 and provide the input assumptions for this estimation. In response to RAI 2.4.7-2, the applicant stated that it calculated the ice thickness using the method described in USACE, EM 1110-2-1612, "Engineering and Design—Ice Engineering," issued in October 2002. General assumptions in the applicant's calculation included an ice formation period of November through February and little snow accumulation on the ice surface. Since there are no records for freezeup of Clinton Lake, the applicant determined an approximate date based on observed freezeup dates for Lake Monona in Madison, Wisconsin, which is of similar size and volume as Clinton Lake and is located approximately 180 miles north of Clinton Lake. The applicant used air temperature data from Decatur, Illinois, located 10 miles south of Clinton Lake, to estimate freezing degree-days for the winter seasons of 1978 through 2003. The applicant used a conservative coefficient of ice cover (0.8) that assumed a windy lake with no snow cover. The applicant reported a maximum ice thickness of 22.2 in. and an average thickness of 14.2 in. The applicant will revise the SSAR to include additional information on ice depth.

SSAR Section 2.4.7 did not provide sufficient detail for the staff to determine the relationship of the ESP intake structure to the existing CPS intake structure. It was also not possible to determine the depth of water over the intake during normal and low-water conditions. The staff requested, in RAI 2.4.7-3, that the applicant describe the relationship, including the layout and depth, of the ESP intake relative to the current CPS intake. In response to RAI 2.4.7-3, the applicant stated that the ESP facility intake will be located 65 ft west of the existing CPS plant intake. The applicant stated that the bottom concrete slab of the CPS intake structure is located at an elevation of 657.5 ft MSL, and the intake extends from an elevation of 670 ft MSL to an elevation of 697 ft MSL. The elevation of the bottom of Clinton Lake is 668.5 ft MSL. The applicant stated that the layout of the ESP facility intake would be similar to the CPS plant intake. The bottom of the ESP facility intake would be located at an elevation of 670 ft MSL, and the inlet opening would extend upwards to at least the normal water surface elevation in Clinton Lake, which is 690 ft MSL. The applicant stated that the basemat of the ESP facility intake would be located at an approximate elevation of 657.5 ft MSL; the final elevation would depend on the submergence required by the pumps. The applicant also stated that the ESP facility intake pumps would be mounted at an approximate elevation of 699 ft MSL, the same elevation as the CPS intake pumps.

SSAR Section 2.4.7 did not provide sufficient detail regarding formation of frazil and anchor ice on or near the intake structure. The staff requested, in RAI 2.4.7-4, that the applicant describe site characteristics for frazil and anchor ice formation. In response to RAI 2.4.7-4, the applicant revised Chapter 2 of the SSAR and added a new section (Section 2.4.7.1) on frazil ice and anchor ice. The applicant stated in the new SSAR Section 2.4.7.1 that accumulation of frazil and anchor ice can cause blockages of intake water systems. This ice accumulates on trash racks or screens in the intake pathway. Frazil ice has a fine, small, needle-like structure or thin, flat, circular plates of ice suspended in water. In supercooled water, frazil ice particles can adhere to form clusters or flocs that can accumulate in trash racks or screens. Frazil ice on the surface of supercooled water can form floating ice pans. Frazil ice can also form as hanging dams on the bottom of a solid ice sheet. Anchor ice is submerged ice attached to the streambed. Generally, anchor ice forms in shallow, turbulent waters. The applicant stated that conditions that might lead to formation of frazil or anchor ice could occur in streams that empty into Clinton Lake but are not expected in the intake structure area. The applicant stated that when anchor ice breaks loose from the streambed, it flows into Clinton Lake and forms or joins with the cover ice on the lake. The applicant concluded that this anchor ice would not interfere with the operation of the ESP facility intake structure.

The applicant stated that the CPS water intake is designed to avoid obstruction from surface ice and accumulation of frazil ice by circulating waste heat through a warming line back to the inlet of the screenhouse. This warming line is designed to maintain a minimum water temperature of 40 °F at the intake during winter operation. The applicant stated that the CPS plant has not experienced operational problems because of frazil ice accumulation in the intake.

The applicant stated that the ESP facility intake would be located in the vicinity of the existing CPS intake. The applicant stated that a warming line from the hot side of the cooling towers would be provided to the ESP facility intake to prevent formation of frazil ice at the intake for NHS cooling tower makeup. The applicant also stated that it would design these features independently of the existing CPS facility.

SSAR Section 2.4.7 did not provide sufficient information regarding formation of ice in the lake or near the intake structure during periods when the existing unit is nonoperational, thus eliminating the heat load to Clinton Lake. The staff requested, in RAI 2.4.7-5, that the applicant discuss the impacts to ice formation if the existing unit were no longer operating. In response to RAI 2.4.7-5, the applicant discussed this issue in two new paragraphs that it added to the end of SSAR Section 2.4.7, as well as in the new SSAR Section 2.4.7.1 provided in response to RAI 2.4.7-4.

The two new paragraphs that the applicant added to Section 2.4.7 state that no ice formation currently occurs in the discharge channel when the CPS Unit 1 is operating. The applicant expected no change to occur with the addition of the proposed ESP facility. The capacity of the discharge channel is approximately 3058.3 cfs or 1.37 million gpm at a discharge velocity of 1.5 feet per second (fps). The discharge from CPS Unit 1 is approximately 445,000 gpm of warm cooling water during the winter months. The ESP facility would add a blowdown water discharge of 12,000 gpm, increasing the discharge in the channel to 457,000 gpm. The applicant stated that this combined discharge is well within the discharge capacity of the channel.

The applicant stated that there is some possibility of ice formation on portions of the discharge channel if only the ESP facility is in operation. Under these circumstances, warm water discharge to the channel would be significantly reduced, resulting in a lower heat output and a lower flow velocity, leading to an increased potential for surface ice accumulation, particularly at locations away from the point of discharge. The applicant stated that the ice accumulation would be much thinner than the predicted normal lake accumulation because of the heat and velocity components of the ESP facility discharge. The applicant also stated that, if ice did form, it would remain on the surface, allowing unrestricted flow below the water surface. The applicant concluded that it did not expect jamming and clogging of the discharge channel because of icing.

SSAR Section 2.4.7 did not provide sufficient detail for the staff to determine if formation of ice on the lake and near the intake structure could constrain intake depth. The staff requested, in RAI 2.4.7-6, that the applicant discuss whether ice sheet formation is likely to constrain the ESP facility UHS intake depth. In response to RAI 2.4.7-6, the applicant stated that ice sheet formation in Clinton Lake will not constrain the ESP facility's UHS intake depth. The applicant stated that the thickness of ice cover is a small percentage of the intake height, and warming water used to prevent formation of frazil ice will retard the formation of an ice cover in the immediate area of the intake trash racks or screens. The applicant revised SSAR Section 2.4.7 to provide additional information on ice effects related to the ESP facility's UHS intake depth.

SSAR Section 2.4.7 provided an average thickness of an ice sheet on the surface of Clinton Lake. The staff needed to understand if such an ice sheet formation, coupled with a loss of Clinton Dam and subsequent draining of the main lake, could lead to a loss of capacity of the submerged UHS pond. The staff requested, in RAI 2.4.7-8, that the applicant describe the reduction in UHS capacity caused by a loss of Clinton Dam during periods when an ice sheet is covering the lake. In response to RAI 2.4.7-8, the applicant stated that the UHS for the ESP facility will consist of cooling towers, if the selected reactor type does not use passive emergency cooling methods. The applicant stated that Clinton Lake is used as a source of makeup water for the ESP facility's UHS cooling towers and not as a heat sink. The applicant stated that if Clinton Dam were to be lost, any surface ice would also be expected to be lost since it floats on the surface. The applicant also stated that, if this surface ice sheet were to drop to an elevation equal to the top of the submerged UHS pond, a small decrease in the capacity of the submerged UHS pond, which acts as the heat sink for CPS Unit 1, would occur. The applicant stated that during this condition, additional heat removal capacity would be available in the submerged UHS pond in the form of latent heat of fusion of ice. The applicant also stated that adequate water for makeup to the ESP facility's UHS cooling towers would be available, since the required shutdown of CPS after a dam failure would supply heat to the submerged UHS pond and convert the ice back into water.

In Revision 2 of the SSAR, the applicant stated that ice thickness calculations were carried out for the period 1902 through 2001. The applicant reported that the average ice sheet thickness over this period was 16.2 in. and that the maximum was 27.0 in. during 1977-78 winter. The applicant used accumulated freezing degree-days (AFDD) data from USACE Engineering Research and Development Center (ERDC) at the Cold Regions Research and Engineering Laboratory (CRREL) and the approach as described by ERDC/CRREL Technical Note 04-3. The applicant used a value of 0.8 for the ice cover condition coefficient. The applicant stated that the average AFDD was 409.9 with a maximum of 1141.5 (in Fahrenheit degree days).

The applicant stated in Revision 2 of the SSAR that the openings of ESP intake structure will extend vertically from the water surface elevation to approximately 669 ft MSL, providing a vertical opening of about 21 ft when the Clinton Lake water surface elevation is at a normal pool level of 690 ft MSL. An ice sheet, equal in thickness to the maximum estimated ice-sheet thickness of 27.0 in., would potentially block only a small portion of the intake opening, leaving approximately 18.75 ft of vertical opening for water intake with initial lake water surface elevation at 690 ft MSL before ice formation, and a vertical opening of 5.75 ft if the initial lake water surface elevation were at the minimum of 677 ft MSL. The applicant stated that this vertical opening, combined with a normal horizontal dimension of the opening for an intake structure, would still be adequate for intake water requirements of the ESP plant.

The applicant stated in Revision 2 of the SSAR that no ice currently forms in the discharge channel with the CPS in operation, which discharges about 445,000 gpm of warm cooling water during winter months. The applicant reported that the capacity of the discharge canal at a flow velocity of 1.5 fps is 1,372,000 gpm, which will not be exceeded with the addition of approximately 12,000 gpm of warm blowdown water from the proposed ESP facility.

The applicant stated that there is some possibility of ice formation in the discharge channel if the ESP facility is operated alone and the CPS is offline, since the warm water discharge to the canal would be reduced to only 12,000 gpm. However, the applicant stated that any such ice would be thin, remain only on the surface, and not restrict flow in the discharge canal.

In Revision 2 of the SSAR, the applicant included a description of formation of frazil and anchor ice. The applicant stated that the current CPS facility water intake is designed to avoid obstruction from surface ice and accumulation of frazil ice by recirculating warm cooling water via a warming line back into the inlet to the screen house. The applicant noted that the warming line is designed to maintain a minimum water temperature of 40 °F during winter at the intake. The applicant reported that the CPS has not encountered a problem due to frazil ice accumulation on intake facilities.

The applicant stated in Revision 2 of the SSAR that a means to prevent the formation of frazil ice at the intake for essential service water cooling tower make-up would be provided, such as a warming line from the hot side of the cooling towers back to the intake. The applicant stated that the design of these features would support the operation of the ESP facility independent of the CPS facility.

The applicant estimated that approximately 326 ac-ft of liquid water would be displace by a 27.0 in ice sheet settling down on the UHS pond in the event of complete loss of the main dam. The applicant also estimated that an excess capacity of 395 ac-ft is normally available. Since the evaporation of water from the pond would be negligible in presence of complete ice cover, the applicant estimated that the net change would result in essentially the same excess capacity of liquid water in the UHS pond. If the main dam failure occurs with maximum ice thickness on the lake and the CPS facility not in operation, the UHS water normally reserved for CPS shutdown would also be available to the ESP facility. The applicant concluded that the UHS liquid water capacity is sufficient to support the combined emergency operation of CPS and the ESP facilities.

2.4.7.2 Regulatory Evaluation

SSAR Table 1.5-1 presents the applicant's conformance to the NRC RGs. The staff requested, in RAI 1.5-1, that the applicant provide a comprehensive listing of the NRC regulations applicable to its ESP SSAR. In its response to this RAI, the applicant indicated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. RS-002, Attachment 2, describes the methods of review and the applicable acceptance criteria that the staff uses to develop its findings and conclusions related to the hydrologic aspects of site characterization for an ESP. Although the applicant did not indicate how the individual sections of SSAR Section 2.4 addressed the hydrology-related site suitability criteria in RS-002, Attachment 2, the staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance, as identified below.

Section 2.4.7 of RS-002, Attachment 2, provides the review guidance used by the staff in evaluating this SSAR section. Acceptance criteria for this section are based on meeting the requirements of 10 CFR Parts 52 and 100, as they relate to identifying and evaluating the hydrologic features of the site. Further, RS-002, Attachment 2, states the following:

> Compliance with 10 CFR 52.17(a) and 10 CFR 100.20(c) require that the site's physical characteristics (including seismology, meteorology, geology, and hydrology) be taken into account when determining its acceptability for a nuclear power reactor. To satisfy the hydrologic requirements of 10 CFR Parts 52 and 100, the SSAR should contain a description of any icing phenomena with the potential to result in adverse effects to the intake structure or other safety-related facilities for a nuclear power plant or plants of a specified type (or falling within a PPE) that might be constructed on the proposed site. Ice-related characteristics historically associated with the site and region should be described, and an analysis should be performed to determine the potential for flooding, low water, or ice damage to safety-related SSCs. The analysis should be sufficient to evaluate the site's acceptability and to assess the potential for those characteristics to influence the design of SSCs important to safety for a nuclear power plant or plants of a specified type (or falling within a PPE) that might be constructed on the proposed site. Meeting this guidance provides reasonable assurance that the effects of potentially severe icing conditions would pose no undue risk to the type of facility proposed for the site.

In those cases for which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting limiting values of relevant parameters. RG 1.59 provides guidance for developing the hydrometeorologic design basis.

To judge whether the applicant has met the requirements of 10 CFR Parts 52 and 100, as they relate to ice effects, the staff used the following specific criteria in RS-002, Attachment 2:

- Publications of NOAA, USGS, USACE, and other sources are used to identify the history and potential for ice formation in the region. Historical maximum depths of icing should be noted, as well as mass and velocity of any large, floating ice bodies. The phrase, "historical low water ice affected," or similar phrases in streamflow records (USGS and State publications) will alert the reviewer to the potential for ice effects. The applicant should consider and evaluate if the following items are necessary:

    - The regional ice and ice jam formation history should be described to enable an independent determination of the need for including ice effects in the design basis.

    - If the potential for icing is severe, based on regional icing history, it should be shown that water supplies capable of meeting safety-related needs are available from under the ice formations postulated and that safety-related equipment could be protected from icing as in the second item above. If this cannot be shown, it should be demonstrated that alternate sources of water that could be protected from freezing are available and that the alternate source would be capable of meeting safety-related requirements in such situations.

- If floating ice is prevalent, based on regional icing history, potential impact forces on safety-related intakes should be considered. The dynamic loading caused by floating ice should be included in the structural design basis. (This item is to be addressed at the COL or CP stage.)

- If ice blockage of the river or estuary is possible, the applicant should demonstrate that the resulting water level in the vicinity of the site has been considered. If this water level would adversely affect the intake structure, or other safety-related facilities of a nuclear power plant(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site, it should be demonstrated that an alternate safety-related water supply would not also be adversely affected.

- The applicant's estimates of potential ice flooding or low flows are acceptable if the estimates are no more than 5 percent less conservative than the staff estimates. If the applicant's estimates are more than 5 percent less conservative than the staff's, the applicant should fully document and justify its estimates or accept the staff estimates.

2.4.7.3 Technical Evaluation

The applicant reported an ice jam on Salt Creek at Rowell that formed on February 11, 1959. The staff searched the USACE historical Ice Jam Database and found two reported ice jams on Salt Creek near Rowell. One of these jams was the February 11, 1959, ice jam the applicant reported. This ice jam resulted in a maximum gauge height of 24.84 ft. The staff found that the mean daily discharge in Salt Creek near Rowell on this day was 6800 cfs and the peak discharge was 7500 cfs, according to the USGS streamflow observations in the NWISWeb Data for the Nation Web site. The other ice jam was reported on January 8, 1996. This ice jam resulted in low-water conditions on January 8 and 9, with a daily mean discharge of 8.5 cfs. Examination of daily streamflow records at Rowell shows a decrease in daily mean discharge from 13 cfs on January 1 to a low of 8.5 cfs on January 8 and 9, and a return to 13 cfs on January 16, 1996.

The staff prepared a stage-discharge relationship from available gauge heights for peak streamflow at the Rowell gauge using data from the period before the construction of Clinton Dam. Figure 2.4-12 of this SER shows this stage-discharge relationship. Using this relationship, the staff estimated a stage of 22.8 ft corresponding to a discharge of 7500 cfs, and an ice-jam-induced stage increase of 2.0 ft. If an ice-jam-induced flood were to augment the PMF, the maximum expected water surface elevation in Clinton Lake would be 718.5 ft MSL.

The staff estimated the all-season PMP depth for Clinton Lake's drainage area in Section 2.4.3 of this SER using HMRs 51 and 52 and ANSI/ANS-2.8-1992. The 48-hour PMP depth was 26.8 in. and the 72-hour PMP depth was 28.7 in. The National Weather Service's current HMRs do not provide a method to estimate a monthly PMP for areas exceeding 10 mi^2. Methods for estimating a monthly PMP appear in HMR 33, but the current HMRs (i.e., HMRs 51 and 52) supersede that report. The staff independently confirmed that the 48-hour winter PMP depth is less than the all-season 48-hour PMP depth. The staff's estimate of the all-season PMP using the current HMRs is greater than the applicant's winter and all-season PMP. The staff concluded that a flood generated by a winter PMP and augmented by an ice-jam flood would be less critical than the all-season PMF.

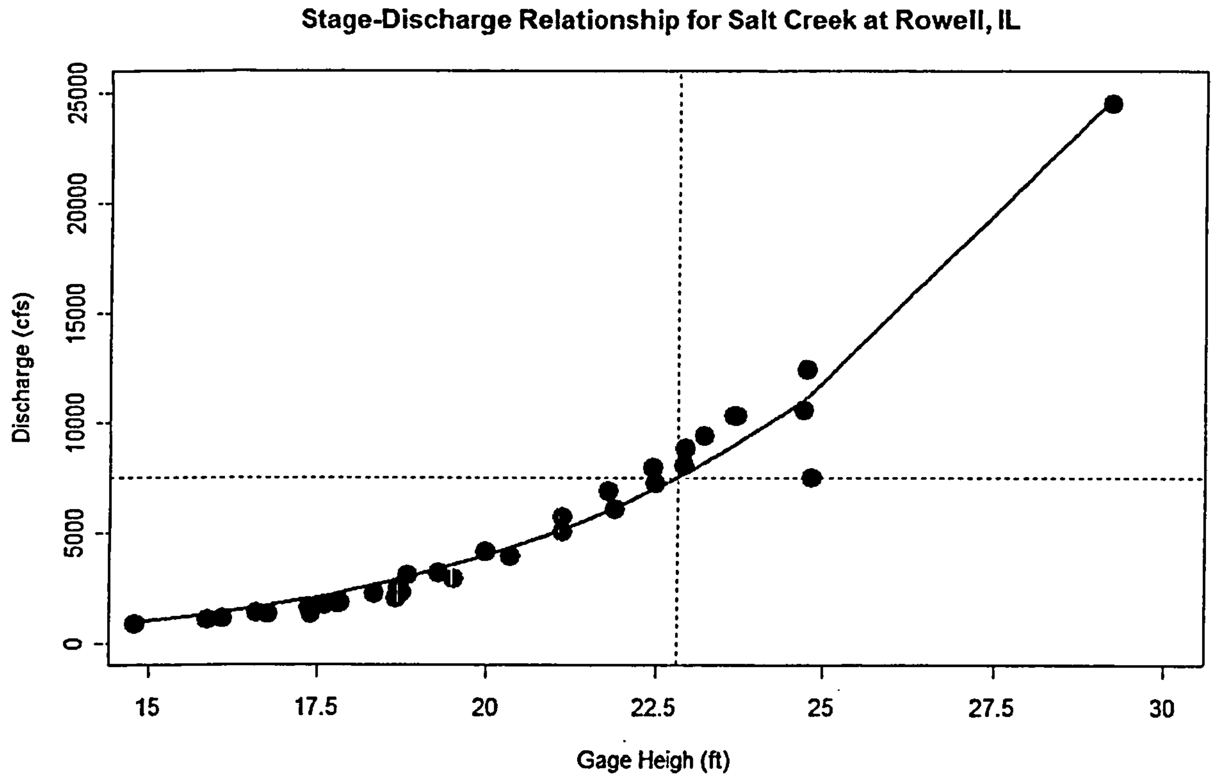


Figure 2.4-12 Stage-discharge relationship for Salt Creek at Rowell, IL

The staff independently estimated the likely surface ice thickness that might form near the intake structures. During this estimation, the staff used mean daily air temperatures recorded at the Decatur, Illinois, meteorologic station. Maximum and minimum daily air temperatures at this station are available for water years 1902 to 1999. The staff estimated cumulative degree-days starting December 1 through May 31 for each water year. The most severe cumulative degree-days below freezing occurred in water year 1978 (see Figure 2.4-13 of this SER).

The maximum accumulated degree-days below freezing during the period of December 1, 1976, to May 31, 1977, was 1086.5 °F, as shown in Figure 2.4-13. The staff used Assur's method (Chow, 1964) to estimate a maximum ice thickness of 31.4 in. The staff determined that it is possible for an ice sheet to form for extended periods in Clinton Lake.

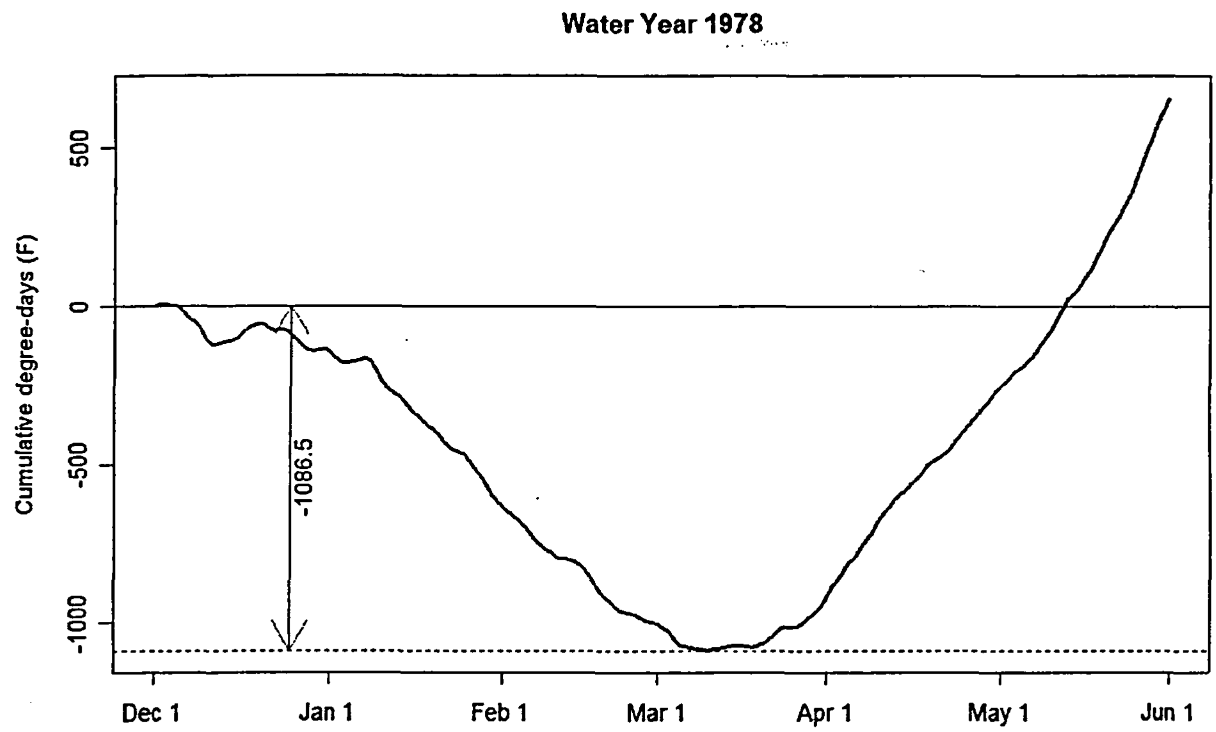


Figure 2.4-13 Accumulated degree-days since December 1, 1977, at the Decatur meteorologic station

SSAR Section 2.4.7 did not describe the possibility and potential impact of a collision of the ice sheet or a breakaway chunk of the ice sheet with the intake structure. The staff needed to evaluate the possibility of any limitations on the performance of safety-related intakes subsequent to such an impact. In RAI 2.4.7-1, the staff requested that the applicant discuss this potential collision and its impact on the ESP facility intake structure. In response to RAI 2.4.7-1, the applicant stated that a potential exists for an ice sheet to affect the intake structure, and the COL applicant would consider these effects at the COL stage. Since the ESP facility intake structure is safety related and the potential for ice formation is a site-induced condition, the COL applicant would need to demonstrate that the intake structure can withstand the effects of any ice sheet crushing, bending, buckling, splitting, or a combination of these modes. This is **COL Action Item 2.4-5.** The staff had planned to include this issue as DSER Permit Condition 2.4-5. The staff had also planned to specify attributes of the ice sheet, such as its thickness, mass, and velocity, that the applicant should use for design of the ESP facility's UHS intake structures. The staff established maximum ice thickness based on its review of applicant's response to DSER Open Item 2.4-9 (see below). However, the need for a UHS intake structure will depend on whether the selected reactor type requires a UHS. The staff determined that COL Action Item 2.4-5 is sufficient to ensure the safety of the ESP facility's UHS intake structures, if the selected reactor design requires a UHS and concluded that it is not necessary to impose DSER Permit Condition 2.4-5.

SSAR Section 2.4.7 did not provide sufficient details about the estimation of ice sheet thickness. In RAI 2.4.7-2, the staff requested that the applicant provide details of the ice sheet thickness estimation, including the input assumptions for the method employed. The staff performed its own independent estimation of the thickness of an ice sheet that may form on the surface of Clinton Lake. The staff used air temperature data from the Decatur meteorologic station as described above. The staff's estimate of ice sheet thickness was significantly greater than that of the applicant's. Therefore, the staff determined that the applicant needed to provide more details regarding the method and air temperature dataset it used in estimating the thickness of an ice sheet that may form on the surface of Clinton Lake. The staff also asked the applicant to demonstrate that the ice thickness estimate is adequate. This was DSER Open Item 2.4-9.

In response to DSER Open Item 2.4-9, the applicant stated, in its submission to the NRC dated April 26, 2005, that it obtained additional data, evaluated the differences between its and the staff's methods, and revised its estimate of ice thickness in Clinton Lake. The applicant presented the air temperature data and the method used for estimating the ice thickness in Clinton Lake in an attachment to its response.

The applicant stated that the above described evaluation established an expected maximum ice thickness of 24.8 in. for Clinton Lake, which should be used for determining the water available in the submerged UHS pond. The applicant stated that it based its estimation of expected maximum ice thickness on worst-case available air temperature data from the Decatur meteorologic station, which resulted in an estimated 1065 °F accumulated freezing degree-days. The applicant used procedures described in USACE EM1110-2-1612 (this document is also referred to as USACE (2002)) to estimate ice thickness as a function of estimated accumulated freezing degree-days. The applicant estimated the onset of ice layer formation in Clinton Lake based on observed freezing in another lake located approximately 180 miles north of Clinton Lake. The applicant disagreed with the staff's method for setting the onset of ice layer formation (the onset date affected the estimation of accumulated freezing degree-days) and the actual relationship used to estimate the ice thickness (the applicant claimed that the relationship used by the staff in the DSER did not consider recent advances in ice thickness estimation relationships).

The staff reviewed the applicant's response to DSER Open Item 2.4-9, including the additional data presented by the applicant and the details of the methods employed by the applicant for estimating ice thickness in Clinton Lake. The staff determined that the applicant used the same data as the staff had in preparing the DSER, except for the slightly longer duration of the dataset. The staff used air temperature collected at the Decatur meteorologic station for water years 1902–1999, and the applicant used air temperature data for all winters from 1896–2003. The longer dataset used by the applicant did not change the worst winter year (in terms of accumulated freezing degree-days) from that determined by the staff in its previous assessment.

The staff determined that there are two major differences in the revised ice-thickness procedure presented by the applicant in its response to DSER Open Item 2.4-9 as compared to the staff's previous procedure used in the DSER. The first difference is that the applicant used the estimation equation in USACE (2002), whereas the staff used Assur's 1956 equation in its DSER review. The second difference is that the applicant estimated the maximum accumulated freezing degree-days starting from an estimated freezeup onset date, whereas the staff used a fixed December 1 freezeup date in its DSER review. These two differences are discussed in detail below.

Ice Thickness Estimation Equation

Assur's ice-thickness estimation equation, which the staff used in the DSER, was published in 1956. The USACE (2002) estimation equation is more recent than Assur's estimation equation, although both equations estimate an ice thickness that is proportional to the square root of accumulated freezing degree-days. The difference between the two methods arises from the use of different coefficients of proportionality. Assur's equation applies a constant of proportionality of ($1.06 \times \alpha$), with different values for α recommended for ice sheets covered with moderate snow (α ranging from 0.65 to 0.75) and for ice sheets not covered with snow (α ranging from 0.85 to 0.9). Assur suggested a theoretical maximum value of 1.0 for α. The USACE (2002) equation applies a constant of proportionality α, only. The recommended value of α under windy, snow-free lake conditions is 0.8 and that under average lake conditions, in the presence of a snow cover, ranges from 0.5 to 0.7. Assur's equation is more conservative than the USACE (2002) equation because of the differences in the recommended values of α and the presence of 1.06 multiplier in Assur's equation. The staff used the most conservative α (equal to 0.9) recommended by Assur in the DSER review, which implies an ice sheet not covered with snow. For similar conditions, USACE (2002) recommends a maximum α of 0.8. Therefore, use of Assur's equation would yield an ice thickness 19 percent larger than that derived from the USACE (2002) equation for the same accumulated freezing degree-days.

The applicant stated in its response to DSER Open Item 2.4-9 that the USACE (2002) equation was more accurate because it was a refinement on the earlier method based on additional study. The staff's review of USACE (2002) did not provide any substantiation of this statement. The applicant did not provide any other reference that describes this refinement to enable the staff to assess the accuracy of the USACE (2002) equation in relation to Assur's equation. The applicant also stated that both ice-thickness estimation equations likely overestimate the ice thickness, but did not provide any references to substantiate this statement.

The staff contacted researchers at the USACE CRREL to determine the currently accepted standard for estimating ice thickness. Based on email communication with CRREL, the staff determined that USACE (2002) is the currently accepted standard for design ice engineering. Based on the above review, the staff determined that the USACE (2002) equation is acceptable for estimating the ice thickness in Clinton Lake and other safety-related water storage reservoirs, should any be required by the selected ESP plant reactor type.

USACE (2002) states that a differential equation describing the rate of thermal growth of an ice cover can be written based on several assumptions. These assumptions are (USACE, 2002):

1. Ice forms in a homogeneous, horizontal layer,
2. Ice grows only at its horizontal interface with water,
3. The thermal conditions in the ice layer are quasi-steady,
4. The heat flux from the water is negligible,
5. The heat flux is only in the vertical direction, and
6. The heat loss from the surface of the ice layer to the atmosphere is a linear function of the temperature difference between the surface of the ice layer and the air.

The first five assumptions above are appropriate for an ice cover formation on a lake surface when the horizontal extent of the ice cover is large compared to its thickness, and the lake is not very deep. The sixth assumption may be inaccurate at the beginning of ice formation when the ice cover is very thin.

The rate of thermal growth of ice can be expressed as

$$\frac{dh}{dt} = \frac{1}{\rho\lambda}\frac{(T_m - T_a)}{\left(\frac{h}{k_i} + \frac{1}{H_{ia}}\right)}$$

where h is ice thichness, t is time, T_m is temperature at ice and water interface, T_a is air temperature, k_i is thermal conductivity of ice, H_{ia} is heat transfer coefficient from the surface of the ice to the atmosphere, ρ is density of ice, and λ is latent heat of ice. The nonlinear differential equation above can be solved (USACE 2002) to yield

$$h_j = \sqrt{(B + h_k)^2 + 2A(U_j - U_k)} - B$$

where h_j is calculated ice thickness on jth day, h_k is ice thickness on kth day, either observed or calculated with $j > k$,

$$A = \frac{k_i}{\rho\lambda},\ B = \frac{k_i}{H_{ia}},\ U_j = \sum_{i=1}^{j}(T_m - T_{ai}),\ \text{and}\ U_k = \sum_{i=1}^{k}(T_m - T_{ai}).$$

U_j and U_k are accumulated freezing degree-days between onset of freezeup and days j and k, respectively, with $U_j > U_k$, and T_{ai} is air temperature on ith day. If heat conduction through the ice cover is the controlling rate in overall energy flux (i.e., $k_i << H_{ia}$), B can be ignored. Additionally, if initial ice thickness is assumed to be zero (i.e., $U_k = 0$), then ice thickness on jth day is

$$h_j = \alpha\sqrt{U_j}$$

where

$$\alpha = \sqrt{\frac{2k_i}{\rho\lambda}}.$$

<u>Maximum Accumulated Freezing Degree-Days</u>

The applicant used accumulated freezing degree-days in the USACE (2002) ice-thickness estimation equation based on the most severe winter on record at Decatur, Illinois. The staff used this same winter in its DSER estimation of ice thickness for Clinton Lake. However, the applicant's estimate of accumulated freezing degree-days is 963 °F, as compared to the staff's DSER estimate of 1086.5 °F; the applicant's estimate is, 11.4 percent lower than the staff's DSER estimate.

The staff's review of the applicant's method for estimating accumulated freezing degree-days during winter revealed that the difference between the applicant and the staff's estimate arises mainly from the difference between the onset of freezeup determined by the applicant and that previously assumed by the staff. The applicant presented data for observed freezeup of Monona Lake, which is located approximately 180 miles north of Clinton Lake near Madison, Wisconsin. The Wisconsin State Climatology Office has maintained freezeup dates for Monona Lake since 1851. The applicant analyzed accumulated freezing degree-days and corresponding observed freezeup dates for Monona Lake for the winters from 1896 through 2003, and concluded that accumulated freezing degree-days ranging from a low of 80 °F to a high of 406 °F are required for Monona Lake to reach freezeup. The applicant argued that freezeup in Clinton Lake would be similar to that in Monona Lake, even though the two lakes have different average depths (15 ft for Clinton Lake as compared to 27 ft for Monona Lake). For the winter of 1977–78, the applicant estimated a freezeup date of December 27 for Clinton Lake, assuming that approximately the same number of accumulated freezing degree-days would be required for freezeup to occur for both lakes. The applicant estimated cumulative positive freezing degree-days from November 1 through the day before the observed freezeup date at Monona Lake and assumed that the date of freezeup at Clinton Lake would be the day with the same or nearly the same cumulative positive freezing degree-days. Based on this assumption, the applicant-estimated maximum accumulated freezing degree-days during the winter of 1977–78 is 963 °F, a reduction of 11.4 percent from the staff's DSER estimate of 1086.5 °F.

The staff contacted the Wisconsin State Climatology Office and talked to Dr. Edward Hopkins, the Assistant State Climatologist. Based on this conversation, the staff determined that lake freezeup data for the United States can be obtained from the National Snow and Ice Data Center located in Boulder, Colorado. The Wisconsin State Climatology Office has done some characterization of the extensive freezeup and ice observation it carries out and maintains for some of the Wisconsin lakes, including Monona Lake. According to this characterization (see http://www.aos.wisc.edu/%7Esco/lakes/icesum05.html), the median freezeup date for Monona Lake is December 15. The earliest Monona Lake froze was on November 22, 1880. The latest freezeup date was January 30, 1932.

During the conversation with Dr. Hopkins, the staff also became aware of a power plant that discharges warm water, run through its condenser, into Monona Lake. The staff's further investigation revealed that Madison Gas and Electric owns and operates Blount Station, which was constructed in 1902 with a maximum generating capacity of 200 megawatts (MW) (see http://www.mge.com/about/electric/blount.htm). Although more details of the Blount Station discharge are not available, the staff concluded that Monona Lake is not an appropriate lake to compare to Clinton Lake in terms of freezeup for two reasons. First, the warm water discharged from Blount Station into Monona Lake has some influence on its freezeup dates, particularly since 1902, affecting any estimation of freezeup dates under natural conditions using the observed freezeup of Monona Lake since 1902. An inspection of the time series of duration of ice cover (created by the Wisconsin State Climatology Office) on Monona Lake for the winters from 1851 to 2005 revealed a significant drop in the duration of ice cover immediately after construction of the Blount Station in 1902 (see http://www.aos.wisc.edu/%7Esco/lakes/monona-dur.gif), reflecting the effect of the power plant discharge on the freezing characteristics of the lake. Second, Monona Lake is significantly deeper (27 ft) than Clinton Lake (15 ft). Based on these reasons, the staff determined that the applicant's conclusion that Clinton Lake's freezeup is similar to that of Monona Lake is not appropriate.

The staff obtained freezeup data for lakes in the vicinity of Clinton Lake from the National Snow and Ice Data Center, but could not locate a lake with characteristics similar to those of Clinton Lake for an independent verification of the freezeup dates the applicant used in its analysis. Based on the characteristics of Monona Lake, accounting for the fact that its freezeup in winter is affected by discharge form Blount Station, the staff determined that it is not overly conservative to assume a freezeup date of December 1 for Clinton Lake. In years not affected by the Blount Station discharge, Monona Lake froze as early as November 22.

Based on the above review, the staff determined that ice thickness in Clinton Lake should be determined using a conservative freezeup date of December 1 and the USACE (2002) estimation equation. The staff's revised its estimate of maximum ice thickness in Clinton Lake to 26.4 in. as shown below.

$$h_i = \alpha \cdot \sqrt{AFDD} = 0.8 \times \sqrt{1086.5} = 26.4\, in$$

Based on the above review, the staff had planned to include a maximum ice thickness of 26.4 in. as a site characteristic in any ESP that may be issued for this site.

Subsequent to discussions with the applicant over concerns that December 1 may be too conservative (i.e., early in the winter season) for initiation of freeze-up, the staff reviewed USACE technical note ERDC/CRREL TN-04-3, "Methods to estimate River Ice Thickness Based on Meteorological Data" by K.D. White. This technical note recommends that freezing degree days (FDD) and AFDD be calculated starting October 1 of each water year. The technical note mentions that AFDD do not begin accumulating until the first sustained period of cold temperatures, and that the "zero AFDD" point be assigned to a day in late fall or early winter when the AFDD curve goes from a negative to a consistently positive slope.

The staff obtained AFDD data from ERDC located in Hanover, New Hampshire. ERDC calculated AFDD data based on mean daily air temperature recorded at the National Weather Service station in Decatur, Illinois, for water years 1902 to 2000. According to USACE (E-mail correspondence between Rajiv Prasad and Carrie M. Vuyovich), AFDD on any day of the winter season, $AFDD_n$, represents the accumulated difference between freezing and the average daily temperature for the previous n days. The accumulation process starts each fall before the average daily temperature has fallen below freezing. ERDC starts calculation of AFDD on August 1 of each year and the calculation ends July 31 of the following year. AFDD graph through a winter can show multiple peaks. Early in the winter, AFDD graph can also fall to zero during warm spells.

The staff extracted the "zero AFDD" date for each water year during 1902-2000 corresponding to maximum AFDD values. The "zero AFDD" date corresponding to maximum AFDD for water years on record varied from November 16 to March 5, with 14 percent falling in November, 60 percent in December, 21 percent in January, four percent in February, and one percent in March. Fifteen percent of "zero AFDD" dates preceded December 1. The staff determined that winter of water year 1978 (calendar years 1977-1978) was the coldest on record with a maximum AFDD of 1141.5 °F (Figure 2.4-14 below). The "zero AFDD" day for this year was November 25, 1977. The maximum AFDD occurred on March 10, 1978. The staff revised their estimate of maximum ice thickness in Clinton Lake to 27.0 in as shown below.

$$h_i = \alpha \cdot \sqrt{AFDD} = 0.8 \times \sqrt{1141.5} = 27.0in$$

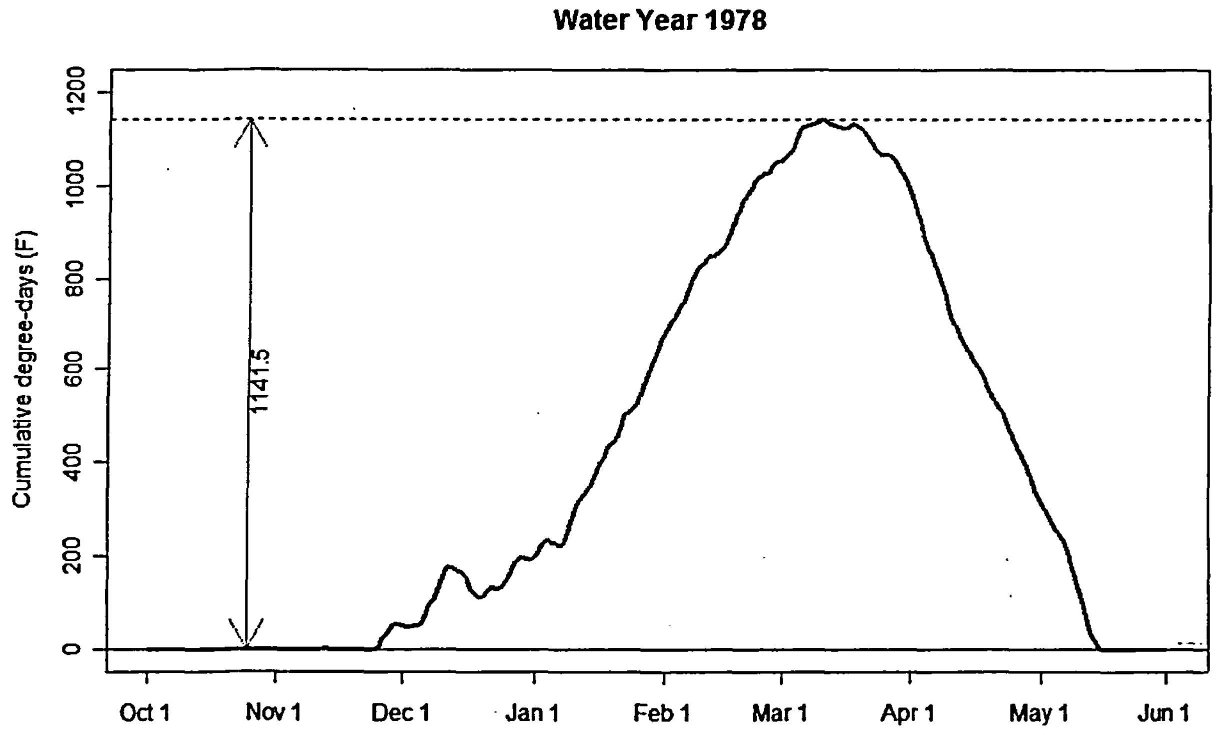


Figure 2.4-14 AFDD during 1977-78 as calculated by Engineering Research and Development Center, Hanover, New Hampshire.

The applicant revised its ice thickness estimation and described the revisions to the application in a letter dated December 21, 2005, to the NRC. The applicant stated that ice thickness was estimated for the Clinton Lake during the period 1902-2001. The applicant obtained AFDD data for Decatur, Illinois, from the ERDC and revised its estimation of ice thickness using the procedure described in the USACE Engineering and Design-Ice Engineering Manual (EM1110-2-1612) and USACE technical note ERDC/CRREL TN-04-3. The applicant used a value of 0.8 for the coefficient of ice cover condition (α in the equation above). The applicant reported that the mean ice thickness estimated over the period 1902-2001 is 16.2 in. with a maximum ice thickness of 27.0 in. during the 1977-78 winter.

The applicant stated further that the only ESP structure exposed to ice in Clinton Lake is the new ESP intake structure, which will be similar to, but smaller than the existing CPS intake structure. The intake openings of the ESP intake structure are expected to vertically extend from an elevation of 690 ft MSL, the normal water surface elevation in Clinton Lake, to 669 ft MSL providing an opening of approximately 21 ft within the lake. The applicant stated that the maximum estimated ice thickness of 27 in. (2.25 ft) would only block a relatively small portion of the total ESP intake opening with 18.75 ft of the opening still available for inflow. The applicant stated that if the water surface elevation in Clinton Lake falls to its minimum elevation of 677 ft MSL, the height of the intake opening will reduce to 5.75 ft, which, the applicant stated, is more than adequate to maintain required inflow for the ESP facility intake. These design issues will be reviewed by the staff at the COL stage according to existing NRC regulations and regulatory guidance.

The applicant also stated that the final intake structure design will include effects of applicable ice forces on the intake structure including those related to crushing, bending, buckling, splitting, or a combination of these. The applicant stated that the total force on the entire structure is important for the design of foundations to resist sliding and overturning, and local contact forces are important in the design of internal intake structural members and the external skin of the intake structure. As stated above, the design issues will be reviewed by staff at the COL stage according to existing NRC regulations and regulatory guidance.

Based on the above review, the staff proposes to include a maximum ice thickness of 27 in. as a site characteristic in any ESP that may be issued for this site. Therefore, the staff considers Open Item 2.4-9 resolved.

SSAR Section 2.4.7 did not provide sufficient detail for the staff to determine the relationship of the ESP facility's intake structure to the existing CPS intake structure and the depth of water over the intake during normal and low-water conditions. The staff needed this information to evaluate the performance limitations of the intakes during icy or low-water conditions. In RAI 2.4.7-3, the staff requested that the applicant describe the relationship, including its layout and depth, of the ESP facility's intake relative to the current CPS intake. The applicant's response to RAI 2.4.7-3 did not resolve the staff's concern about the precise layout of the ESP facility's intake structure. According to Figure 5.3-1 in the EGC ESP environmental report (ER), the ESP facility's UHS intake would be located at an elevation of 668 ft MSL, which is below the lake bottom mentioned in the RAI response. The staff needed the bounding dimensions and critical elevations of the ESP facility's intake structure, including its conceptual plan and cross section, clearly indicating the elevation of the basemat, the elevation of the screenhouse opening, the elevation of the NHS makeup water intake pipe, the elevation of the UHS makeup water intake pipe, and their relationship to the existing lake bed. The staff asked the applicant to provide a schematic diagram clearly showing these items. This was DSER Open Item 2.4-10.

In response to DSER Open Item 2.4-10, the applicant stated, in its submission to the NRC dated April 4, 2005, that the EGC ESP ER Figure 5.3-1 is a cross section of Clinton Lake looking away from the CPS intake; the 668 ft MSL elevation refers to the lake and not the plant intake structure. The applicant stated that the design of the ESP intake structure will depend upon the reactor selected for the ESP facility and, therefore, no schematic diagrams of the intake structure are available at the ESP stage. The applicant noted that SSAR Section 2.4.7 provides the approximate elevation of the screenhouse openings and mentions that the ESP intake structure will be similar to the existing CPS intake structure except that it will be smaller. The intake opening(s) to the ESP intake structure will extend vertically from an elevation of 690 ft MSL or higher to approximately 669 ft MSL. The applicant stated that the basemat of the ESP intake structure is expected to be located similarly to that of the CPS intake structure, which is located at an elevation of 657.5 ft MSL. The final design elevation of the ESP intake basemat will depend on the submergence requirements of the ESP UHS makeup water pumps. The applicant also stated that there will be no intake pipe since vertical intake pumps will be located in suction bays behind the intake screens. The applicant stated that the lake bottom at the intake is at an elevation of 668.5 ft MSL.

The staff's concern in DSER Open Item 2.4-10 was to verify that the ESP UHS makeup pumps will have sufficient submergence within the intake structure to ensure that no interference is caused by any ice sheet that may form on the surface of Clinton Lake during low-water conditions in the lake. The staff reviewed the applicant's response to DSER Open Item 2.4-10 and concluded that sufficient design details of the ESP UHS makeup water pumps are not available at the ESP stage to justify a schematic diagram of the proposed ESP intake structure. The staff will evaluate the design of the ESP intake structure at the COL stage in accordance with NRC regulations and regulatory guidance to ensure the safety of the ESP facility. Based on this review, the staff considers DSER Open Item 2.4-10 resolved (see COL Action Item 2.4-7).

SSAR Section 2.4.7 did not provide sufficient detail regarding formation of frazil and anchor ice on or near the intake structure. The staff needed this information to assess the adequacy of the intake structure during prolonged cold conditions. In RAI 2.4.7-4, the staff requested that the applicant describe site characteristics for frazil and anchor ice formation. In response to RAI 2.4.7-4, the applicant described a warming line that is used to maintain a minimum water temperature of 40 °F in the CPS intake and suggested a similar approach for the ESP facility. Based on the applicant's proposed approach, the COL applicant will have to design the ESP facility's UHS intake to maintain a minimum water temperature of 40 °F at all times to preclude formation of frazil and anchor ice on the intake inlet. This is **COL Action Item 2.4-6.** The staff planned to include this item as DSER Permit Condition 2.4-6. However, the need for an ESP facility UHS intake structure is dependent on whether the selected reactor design requires a UHS. Since the reactor design has not been selected at the ESP stage, the staff determined that COL Action Item 2.4-6 is sufficient to preclude the formation of frazil and anchor ice on the ESP facility's UHS intake inlet, should the selected reactor design require one. The staff concluded, therefore, that it is not necessary to impose DSER Permit Condition 2.4-6.

SSAR Section 2.4.7 did not provide sufficient information regarding formation of ice in the lake or near the intake structure during periods when the existing unit is nonoperational, thus eliminating the heat load to Clinton Lake. In RAI 2.4.7-5, the staff requested that the applicant discuss the impacts to ice formation if the existing unit were no longer operating. The staff determined that the applicant's response to RAI 2.4.7-5 was inadequate for two reasons. First, the applicant did not discuss the impact of ice formation when CPS Unit 1 was no longer operating. Second, the staff was concerned with ice formation in Clinton Lake and not in the discharge channel. COL Action Item 2.4-6 will ensure that the minimum intake water temperature is 40 °F at all times and, in the event that CPS Unit 1 is no longer in operation, the ESP facility would be shut down when the intake water temperature fell below 40 °F.

SSAR Section 2.4.7 did not provide sufficient detail for the staff to determine whether the formation of ice on the lake and near the intake structure could constrain intake depth. The staff needed this information to evaluate the adequacy of safety-related intakes. In RAI 2.4.7-6, the staff requested that the applicant discuss whether ice sheet formation is likely to constrain the ESP facility's UHS intake depth. Based on a minimum safe ESP facility shutdown water surface elevation of 677 ft MSL, reduced by the staff-estimated maximum ice sheet thickness of 31.4 in., the staff determined that the ESP facility's UHS intake needs to be located below an elevation of 674.4 ft MSL. According to ER Figure 5.3-1, the ESP facility's UHS intake would be located at an elevation of 668 ft MSL. The staff concluded that the ice sheet formed on Clinton Lake would not constrain the intake. This is predicated on the location of the ESP facility's UHS intake at an elevation of 668 ft MSL. This is **COL Action Item 2.4-7.** The staff had planned to include this item as DSER Permit Condition 2.4-7. However, the need for an ESP facility UHS intake structure depends on whether the selected reactor design requires a UHS. Since the reactor design has not been selected at the ESP stage, the staff determined that COL Action Item 2.4-7 is sufficient to ensure that the ESP facility's UHS intake will be located at an elevation of 668 ft MSL. The staff concluded, therefore, that it is not necessary to impose DSER Permit Condition 2.4-7.

SSAR Section 2.4.7 provided an average thickness of an ice sheet on the surface of Clinton Lake. It is possible that some loss in capacity of the submerged UHS pond could occur if such an ice sheet formation were coincident with a loss of Clinton Dam, thus resulting in the draining of the main lake. In RAI 2.4.7-8, the staff requested that the applicant describe the reduction in submerged UHS pond capacity caused by a loss of Clinton Dam coincident with an ice sheet covering the lake. The applicant's RAI response that surface ice on the submerged UHS pond would float away in the event of a complete loss of Clinton Dam is not a conservative assumption. The staff determined that it is conservative to assume that surface ice could remain in the submerged UHS pond upon the loss of Clinton Dam, leading to reduced water storage capacity in the submerged UHS pond. Similarly, the applicant's RAI response that a drop of surface ice below the top of the submerged UHS dam upon loss of Clinton Dam would lead to a small reduction in capacity in the submerged UHS pond is not a conservative assumption. The applicant did not quantify this loss of capacity in the submerged UHS pond, as originally requested in RAI 2.4.7-8.

The applicant's response to RAI 2.4.7-8 is neither consistent nor conservative for several additional reasons. The applicant stated that Clinton Lake would be used as a source of makeup water for the ESP facility's UHS, and not as a heat sink. However, in its response to the RAI, the applicant took credit for heat of fusion of ice available for heat removal, even though it argued that most of the surface ice would float away and be lost. The staff agrees with the applicant that the submerged UHS pond should not be considered a heat sink for the ESP facility UHS. The staff disagreed, therefore, that heat of fusion of ice is available for cooling needs.

The staff determined that the applicant should quantify the reduction in water storage capacity of the submerged UHS pond in the event of a complete loss of Clinton Dam coincident with the presence of surface ice. This was **DSER Open Item 2.4-11.**

In response to DSER Open Item 2.4-11, the applicant stated, in its submission to the NRC dated April 26, 2005, that the amount of water displaced by the settling of an ice sheet into the submerged UHS pond following a catastrophic failure of Clinton Dam, while an ice sheet was already present on the surface of Clinton Lake, would be approximately 300 ac-ft. The applicant estimated this displacement using the top surface area of 158 ac for the submerged UHS pond multiplied by an ice sheet thickness of 24.8 in. and then accounting for the ratio of the density of ice to the density of water, which is 0.917 (158 ac x 24.8 in. / 12 in./ft x 0.917 = 299.4 ac-ft).

The applicant stated that its previous assumption that the ice would float away in the event that Clinton Dam broke was based on the scenario with both the CPS and the ESP facility operating. The applicant stated that excess capacity in the submerged UHS pond is greater with the ice sheet covering the surface than without the ice sheet because the ice cover would restrict evaporation from the submerged UHS pond to a negligible amount. The applicant stated that excess volume in the submerged UHS pond corresponding to both ice-covered and open-water scenarios is provided in response to DSER Open Items 2.4-14 and 2.4-16.

The applicant also stated that if complete failure of the Clinton Dam were to take place while an ice sheet was covering the submerged UHS pond, but CPS was not operating, then the volume usually reserved for the CPS UHS cooling requirements (approximately 327 ac-ft over 30 days) would also be available to the ESP facility's UHS makeup (approximately 87 ac-ft over 30 days) and would be sufficient to meet the ESP facility's UHS requirements.

The staff reviewed the applicant's response to DSER Open Item 2.4-11 and concluded that it provided enough information to quantify a reduction in water storage capacity of the submerged UHS pond resulting from the presence of surface ice in Clinton Lake. Based on the staff's revised estimate of maximum ice thickness (see the discussion above related to DSER Open Item 2.4-9) in Clinton Lake, the staff estimated that the volume of displaced liquid water caused by this ice sheet settling into the submerged UHS pond is approximately 326 ac-ft (158 ac x 27.0 in / 12 in/ft x 0.917 = 326.0 ac-ft). The staff also used the information provided by the applicant in response to Open Item 2.4-11 to help resolve other open items related to the submerged UHS pond water storage capacity.

In a letter dated December 21, 2005, the applicant revised its maximum ice thickness estimate to 27.0 in. The applicant also revised its earlier response to Open Item 2.4-11 in this letter and revised its estimate of reduction in the storage capacity within the submerged UHS pond in presence of surface ice. The applicant stated that the reduction of storage capacity in the submerged UHS pond due to an ice sheet 27.0 in. in thickness will be approximately 326 ac-ft. Based on applicant's revised response to Open Item 2.4-11, the staff determined that applicant's revised ice thickness is identical to the staff's independent estimate. Therefore, the staff considers Open Item 2.4-11 resolved.

2.4.7.4 Conclusions

As set forth above, the applicant provided sufficient information pertaining to the identification and evaluation of ice effects at the site. SSAR Section 2.4.7 conforms to Section 2.4.7 of RS-002, Attachment 2, with regard to this objective.

Section 2.4.7 of RS-002, Attachment 2, provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating ice effects at the site. Although the applicant did not specifically address the above regulations in SSAR Section 2.4.7, the staff concludes that by conforming to RS-002, Attachment 2, Section 2.4.7, it has met the requirements to identify and evaluate ice effects at the site with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c), except as noted in Section 2.4.7.3 above. Further, with the exceptions noted, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area in establishing design-basis information pertaining to ice effects, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

2.4.8 Cooling Water Canals and Reservoirs

Clinton Lake, an impoundment formed by construction of an earthen dam across Salt Creek about 1200 ft downstream from the confluence of the North Fork of Salt Creek with Salt Creek, was constructed to provide cooling water for the CPS. The ESP site is approximately 3.5 miles northeast of the dam.

Unit 1 of CPS uses a once-through cooling system to dissipate heat from the turbine condenser. A discharge flume is provided to convey CPS Unit 1 circulating water discharge to the Salt Creek finger of Clinton Lake. The UHS for CPS Unit 1 is water held behind a submerged dam constructed within the North Fork of Salt Creek in Clinton Lake. The applicant refers to this water source as the submerged UHS pond.

The ESP facility would also use Clinton Lake as the source of cooling water. The applicant proposed that the ESP facility use a closed cooling system with wet cooling tower(s). The UHS for the ESP facility would consist of a mechanical draft cooling tower(s) with no water storage. The submerged UHS pond using the new intake would supply any makeup water required for the ESP facility's UHS for a period of 30 days. Therefore, the new intake would be a safety-related structure.

2.4.8.1 Technical Information in the Application

The applicant stated in SSAR Section 2.4.8.1 that it would use Clinton Lake as a source of raw water for the ESP facility. The applicant would add a new intake structure near the existing CPS Unit 1 screenhouse to supply water to the ESP facility. The ESP facility would use cooling tower(s) for normal cooling and possibly also for safety-related cooling. The lake would supply makeup water for evaporation and blowdown losses from the tower(s).

The applicant evaluated the capacity of the lake under a design drought with a 100-year recurrence interval. The applicant committed to maintain the lake water surface elevation at 677 ft MSL even during a 100-year drought. The applicant stated in the SSAR that, if necessary, it would use a power reduction program to minimize makeup water requirements to maintain the lake water surface elevation at 677 ft MSL.

The applicant stated in SSAR Section 2.4.8.1.1 that no changes would be made to the Clinton Dam for the ESP facility. The dam, a homogeneous earthfill dam with a maximum height of 65 ft above the bed of Salt Creek, is 3040 ft long. The top of the dam is at an elevation of 711.8 ft MSL. Both the upstream and downstream faces of the dam have side slopes of 3:1 (horizontal to vertical). The upstream face has an 18-in. thick riprap for protection against erosion from a 50-mph wind wave on the normal pool level of the lake. On the downstream face, seeded topsoil provides protection against erosion from rainfall. An 18-in.-thick riprap is also provided. At the toe of the dam, for protection against tailwater erosion, there is an 18-in.-thick riprap designed for 50-mph wind acting on a 100-year tailwater flood level.

The applicant estimated the PMF level in Clinton Lake to be 708.8 ft MSL and the maximum level, corresponding to wave runup acting on the PMF level, to be 711.95 ft MSL. The top of the dam is at a slightly lower elevation of 711.8 ft MSL. The applicant estimated that the duration for which wave action on a PMF level would lead to overtopping of the dam as 2.5 hours. The applicant stated that this overtopping would occur in the form of a fine spray and that this spray falling on the downstream face of the dam would not result in any significant damage to the dam.

The applicant stated in SSAR Section 2.4.8.1.2 that the ESP facility would require no changes to the service spillway. The service spillway is designed to pass the design flood of 100-year recurrence interval with a water surface elevation of 697 ft MSL in the lake. The service spillway, located on the west abutment of the dam, is an uncontrolled concrete ogee semicircular in plan, with a crest length of 175 ft and a crest elevation of 690 ft MSL. The height of the concrete ogee is 10 ft. Water is discharged from the ogee through an 80-ft-wide concrete chute into a stilling basin, and a discharge canal conveys the water from the stilling basin to the main channel of Salt Creek. Riprap extends for 80 ft downstream from the stilling basin as protection against erosion. Peak discharge through the service spillway corresponding to the 100-year flood is 11,450 cfs, and that corresponding to the PMF is 33,200 cfs.

The applicant stated that it used the 100-year flood water level in the lake as the basis for determining the crest elevation of the auxiliary spillway. The auxiliary spillway functions only during floods greater than the 100-year flood. The crest of the auxiliary spillway is at an elevation of 700 ft MSL to allow the 100-year flood to discharge entirely through the service spillway.

The applicant stated in SSAR Section 2.4.8.1.3 that the ESP facility requires no changes to the auxiliary spillway. The auxiliary spillway is located to the east of the dam and is designed to pass floods greater than the 100-year flood, including the PMF. The auxiliary spillway is of the open-cut type, with a crest length of 1200 ft and a crest elevation of 700 ft MSL. The applicant estimated peak discharge through the auxiliary spillway during the PMF as 102,800 cfs. The maximum water velocity at the crest is 14 ft/s. The crest control section of the auxiliary spillway is 25 ft wide and consists of asphalt concrete. To protect the crest against scouring, concrete cutoffs and riprap are provided upstream and downstream of the crest.

The applicant stated in SSAR Section 2.4.8.1.4 that the ESP facility would require no changes to the lake outlet works. The lake outlet works are located on the west abutment of the dam, 160 ft east of the service spillway. The primary function of the lake outlet works is to release a minimum flow of 5 cfs downstream of the dam. The lake outlet works consist of a submerged concrete intake, a 36-in.-diameter entrance pipe, a control house with three sluice gates, and a 48-in.-diameter outlet pipe, which terminates at the spillway stilling basin. The crest of the intake structure for the outlet works is at an elevation of 686 ft MSL, with an inlet diameter of 84 in. transitioning to a 36-in.-diameter throat. A trash rack and a vortex breaker are provided at the inlet. The sluice gates regulate the downstream releases. The gates are manually operated from the top of the control house.

The applicant stated in SSAR Section 2.4.8.1.5 that the existing submerged UHS pond would serve as the source of makeup water for the safety-related cooling tower(s) for the ESP facility when water from Clinton Lake was not available. The new intake structure, which would be located next to the existing screenhouse for the CPS intake, would supply the makeup water. The applicant judged the capacity of the submerged UHS pond to be sufficient to meet the safety-related cooling water requirement for the existing CPS unit, as well as to meet the makeup water requirement for the safety-related cooling tower(s) of the ESP facility for 30 days.

The applicant states that there would be no change in the flowpath through the submerged UHS pond. The UHS pond consists of a submerged pond behind a submerged dam constructed across the North Fork of Salt Creek. This submerged dam is located 1 mi west of the CPS Unit 1 screenhouse. The top of the submerged dam is at an elevation of 675 ft MSL; its top width is 30 ft and its length is 2350 ft. The submerged dam consists of homogeneous compacted backfill material, and both of its faces have a side slope of 5:1 (horizontal to vertical). A 2-ft-thick compacted soil-cement layer covers the top and both faces of the submerged dam. The surface area of the submerged UHS pond at the design elevation of 675 ft MSL is 158 ac, and its corresponding volume is 1067 ac-ft.

The top of the baffle dike within the submerged UHS pond is at an elevation of 676 ft MSL. A 3-ft-thick compacted soil-cement layer covers the dike. The baffle dike is 3300 ft long.

The applicant analyzed flow conditions over the submerged UHS dam resulting from a sudden breach of the main dam. A 100-ft-wide breach extending from the top of the dam to the creek bed was assumed to occur during the PMF event, with the water surface elevation of the lake at 708.8 ft MSL. The applicant analyzed the flow conditions over the submerged UHS dam using the level-pool routing procedure and estimated water surface elevations upstream and downstream of the submerged UHS dam. The applicant estimated maximum velocities at the crest and at the toe of the submerged UHS dam to be 3.8 and 11.8 fps, respectively, 43 hours after the main dam breach. The maximum velocity estimated on the face of the baffle dike is 1.2 fps.

The applicant also estimated velocities over the submerged UHS dam and the baffle dike during a PMF event with the lake level at the 100-year drought elevation of 682.3 ft MSL. Estimates of these maximum velocities over the submerged UHS dam and the baffle dike are 2.1 and 2.6 fps, respectively.

The applicant concluded that during both scenarios, the main dam breach and the occurrence of a PMF with the lake at the 100-year drought elevation, the compacted soil-cement layer would protect the submerged UHS dam and the baffle dike.

The applicant stated in SSAR Section 2.4.8.2 that the existing CPS discharge flume would convey the blowdown discharge from the ESP facility to the Salt Creek finger of Clinton Lake. The applicant stated that the discharge flume was designed to carry a maximum flow of 3057 cfs that would be discharged from CPS Unit 1 and the abandoned CPS Unit 2. The applicant stated that, because of the abandonment of CPS Unit 2, current flow in the discharge flume is only 50 percent of its design capacity.

The applicant states that there would be no change to the discharge flume. The discharge flume is located to the east of the plant area and runs due east towards Clinton Lake. The applicant stated that the discharge point of the flume into Clinton Lake provides an effective cooling surface area of 3650 ac in Clinton Lake. The flume has a bottom width of 120 ft, a side slope of 3:1 (horizontal to vertical), a total length of 3.4 miles, and a nonscouring design velocity of 1.5 fps). The minimum freeboard of 3.8 ft is provided in the flume. A 6-in.-thick crushed stone layer covers the side slopes of the flume for protection against erosion from wind wave action, and riprap on the lakeside of the embankment fill protects against erosion resulting from wind wave action in the lake. Two drop structures are provided along the flume to adapt it to ground topography and to prevent scouring in the flume. Both drop structures are 70 ft wide. One drop structure is designed for an 18-ft drop, and the second is designed for a 26-ft drop.

The staff requested, in RAI 2.4.8-1, that the applicant explain how it calculated the cooling water needs for the CPS and ESP facilities, as discussed in SSAR Section 2.4.8.1.5. In response to RAI 2.4.8-1, the applicant stated that it used the LAKET model, which is a one-dimensional lake temperature prediction program, to estimate the 30-day cooling water needs for emergency shutdown of CPS Unit 1. The applicant performed the LAKET modeling as part of the CPS UHS design to support two 992-megawatt electric (MWe) power generation facilities. The applicant stated that this design considers the volume of cooling water required for the two CPS facilities, loss in the submerged UHS pond capacity resulting from sedimentation from a 100-year flood event and from liquefaction resulting from a seismic event, and the volume of water required for fire protection. This analysis established the minimum design volume of the CPS submerged UHS pond as 849 ac-ft.

The applicant stated that the UHS for the ESP facility would consist of new cooling tower(s) that would provide necessary heat dissipation but require makeup water. The applicant estimated the 30-day makeup water volume based on the 30-day makeup water estimate from the PPE, plus a 33 percent factor for blowdown and an additional 20 percent factor for overall margin. The applicant stated that the 30-day makeup volume for the ESP facility would be 87 ac-ft.

The applicant stated that it periodically measures the volume in the submerged UHS pond and recently measured it to be 1022 ac-ft. The applicant stated that, if the CPS UHS 30-day minimum design volume of 849 ac-ft were subtracted from the recently measured volume of the submerged UHS pond, the remaining available volume would be 173 ac-ft, which is 86 ac-ft greater than that required for the ESP facility. The applicant concluded that the current CPS submerged UHS pond has sufficient capacity to serve both CPS Unit 1 and to provide makeup for the new nuclear unit(s).

The applicant stated that it also checked the surface area of the submerged UHS pond, as it is the single most important factor in controlling the heat dissipation from the CPS heat sink. The design surface area of the CPS submerged UHS pond at a water surface elevation of 675 ft MSL is approximately 150 ac. The applicant stated that the as-built surface area of the submerged UHS pond at a water surface elevation of 675 ft MSL is 158 ac, slightly larger than the design surface area. The applicant stated that a 0.5-ft reduction in the water surface elevation of the submerged UHS pond would be expected if a volume of 87 ac-ft, equal to the 30-day ESP facility UHS makeup water requirement, were withdrawn. The applicant concluded that the design heat dissipation capacity of the CPS submerged UHS pond would be maintained while accounting for the ESP facility UHS makeup water requirements.

The applicant provided a review of the original CPS UHS modeling using the LAKET program. The applicant stated that it performed the original analysis to determine the maximum possible starting water temperature in the submerged UHS pond without exceeding the 95 °F UHS outlet temperature that could exist during a two-unit loss-of-coolant accident (LOCA) and a loss of offsite power (LOOP). The applicant stated that the model was updated in 1985, and a sensitivity test was performed in 1986. The applicant stated that it estimated maximum temperatures in the submerged UHS pond at various depths during this sensitivity analysis to determine whether dredging would be necessary to remove accumulated sediment. The analysis also determined the maximum submerged UHS pond water temperature that will allow shutdown of one of the units from 100-percent power load without exceeding the maximum allowable UHS outlet temperature of 95 °F. The analysis indicated that the maximum allowable UHS outlet temperature of 95 °F for CPS will not be exceeded with an initial submerged UHS pond volume of 590 ac-ft and an initial submerged UHS pond water temperature ranging from 84 to 95 °F.

The applicant stated that a review of the model documentation indicated that the input to the original 1995 LAKET model and the additional modeling performed in 1985 and 1986 were based on worst-case or most-conservative environmental parameters. The applicant stated that it examined temperatures in Salt Creek downstream from Clinton Lake for the period before 1975 and for recent time periods. The applicant found no significant changes in temperature between these two periods and concluded that the original model results are still applicable.

The applicant noted that it based the previous modeling on a one-dimensional vertically and laterally averaged approach, which does not account for thermal stratification. The applicant stated that thermal stratification would result in higher surface temperatures than the depth-averaged value, resulting in enhanced heat transfer to the atmosphere, thus making model predictions more conservative by predicting a lower heat transfer rate than would actually be expected to occur. The applicant stated that the existing intake structure is located such that it draws water from the deeper part of the lake. The new ESP facility intake structure would also be designed to draw water from the deeper part of the lake. The applicant reasoned that, since deeper water is likely to be cooler because of thermal stratification, the initial model approach and its results remain valid for the ESP application.

The applicant stated that the submerged UHS pond for the CPS is designed to provide sufficient water and cooling capacity to safely shut down two 992-MWe boiling water reactors (BWR) units and maintain the plant in the shutdown condition for a period of 30 days. The minimum submerged UHS pond design volume of 849 ac-ft accounts for the minimum cooling capacity of 590 ac-ft to meet the 95 °F service water inlet maximum temperature, the fire protection requirement of 3 ac-ft, a loss in capacity because of sedimentation from a 100-year flood of 35 ac-ft, and a loss in capacity because of sedimentation from liquefaction of 221 ac-ft. Currently, the CPS consists of a single 1138.5-MWe facility. The applicant concluded that the minimum submerged UHS pond design volume of 849 ac-ft, based on two 992-MWe BWR units, is sufficient for the single existing 1138.5-MWe CPS facility.

The applicant stated that the CPS conducts annual surveys as part of the submerged UHS pond sedimentation monitoring program, and it also monitors sediment accumulation after a major flood passes through the cooling lake. The Monitoring Program Reports 20–23 (1998–2002) indicate that, immediately following the dredging in 1991, the volume of the submerged UHS pond was 1054 ac-ft and, in 2001, the volume declined to 1022 ac-ft because of sedimentation.

The applicant stated that the ESP facility would require a maximum of 87 ac-ft of cooling water from the submerged UHS pond for its 30-day emergency shutdown supply. The applicant estimated that a minimum volume of 935 ac-ft in the submerged UHS pond would be available for the existing CPS unit, assuming none of the ESP facility's UHS-required water, equal to 87 ac-ft, is returned to the submerged UHS pond. The applicant concluded that this scenario allows for a reserve volume of 86 ac-ft for sediment accumulation based on the 2001 measured volume of the submerged UHS pond.

The applicant stated that it would maintain adequate volume in the submerged UHS pond for the requirements of the existing CPS unit and makeup for the proposed ESP facility UHS to account for the minimum required volume of 849 ac-ft for the CPS unit and the minimum required volume of 87 ac-ft for the ESP facility. The applicant stated that, if it elected to construct an additional nuclear power plant at the site, it would modify the current practice of dredging the submerged UHS pond when its capacity declines to less than 849 ac-ft so that dredging would occur when the capacity of the submerged UHS pond decreased to 936 ac-ft. The applicant stated that the estimated annual sedimentation amount is 5 ac-ft. The applicant also stated that, while dredging should occur based on volume measurements of the submerged UHS pond, the new dredging threshold of 936 ac-ft would be expected to result in dredging at least once every 23 years.

The applicant stated that the relationship between the surface area and the volume of the submerged UHS pond based on the design and as-built data found in the September 1975 and April 1985 modeling indicates that the immediate reduction in existing volume by 87 ac-ft would result in a decrease of the water level in the submerged UHS pond of approximately 0.5 ft. The applicant stated that this change in water level would not significantly impact the surface area. The applicant estimated that the new surface area would remain the same or larger than the design surface area, indicating that the heat rejection capacity of the submerged UHS pond would be maintained. The applicant also stated that, according to Section 9.2.5.3 of the CPS USAR, the total heat rejection to the submerged UHS pond over 30 days following an emergency shutdown of the CPS unit would be less than that assumed during the design of the UHS. The applicant concluded that the original modeling of the UHS is still applicable for the new proposed conditions.

The applicant revised SSAR Section 2.4.8.1.5 to provide additional information regarding its estimation of the cooling water requirements.

The staff requested, in RAI 2.4.8-2, that the applicant discuss how it estimated the flow velocities over the crest and toe of the submerged UHS dam, as discussed in SSAR Section 2.4.8.1.5. The staff also asked the applicant to provide figures indicating where the toe of the UHS dam is located relative to the fill shown in SSAR Figures 2.4-14 and 2.4-15. In response to RAI 2.4.8-2, the applicant stated that the SSAR Section 2.4.8.1.5 discussion of flow velocities over the crest and toe of the submerged UHS dam is an unnecessary detail for an ESP review and that it would revise this section by removing the discussion of velocities over the crest.

The staff requested, in RAI 2.4.8-3, that the applicant describe lake drawdown calculations. In response to RAI 2.4.8-3, the applicant updated SSAR Section 2.4.11.1, which discusses the Clinton Lake drawdown evaluation, to provide additional details of this evaluation.

In its RAI response, the applicant stated that it considered runoff, evaporation, and forced evaporation in the drawdown evaluation. The applicant stated that it had established two, 5-year design droughts with return periods of 50 and 100 years and obtained low-flow data for both design droughts from the CPS USAR. The original low-flow data came from Bulletin 51, "Low Flows of Illinois Stream for Impounding Reservoir Design," of the Illinois State Water Authority, issued 1964.

The applicant stated that it used the normal lake water surface elevation of 690 ft MSL as the starting water surface elevation during the drawdown evaluation. The applicant obtained lake stage-storage relationship information from the CPS ER based on the original lake volume of 74,200 ac-ft at normal lake water surface elevation. The applicant estimated Inflow into the lake on a monthly basis by multiplying the rainfall runoff, expressed as a depth, by the watershed area. Outflow from the lake was assumed to consist of downstream discharge, net lake evaporation minus lake precipitation, forced evaporation resulting from existing plant operation, seepage loss, and cooling water consumed by the ESP facility. The applicant assumed the downstream discharge through the dam to be a minimum of 5 cfs when the lake level was at or below the 690 ft MSL spill elevation. The drought analysis did not allow the lake level to exceed 690 ft MSL. The analysis did allow the discharge to be greater than 5 cfs, if inflow would increase the lake level above the spillway elevation of 690 ft MSL. The CPS USAR provided data on net lake evaporation minus lake precipitation data for both design droughts.

The applicant stated that it developed forced evaporation data for the existing CPS unit from data given in the CPS USAR. The initial forced evaporation data were based on two 992-MWe BWR plants operating at a 70-percent load factor. Forced evaporation is defined as the additional evaporation resulting from an increase in lake water temperature caused by the discharge of cooling water to the lake from the once-through cooling system for the two original plants. The applicant subsequently revised the forced evaporation rate for the two originally proposed plants to estimate the rate for the single, uprated existing CPS unit. The CPS Unit 1 was uprated from its original 992-MWe rating to 1138.5 MWe in 2002. The applicant divided the forced evaporation rate from the CPS USAR by 0.7 to obtain the forced-evaporation rate for a 100-percent load factor. The applicant then divided the resulting forced-evaporation rate by two because only one of the two originally planned units was constructed. This new forced-evaporation rate was again adjusted for the plant uprate by multiplying by a factor of 1.147 (1138 divided by 992).

The applicant stated that it had recently checked the forced-evaporation rates for the original 992-MWe plant operating at a 100-percent load factor. Forced and natural evaporation occur simultaneously as the circulating cooling water flows through the cooling loop. To differentiate between the amounts of natural and forced evaporation, the applicant determined the equilibrium temperature of the lake on a monthly basis using monthly meteorologic data over the period of record. The applicant stated that the equilibrium temperature is the temperature of water in the lake about 1 ft below the surface, where the heat input to the lake is exactly balanced by the heat output from the lake. The applicant stated that the equilibrium temperature is determined by performing a heat balance for solar heat gain, heat loss by convection, evaporative cooling, and radiant heat transfer from the water to the surroundings. The amount of natural evaporation is determined based on the equilibrium temperature.

The applicant stated that it developed a model based on the method of Langhaar to determine the amount of forced evaporation. The model was validated based on its agreement with the results of an earlier study by Edinger. The applicant then applied the model to simulate the cooling lake for each month using monthly average climatic conditions over the period of record. The applicant stated that the evaporation estimated by this model was the total, or the sum of natural and forced evaporation. Forced evaporation was the difference between the total and previously estimated natural evaporation.

The applicant stated that the analysis for the existing CPS unit and the ESP facility assumed a 100-percent load factor during their respective operations. It was assumed that each design drought would begin in January of the first year. Seepage loss was assumed to be 0.5 percent of the lake capacity per month. The applicant carried out the drawdown calculations on a monthly time step. EGC calculated a net volume gain or loss by subtracting losses and adding gains to the initial lake volume for each month to obtain the initial lake volume for the next month. The applicant used the lake stage-surface area and stage-volume relationship from the CPS ER to estimate lake water surface elevation and area for the next month. It then repeated these calculations for the 50-year and the 100-year drought.

The applicant also determined the amount of cooling water available during the droughts. The average annual water consumption for the existing CPS unit at 100-percent load factor is 1100 ac-ft per month (ac-ft/mo). The applicant stated that the total amount of water available during the 100-year drought is 2400 ac-ft/mo. The applicant estimated that the amount of available water in excess of that needed for the CPS unit is 1300 ac-ft/mo during the 100-year drought. The applicant stated that, based on the drawdown analysis corresponding to the 50-year drought, the total amount of water available during the 50-year drought is 3100 ac-ft/mo. The applicant estimated that the amount of available water in excess of that needed for the CPS unit is 2000 ac-ft/mo during the 50-year drought.

The applicant also stated that the available water quantities are expected to maintain the lake water surface elevation at or above the CPS minimum lake elevation of 677 ft MSL with both the existing CPS unit and the proposed ESP facility in operation.

The staff requested, in RAI 2.4.8-4, that the applicant describe how it estimated the UHS capacity loss resulting from sediment or debris during extreme events. In response to RAI 2.4.8-4, the applicant stated that the ESP facility would use the safety-related cooling tower(s) as the UHS, if one were to be required, and would use the CPS submerged UHS pond only as a source of makeup water. For this reason, sediment or debris does not directly affect the ESP facility's UHS.

The applicant stated that, according to soil surveys of Illinois, early spring rains in areas where soil is exposed because of farming can cause extensive erosion when the soil surface is partially frozen leading to greater runoff. The applicant stated that the highest 24-hour PMP occurs in the summer and fall (June through September), with the monthly PMP value ranging from 24.4 to 31.2 in. The applicant reasoned that the occurrence of the PMP would not be coincident with the conditions for maximum runoff.

The applicant stated that the design of the CPS UHS pond considered four failure modes:

(1) loss of cooling water inventory because of its displacement by alluvial flow slides into the UHS

(2) loss of the service water system because of blockage of the service water pump intakes from unstable soil flow blocking or entering the intake structure

(3) loss of UHS circulation pattern because of local slides producing dams or dikes across the circulation channel

(4) loss of UHS water as a result of the UHS dam or its flanks breaching because of a combination of seismic loading, liquefaction, and washout

The applicant stated that, in addition to the storage requirements for cooling purposes and fire water supply, the submerged UHS pond was designed to account for sedimentation. The design of the submerged UHS pond considered sediment inflow from liquefaction and an associated loss in capacity of 221 ac-ft, fire water storage capacity of 3 ac-ft, minimum cooling water capacity of 590 ac-ft required to meet the 95 °F shutdown service water inlet temperature, and loss in capacity of 35 ac-ft from sedimentation resulting from a 100-year flood.

In Revision 4 of the SSAR, the applicant stated that the probable maximum flood water surface elevation is 709.8 ft MSL. The applicant also stated that any overtopping wave would only produce a spray because of riprap placed on the upstream face of the dam. The applicant stated that the downstream face of the dam is protected against gully erosion by grass and therefore, any overtopping resulting in spray on the downstream face is not expected to result in significant damage to the dam.

2.4.8.2 Regulatory Evaluation

Acceptance criteria for this section are based on meeting the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the hydrologic features of the site.

Compliance with 10 CFR 52.17(a) and 10 CFR 100.20(c) requires consideration of the site's physical characteristics (including seismology, meteorology, geology, and hydrology) when determining its acceptability for a nuclear power reactor. To satisfy the hydrologic requirements of 10 CFR Parts 52 and 100, the applicant's safety assessment should contain a description of cooling water canals and reservoirs for a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site. The applicant should include details in its analysis of cooling water canals and reservoirs sufficient to evaluate the site's acceptability and to assess the potential for those characteristics to influence the design of SSCs important to safety for a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site. Meeting this requirement provides reasonable assurance that the capacities of cooling water canals and reservoirs are adequate.

In those cases for which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. The applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of parameters. Important PPE parameters for safety assessment described in SSAR Section 2.4 include, but are not limited to, cooling needs (e.g., adverse local meteorological conditions, high ambient temperature).

2.4.8.3 Technical Evaluation

The staff visually inspected the site during the site safety analysis visit on May 11, 2004. The staff determined that the SSAR accurately describes the intakes, discharge canals, outfalls, and reservoirs near the ESP site.

The applicant stated in SSAR Section 2.4.8.1 that the ESP facility would use cooling tower(s) for the normal cooling of the power plant. In addition, the applicant stated in SSAR Section 2.4.8.1 that the UHS system for the ESP facility might also use cooling tower(s). In the same section, the applicant stated that a lake drawdown analysis, to be performed at the design stage, would indicate whether a load reduction to the ESP facility, or a wet/dry hybrid cooling tower system, might be necessary to maintain water surface elevation in Clinton Lake at or above 677 ft MSL during a 100-year drought.

According to the PPE table (SSAR Table 1.4-1, item 3.3.9), average makeup water for the UHS system with mechanical draft cooling tower(s) is 555 gpm. This makeup water flow is equivalent to a volume of 73.6 ac-ft over a 30-day period. The staff estimated that applying a 33-percent factor for blowdown, and an overall 20-percent margin, the 30-day makeup water needed for the ESP facility's UHS system would be 73.6 x 1.33 x 1.2 = 117.4 ac-ft. The staff's estimate was considerably different from the applicant's estimate of 87 ac-ft. The staff determined that the applicant needed to justify its makeup water requirements for the proposed UHS. This was DSER Open Item 2.4-12.

In response to DSER Open Item 2.4-12, the applicant stated, in its submission to the NRC dated April 4, 2005, that the difference between the EGC and the NRC estimates of the 30-day makeup water needed for the ESP facility's UHS is the result of double counting of the blowdown in the NRC estimate. The applicant explained that if the average makeup flow rate of 555 gpm (SSAR Table 1.4-1, item 3.3.9) used by the NRC in its calculations, which includes blowdown, were replaced by 411 gpm (SSAR Table 1.4-1, item 3.3.7), the 30-day makeup water volume needed for the ESP UHS system would be 87 ac-ft.

The staff reviewed the applicant's response to DSER Open Item 2.4-12 and verified that the applicant's calculations were accurate. The staff also verified that the 30-day makeup water volume required by the ESP facility's UHS, excluding blowdown, would be 87 ac-ft. Based on the above review, the staff considers DSER Open Item 2.4-12 resolved.

The staff concluded that the applicant needed to provide additional details on the ESP facility's normal and UHS systems and their cooling water requirements to allow determination of the maximum PPE heat rejection parameters. The applicant needed to provide a commitment to specific ESP facility normal and UHS systems for the staff to conclude this review. The staff needed this information at the ESP stage to evaluate the adequacy of the water stored in the submerged UHS pond available for the ESP facility. This was DSER Open Item 2.4-13.

In response to DSER Open Item 2.4-13, the applicant stated, in its submission to the NRC dated April 4, 2005, that SSAR Table 1.4-1 provides the maximum PPE heat rejection requirements and, therefore, the staff need not determine them.

The applicant stated that the ESP facility NHS will be a mechanical draft cooling or a natural draft cooling tower system. The applicant stated that the NHS cooling tower may use dry cooling in combination with wet cooling, or only wet cooling, depending on the selected reactor type for the ESP facility. The applicant also stated that a commercial decision might be made to use wet/dry cooling to limit the amount of evaporation and maintain plant operation during drought periods.

The applicant stated that the ESP facility's UHS, if one were required by the selected reactor type, would consist of a mechanical draft cooling tower(s). The applicant also stated that some of the reactor types that could be used for the ESP facility use passive cooling or air blast cooling and do not require a UHS. The applicant argued that because not all reactor types that could be used for the ESP facility require a UHS, the SSAR was written to recognize that a UHS will be provided only if required.

The applicant stated that the adequacy of the submerged UHS pond volume available for the ESP facility cannot be determined until the design of the ESP facility is determined. The applicant stated that at the ESP stage, it was only possible to determine the volume of water available in the submerged UHS pond that could be utilized for safe shutdown of the ESP facility.

The staff reviewed the applicant's response to DSER Open Item 2.4-13 and determined that, as stated in the SSAR and as reiterated by in its response, it is possible that the ESP facility may require a water-cooled UHS. The actual design of the NHS and UHS is an issue that is beyond the scope of this ESP review. However, site characteristics that govern and may limit the design of the NHS and UHS must be established at the ESP stage. The COL or CP applicant needs to conclusively establish that any water-cooled UHS that may be required by a reactor type selected for the ESP facility will be designed to a maximum 30-day makeup water requirement not exceeding 87 ac-ft. This is **COL Action Item 2.4-8.** The COL or CP applicant also needs to establish that the ESP facility's NHS is designed such that there is no over-reliance on the UHS for frequent plant shutdowns. This is **COL Action Item 2.4-9.** Therefore, the staff considers DSER Open Item 2.4-13 to be resolved.

The staff requested, in RAI 2.4.8-1, that the applicant explain how it calculated the cooling water needs for the CPS Unit 1 and the ESP facility. In response to RAI 2.4.8-1, the applicant described earlier modeling performed for the original analysis of the CPS UHS. The model used (LAKET) is apparently no longer available for independent evaluation by the staff. The documentation of earlier applications of the model is limited to the description provided in the CPS USAR. The applicant stated that the depth-averaged temperature model would be more conservative than a stratified model, since the higher surface temperatures would result in increased heat loss. The staff agreed that a depth-averaged temperature model would indeed be conservative for temperature; however, the increased heat loss would come, in part, from increased forced evaporation. This implies that a depth-averaged model may not be conservative in terms of the volumetric analysis. The applicant stated that the UHS for CPS was designed for two units, of which only one was constructed. The UHS volume requirements for the ESP facility would be far less than the requirements for the two 992-MWe units originally planned. The applicant did not provide the volume requirements for the existing single uprated 1138.5-MWe CPS facility. The staff concluded that inadequate information exists to review the earlier modeling study on which the applicant relied. The staff determined that the applicant needed to provide the volume requirements of the UHS for the CPS, taking into consideration the latest power uprate. This was DSER Open Item 2.4-14.

In response to DSER Open Item 2.4-14, the applicant stated, in its submission to the NRC dated April 26, 2005, that the required capacity of the UHS for the CPS uprated Unit 1 is 586 ac-ft. The applicant-estimated CPS shutdown cooling water consumptive use is 327 ac-ft, obtained by multiplying the consumptive water use of 590 ac-ft for the two originally planned CPS units by the ratio of the uprated CPS unit shutdown heat load to the shutdown heat load of the two CPS units originally planned (590 ac-ft x 99,973 BTU / 180,455 BTU = 327 ac-ft). The required capacity of the UHS (i.e., 586 ac-ft) includes 327 ac-ft consumptive use for the CPS facility, 3 ac-ft for fire protection, 35 ac-ft for sedimentation from a 100-year flood, and 221 ac-ft for sediment inflow during SSE liquefaction.

The staff reviewed the applicant's response to DSER Open Item 2.4-14 and determined that the consumptive water use for the uprated CPS facility is 327 ac-ft. The applicant provided enough information to resolve the issue stated in DSER Open Item 2.4-14. Therefore, the staff considers DSER Open Item 2.4-14 resolved.

The staff requested, in RAI 2.4.8-2, that the applicant discuss how it computed the flow velocities over the crest and the toe of the submerged UHS dam. The staff also asked the applicant to provide figures indicating where the toe of the submerged UHS dam is located with respect to the fill shown in SSAR Figures 2.4-14 and 2.4-15. In response to RAI 2.4.8-2, the applicant stated that a discussion of flow velocities over the crest and toe of the submerged UHS dam is an unnecessary detail for an ESP review and it revised the appropriate section of the SSAR to remove the discussion of the flow velocities. SSAR Section 2.4.8.1 describes stabilization of the submerged UHS dam and the baffle dike with compacted soil-cement. Such measures should protect these structures against erosion. The staff determined, therefore, that the applicant specified erosion protection measures and that its response is satisfactory.

The staff requested, in RAI 2.4.8-3, that the applicant describe its lake drawdown calculations. In response to RAI 2.4.8-3, the applicant described an analysis of changes in pool elevation resulting from droughts of 5-year duration with a recurrence period of 50 and 100 years. The applicant did not provide a basis for selecting the 5-year-duration drought over a shorter drought duration which would provide a much lower inflow, albeit for a shorter duration. The staff, based on an independent reading of the report from an earlier study conducted by the Illinois State Water Survey that the applicant used as the basis for the assumed low-flow conditions, concluded that a drought period of shorter duration with the same recurrence period could result in considerably more challenging conditions for lake level. For instance, based on data in the report for the Rowell gauge on Salt Creek, using a recurrence interval of 40 years, the inflows (expressed as area-averaged runoff) for the 1-year drought and 5-year drought are approximately 1 in. and 23 in., respectively. The applicant relied on the CPS USAR as the basis for its values of natural evaporation and precipitation. It performed the analysis using a spreadsheet calculation and provided the spreadsheet as Attachment C to its responses to RAIs 5.2-1 and 5.2-2 generated from the staff's review of the applicant's ER. The staff reviewed the applicant's narrative response to RAI 2.4.8-3, the associated spreadsheet calculations, and the Illinois State Water Survey report on low flows of Illinois streams. The staff concluded that the applicant needed to provide a rationale for using the 5-year drought duration as opposed to a shorter duration drought with a significantly lower inflow estimate. This was DSER Open Item 2.4-15.

In response to DSER Open Item 2.4-15, the applicant stated, in its submission to the NRC dated April 26, 2005, that the 5-year-duration drought was used to evaluate Clinton Lake in the original lake study and the more recent evaluation of the uprated CPS. The applicant stated that, for consistency, the same duration drought was also used for the current ESP application. The applicant also stated that a review of duration of the drought indicated that it is still appropriate rather than a shorter duration drought of significantly lower inflow estimate.

The applicant stated that the storage capacity of Clinton Lake is large enough that short duration droughts of 1 to 2 years do not create critical conditions. The applicant's simple mass-balance calculation with zero inflow indicated that it will take approximately 20 months for Clinton Lake to drop from an initial water surface elevation of 690 ft MSL to the CPS and ESP facility shutdown water surface elevation of 677 ft MSL. The applicant also stated that with an extreme low inflow of 0.04 in. every month, the lake can support normal plant operation for approximately 29 months.

The applicant stated that its review of inflow values associated with the current 5-year-duration drought indicated that shorter-duration droughts are embedded within the 5-year drought used in its analysis for the ESP application. The applicant stated that CPS USAR Table 2.4-24 shows the "5-year duration" drought used in the analysis for the ESP application. The first year of the 5-year drought had a cumulative runoff volume of 0.85 in., which is close to the 45-year recurrence interval, 1-year inflow volume of 0.91 in. shown by Table 4 of the Stall (1964) report. The applicant argued that the 1-year, 50-year recurrence interval drought is thus accounted for in the first year of the 5-year-duration drought. Similarly, the applicant argued, that the first 2 years of the 5-year drought had a cumulative inflow of 4.9 in. as compared to the 45-year recurrence interval, 2-year inflow volume of 4.94 in., reported by Stall (1964). Also, the 5-year duration of the CPS USAR analysis had a cumulative inflow of 24 in., as compared to 23 in. reported in Stall (1964). The applicant stated that similar comparisons and conclusions are also valid for the 100-year recurrence interval drought that it used in the ESP drought analysis.

The staff reviewed the applicant's response to DSER Open Item 2.4-15 and adopted a simpler way to envelop the effects of severe, sustained drought in the Clinton Lake watershed on the lake and its ability to sustain operation of the CPS and the ESP facility. The staff conservatively estimated the rate of fall in water surface elevation in Clinton Lake during drought conditions by assuming that (1) both the CPS and the ESP facility were operating at 100 percent of their respective capacities, (2) there was no inflow into the lake, (3) Clinton Lake was discharging the minimum required 5 cfs downstream of the dam, and (4) the natural evaporation from the lake was set to a conservatively high estimate equal to the 8.35 inches per month (in./mo) of evaporation reported by Roberts and Stall (1967) for July 1936.

The staff estimated the forced evaporation for the existing CPS by assuming that all heat produced by the CPS which was not converted into electrical energy would be dissipated as latent heat of evaporation from Clinton Lake. This assumption resulted in an estimated 38 cfs of forced evaporation caused by the heat load from the CPS. The forced evaporation for the ESP facility was assumed equal to the PPE value of 70.2 cfs, reported in SSAR Table 1.4-1, item 2.4.7. The staff assumed that the total outflow from the Clinton Lake, consisting of natural evaporation, forced evaporation caused by the presence of the CPS and ESP facilities, and the downstream release from the dam would occur with the water surface area of Clinton Lake fixed at a conservatively low value of 2550 ac corresponding approximately to a water surface elevation of 677 ft MSL, thereby resulting in a correspondingly larger water surface drop rate. The staff estimated the maximum water surface drop rate in Clinton Lake to be 41.1 in./mo. Based on this conservatively estimated water surface drop rate, the staff determined that it will take approximately 18 days for the water surface in Clinton Lake to fall from 679 ft MSL to 677 ft MSL.

While it is possible for a more rapid decrease in water surface elevation in Clinton Lake to occur in the presence of a more severe combination of starting water surface elevation, low inflow, and little precipitation, the staff considers the 18-day period required for the water surface elevation to fall from 679 ft MSL to 677 ft MSL indicative of Clinton Lake's large capacity, which allows a gradual decrease in its water surface elevation, even under extreme droughts. The staff concluded, therefore, that water surface elevation in Clinton Lake does not fall rapidly and sufficient time will be available to plant operators before the low-water surface elevation shutdown threshold is reached to plan a shutdown of the proposed ESP facility without endangering its safety, even under severe drought conditions. The staff also concluded that the water surface elevation in Clinton Lake does not fall near the low-water surface elevation shutdown threshold frequently enough to result in an excessive reliance of the ESP facility on its UHS, if one were required. Based on the above review, the staff considers DSER Open Item 2.4-15 resolved.

The staff requested, in RAI 2.4.8-4, that the applicant describe how it estimated UHS capacity loss because of sediment or debris loads during extreme events. In response to RAI 2.4.8-4, the applicant stated that the ESP facility would use cooling tower(s) as the UHS and would only use the submerged UHS pond as a source of makeup water. The applicant explained that, for this reason, sediment or debris would not directly affect the ESP facility UHS.

The applicant stated that the design of the UHS considered the following factors:

- loss of storage capacity because of sediment inflow from liquefaction, equal to 221 ac-ft
- a fire water requirement of 3 ac-ft
- minimum cooling water capacity of 590 ac-ft required for CPS Unit 1
- loss in capacity of 35 ac-ft from sedimentation resulting from a 100-year flood

The staff's estimate of ice sheet formation in Clinton Lake indicated that the maximum ice thickness could reach 31.4 in. Under these icing conditions, if the main dam were to fail, or the water surface elevation in Clinton Lake were to fall to 675 ft MSL, some loss in the storage capacity of the submerged UHS pond would be likely because the ice sheet would settle down into the pond behind the submerged UHS dam. The staff conservatively estimated this loss in capacity by multiplying the surface area of the submerged UHS pond at elevation 675 ft MSL by the maximum thickness of the ice sheet. The staff estimated that the loss in submerged UHS pond capacity because of icing would be 413 ac-ft. Based on this estimate and the issue described in DSER Open Item 2.4-12, the staff concluded that the applicant needed to establish that the submerged UHS pond has adequate capacity to provide makeup water to the ESP facility UHS. This was DSER Open Item 2.4-16.

In response to DSER Open Item 2.4-16, the applicant stated, in its submission to the NRC dated April 26, 2005, that the required capacity of the submerged UHS pond was established based on maximum evaporative loss from the facilities and temperature limitations of 95 °F at the plant intakes.

The applicant stated that the design capacity of the submerged UHS pond with water surface elevation at 675 ft MSL and a top water surface area of 158 ac is 1067 ac-ft. The applicant estimated the 30-d total UHS cooling requirement for the CPS and the ESP facility to be 327 ac-ft and 87 ac-ft, respectively. Additionally, 3 ac-ft may be required for fire protection, 35 ac-ft for sediment accumulation from a 100-year flood event, and 221 ac-ft for sediment inflow caused by liquefaction during an SSE. The applicant-estimated water use for all these requirements is 673 ac-ft, leaving 394 ac-ft of excess capacity in the submerged UHS pond.

The applicant stated that it determined the maximum evaporative loss from the submerged UHS pond during warm weather conditions when atmospheric cooling may be limited. The applicant argued that with an ice cover on the lake, evaporative loss would be limited to a negligible quantity. Under this scenario, the applicant estimated the CPS UHS cooling needs for 30 days as 0 ac-ft. Given a 30-day UHS makeup requirement for the ESP facility of 87 ac-ft, 3 ac-ft for fire protection, 35 ac-ft for sediment accumulation from a 100-year flood event, and 221 ac-ft for sediment inflow caused by liquefaction during an SSE, the applicant estimated that the excess capacity in the submerged UHS pond during ice-covered conditions would be 421 ac-ft, allowing for a loss of liquid water displace by a 24.8-in thick ice sheet approximately equal to 300 ac-ft (158 ac x 24.8 in. / 12 in./ft x 0.917 = 299.4 ac-ft, as stated by the applicant in response to DSER Open Item 2.4-11). The applicant thus concluded that the excess capacity in the submerged UHS pond accounting for the ESP facility's 30-day UHS makeup water requirement is greater with an ice sheet formed on the surface of the submerged UHS pond than without ice formation.

The staff reviewed the applicant's response to DSER Open Item 2.4-16 and determined that the negligible evaporative loss argument is acceptable when an ice sheet is covering the submerged UHS pond. The staff's revised estimate of the maximum thickness of an ice sheet that may form on Clinton Lake is 27 in. (see discussion related to DSER Open Item 2.4-9 above). Based on this revised maximum ice thickness, the volume of liquid water displaced, if this ice sheet were to settle down into the submerged UHS pond, is approximately 319 ac-ft (see discussion related to DSER Open Item 2.4-11 above).

The staff also determined that the applicant used the design capacity of the submerged UHS pond (1067 ac-ft) while estimating the volume of excess water in the submerged UHS pond. The applicant reported, in response to DSER Open Item 2.4-17 (see discussion related to DSER Open Item 2.4-17 below), that the storage capacity of the submerged UHS pond in 2004 was reduced to 991 ac-ft by sediment accumulation. The staff determined that the present storage capacity of the submerged UHS pond must be used to establish excess capacity within it. Most of the CPS 30-day UHS consumptive loss would occur as evaporation from the free water surface under elevated water temperature condition. The presence of an ice sheet on most of the surface of the UHS pond would prevent evaporation from the water surface in contact with the ice sheet. Therefore, the CPS 30-day UHS consumptive loss would be reduced to an insignificant amount. The staff determined the excess capacity to be approximately 318 ac-ft without an ice-cover on the lake (991 ac-ft - (327 ac-ft for CPS 30-day UHS consumptive loss + 3 ac-ft for fire + 35 ac-ft for 100-year flood sedimentation + 221 ac-ft liquefaction sedimentation from SSE + 87 ac-ft for ESP facility 30-day UHS makeup)) = 318 ac-ft), and approximately 319 ac-ft with an ice-sheet covering the surface of the submerged UHS pond (991 ac-ft - {insignificant CPS 30-day UHS consumptive loss + 3 ac-ft for fire + 35 ac-ft for 100-year flood sedimentation + 221 ac-ft liquefaction sedimentation from SSE + 87 ac-ft for ESP facility UHS 30-d makeup + 326 ac-ft lost to ice sheet)) = 319 ac-ft).

In its letter dated December 21, 2005, the applicant revised its estimate of maximum ice thickness in Clinton Lake. The applicant also revised its response to Open Item 2.4-16 in this letter. The applicant stated that reduction in water storage capacity of the submerged UHS pond due to an ice sheet 27.0 in. in thickness will be approximately 326 ac-ft. The applicant estimated the excess water storage capacity within the submerged UHS pond to be approximately 395 ac-ft, based on a total available capacity of 1067 ac-ft. Applicant's estimate (approximately 395 ac-ft) therefore, is larger than staff's estimate (318 or 319 ac-ft). This difference is due to different total storage capacities of the submerged UHS pond used by the applicant and the staff. The applicant stated in response to Open Item 2.4-17 below that the total storage capacity of the submerged UHS pond was reduced to 991 ac-ft in 2004 due to sediment accumulation. As stated above, staff determined that the current storage capacity of the submerged UHS pond must be used to determine excess water storage capacity within it. Due to this difference, the staff's estimate of excess capacity in the submerged UHS pond is much smaller than that stated by the applicant. Nevertheless, the staff estimate of excess capacity in the submerged UHS pond is adequate to provide makeup water to the ESP facility UHS, if one is needed by the selected reactor type. The staff's proposed COL Action Item 2.4-10, stated below, requires that the submerged UHS pond will be dredged frequently to ensure that adequate liquid water will be available for the ESP facility UHS, if a UHS is required by selected reactor type. The frequency of dredging will be established at the COL stage. Therefore, the staff considers DSER Open Item 2.4-16 resolved.

The applicant stated that it monitors the CPS UHS for sediment accumulation periodically and after a major flood passes through the submerged UHS pond. The applicant committed to perform necessary dredging to prevent the accumulation of sediment from exceeding the capacity provided for sediment storage in the design. The staff evaluated the applicant's response to open items listed in this section to consider the adequacy of submerged UHS pond monitoring and dredging. The staff determined that the applicant needed to establish the monitoring and dredging requirements for the UHS pond for the combined operation of the CPS facility and a future facility consistent with the PPE parameter for maximum thermal discharge. This was DSER Open Item 2.4-17.

In response to DSER Open Item 2.4-17, the applicant stated, in its submission to the NRC dated April 26, 2005, that the NRC staff appeared to have confused the actions of the ESP applicant and those of the CPS operators. The applicant stated that the CPS operators monitor the CPS UHS for sediment accumulation, not the applicant. The applicant also stated that it did not commit to dredging the CPS UHS. The applicant also stated that the ESP review stage is inappropriate for establishing operational requirements for the ESP facility, since a water-cooled UHS may not even be required for some potential ESP facility reactor types.

The applicant stated that monitoring reports from 1991 to 2004 show a nominal reduction of 63 ac-ft in the water storage capacity of the submerged UHS pond (from 1054 ac-ft in 1991 to 991 ac-ft in 2004), a loss rate of 4.85 ac-ft/year. The applicant stated that the submerged UHS pond will have an excess capacity of 394 ac-ft, even if the ESP facility were to use a water-cooled UHS. At the stated sedimentation rate, the applicant estimated that the submerged UHS pond would require dredging once every 81 years (394 ac-ft / 4.85 ac-ft/year = 81.2 year). Based on this reasoning, the applicant stated that it did not propose a dredging frequency in the ESP application. The applicant stated that the need for dredging will be evaluated at the COL stage based on the final design of the ESP facility and the results of the CPS UHS sedimentation monitoring reports.

The staff reviewed the applicant's response to DSER Open Item 2.4-17 and determined that, based on the PPE information provided in the SSAR, a water-cooled UHS may be required by the selected ESP facility reactor type. Since the safety of the water-cooled ESP facility UHS will depend on the water availability within the submerged UHS pond, the submerged UHS pond is a safety-related facility for the proposed ESP facility. The staff also determined that site characteristics related to the submerged UHS pond that may be used for design of a future water-cooled ESP facility UHS must be established at the ESP stage. The sediment accumulation rate of 4.85 ac-ft/yr is a normal sediment accumulation rate over the last 13 years only, which may be subject to large increases during years of extreme flood events in the Clinton Lake watershed. Since the submerged UHS pond is a safety-related facility for the ESP facility based on the description in the SSAR, the monitoring and any required dredging of the submerged UHS pond is the responsibility of the ESP facility operators and will be determined at the COL stage. This is **COL Action Item 2.4-10**. Based on the above review, the staff considers DSER Open Item 2.4-17 resolved.

The staff had planned to include the submerged UHS pond monitoring and dredging frequencies as a permit condition. However, the reliance of the ESP facility UHS on water available in the submerged UHS pond is dependent on the selected reactor type requiring a UHS. The staff concluded therefore that COL Action Item 2.4-10 is sufficient to ensure that adequate liquid water will be available for the ESP facility's UHS, if one is required by the selected reactor design and no additional permit conditions are necessary.

2.4.8.4 Conclusions

As set forth above, the applicant provided sufficient information pertaining to identifying and evaluating cooling water canals and reservoirs at the site. SSAR Section 2.4.8 conforms to Section 2.4.8 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," issued July 1981 (hereafter referred to as the SRP), as applicable to an ESP site.

The review guidance in SRP Section 2.4.8 provides that the SSAR should address 10 CFR Parts 50 and 100, as they relate to identifying and evaluating cooling water canals and reservoirs at the site. Although the applicant did not specifically address the above regulations in SSAR Section 2.4.8, the staff concludes that by conforming to SRP Section 2.4.8 the applicant has met the requirements for cooling water canals and reservoirs at the site with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c)(3), except as noted in Section 2.4.8.3 above. Further, with the exception noted, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area in establishing design-basis information related to cooling water canals and reservoirs, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

2.4.9 Channel Diversions

Relatively thin deposits of Quaternary glacial drift dominate the regional surface geology in the vicinity of the ESP site. During the Quaternary period, continental glaciation caused widespread glacial deposition in the region. The deposits at the ESP site are consistent with the regional deposits and are classified as part of the Pleistocene Series, consisting predominantly of glacial or glacially derived sediments of glacial till, outwash, loess (a windblown silt), glaciolacustrine deposits, and alluvium.

2.4.9.1 Technical Information in the Application

The applicant stated in SSAR Section 2.4.9 that is no existing historical evidence of channel diversion in the Salt Creek or the North Fork of Salt Creek upstream of the Clinton Dam. The applicant stated that, based on topographic characteristics and geologic features of the drainage basin, landslides that might lead to blockage of streamflow into Clinton Lake are not possible. The applicant also noted that, as discussed in SSAR Section 2.4.7, the history of ice jam formation does not indicate streamflow diversion during the winter months.

In RAI 2.4.9-1, the staff requested the applicant to reference studies related to the geological features or other characteristics that preclude any likelihood of channel diversion upstream of the ESP site. In response to RAI 2.4.9-1, the applicant stated that it performed a study of geological features and other characteristics related to the potential for channel diversion upstream of the ESP site specifically for the ESP application. The applicant indicated that this site-specific examination did not rely on any previously published studies other than topographic maps. The applicant further stated that its examination of the topographic maps of Salt Creek and the North Fork of Salt Creek did not reveal evidence of natural channel diversions, such as oxbow lakes or broad, well-developed floodplains.

The applicant stated that the creeks and streams in the watershed generally occur in well-defined valleys. Any diversion of water out of these valleys into an adjacent drainage basin would require sufficient energy to overcome the topography and cut a new drainage channel. The applicant stated that, based on the physical characteristics of the drainage area and the creek system, it is unlikely that a potential, naturally occurring channel diversion would shift water out of the Clinton Lake watershed. In Revision 4 of the SSAR, the applicant added information to reflect the above clarification.

2.4.9.2 Regulatory Evaluation

SSAR Table 1.5-1 shows the applicant's conformance to the NRC RGs. In RAI 1.5-1, the staff asked the applicant to provide a comprehensive listing of NRC regulations applicable to its ESP SSAR. In its response to this RAI, the applicant indicated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. Section 2.4 of RS-002, Attachment 2, describes the methods of review and the applicable acceptance criteria that the staff uses to develop its findings and conclusions related to the hydrologic aspects of site characterization for an ESP. Although the applicant did not indicate how the individual sections of SSAR Section 2.4 address the hydrology-related site suitability criteria in RS-002, Attachment 2, the staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance, as identified below.

The staff used the review guidance provided in Section 2.4.9 of RS-002, Attachment 2, to evaluate this SSAR section. These acceptance criteria relate to 10 CFR Parts 52 and 100, insofar as they require that the site evaluation consider the hydrologic characteristics of the site. The regulations at 10 CFR 52.17(a), 10 CFR 100.20(c), and 10 CFR 100.21(d) require that the NRC take into account the physical characteristics of the site (including seismology, meteorology, geology, and hydrology) when determining the acceptability of a site for a nuclear reactor.

Channel diversion or realignment poses the potential for flooding or for an adverse effect on the supply of cooling water for a nuclear power plant(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site. Therefore, it is one physical characteristic that must be evaluated pursuant to 10 CFR 100.21(d). The consideration of the 10 CFR 100.21(d) criteria in this evaluation provides reasonable assurance that the effects of flooding caused by channel diversion resulting from severe natural phenomena would pose no undue risk to the type of facility proposed for the site.

In those cases for which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of the relevant parameters.

To determine whether the applicant met the requirements of 10 CFR Parts 52 and 100, as they relate to channel diversion, the staff used the following specific criteria:

- A description of the applicability (potential adverse effects) of stream channel diversions is necessary.

- Historical diversions and realignments should be discussed.

- The topography and geology of the basin and its applicability to natural stream channel diversions should be addressed.

- If applicable, the safety consequences of diversion and the potential for high- or low-water levels, caused by upstream or downstream diversion, to adversely affect safety-related facilities, water supply, or the UHS should be addressed. RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," issued January 1976, provides guidance on acceptable UHS criteria.

2.4.9.3 Technical Evaluation

The staff developed a basic understanding of the geomorphology of the region during the site visit on May 11, 2004. The staff's search did not produce any evidence of major channel diversion in Salt Creek or the North Fork of Salt Creek. Channel diversions usually occur in relatively flat, deep alluvial plains where the river channel meanders greatly.

Section 2.4.7 of this SER evaluates channel diversion resulting from ice effects, and Section 2.4.11 of this SER evaluates channel diversion resulting from low-water conditions.

SSAR Section 2.4.9 did not provide details of historical or geological evidence of possible diversions and meandering of Salt Creek and the North Fork of Salt Creek upstream of the ESP site. The staff contacted the USGS Illinois Water Science Center to obtain references of channel diversion studies carried out on Salt Creek and the North Fork of Salt Creek. The USGS Illinois Water Science Center stated in email communication to the staff that no channel diversion studies had been carried out on these streams.

To evaluate the impact of channel diversion on the ESP facility, the staff considered a hypothetical scenario in which both the North Fork of Salt Creek and the Salt Creek arms migrated, eliminating subsequent inflow into Clinton Lake. Since channel migration usually happens during high-flow or flood events, the staff assumed that Clinton Lake would be at a normal pool level, should channel migration occur. Subsequent to channel migration, inflow into Clinton Lake would stop, and water surface elevation would start to decrease because of losses caused by natural and forced evaporation, downstream release, and ground water recharge. During the initial period following channel migration, it is expected that the submerged UHS pond would remain intact. The staff determined that sufficient time would be available following the onset of channel migration to safely shut down the ESP facility using the UHS system. The staff concluded, therefore, that, even if channel migration were to stop all inflow into Clinton Lake, it would not adversely affect the safety of the ESP facility.

2.4.9.4 Conclusions

As set forth above, the applicant provided sufficient information pertaining to the identification and evaluation of channel diversion at the site. SSAR Section 2.4.9 conforms to Section 2.4.9 of RS-002, Attachment 2, with regard to this objective.

Section 2.4.9 of RS-002, Attachment 2, provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating channel diversion at the site. Although the applicant did not specifically address the above regulations in SSAR Section 2.4.9, the staff concludes that, by conforming to Section 2.4.9 of RS-002, Attachment 2, it has met the requirement to identify and evaluate channel diversion at the site with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c). Further, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area in establishing design-basis information related to channel diversions, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

2.4.10 Flooding Protection Requirements

The proposed ESP site grade is at an elevation of 735 ft MSL.

2.4.10.1 Technical Information in the Application

SSAR Section 2.4.3.6 estimated the design-basis flood elevation at the ESP site to be 713.8 ft MSL. This elevation included the effects of flooding from a PMF caused by the PMP over the Clinton Dam's drainage area, wind setup, and wave runup. The applicant stated that all safety-related SSCs for the ESP facilities would be located at the existing site grade of 735 ft MSL. The applicant, therefore, concluded that the only safety-related ESP facility structure that could be affected by flooding in Clinton Lake would be the new ESP facility's UHS intake structures. The applicant stated in the SSAR that it would design the ESP facility UHS intake for flood protection of all safety-related equipment located within the intake structures.

The applicant also stated that the design of the ESP facility's UHS intake would consider wind wave forces caused by a sustained 48-mph overland wind speed acting on the PMF water surface elevation, as well as those caused by a sustained 67-mph overland wind speed acting on the normal water surface elevation in Clinton Lake. The applicant noted that the design would consider both breaking and nonbreaking waves.

The applicant stated that the flooding effects of local PMP are design related and will be considered at the COL stage.

The staff requested, in RAI 2.4.10-1, that the applicant discuss the difference in methods it used to determine the design wind speeds of 40 mph, mentioned in SSAR Sections 2.4.3.6 and 2.4.10, and the design wind speeds of 48 mph and 67 mph, mentioned in SSAR Section 2.4.10. In response to RAI 2.4.10-1, the applicant stated that the CPS USAR considered the 40-mph overland wind speed to act on the PMF water surface elevation. The applicant also stated that the design of the circulating water screenhouse for the CPS Unit 1 considered a 48-mph overland wind speed coincident with the PMF water surface elevation. The applicant noted that use of these design wind speeds did not result in any safety issues and concluded that the CPS plant would not flood under any circumstances. The applicant also stated that the ESP site is considered to be a dry site, consistent with Condition 3 of Section 2.4.3 of RS-002, Attachment 2. The applicant further stated that the operation of the ESP facility would not impact the potential for flooding at the existing dam or at the plant site. Therefore, the applicant concluded that the calculation of wave runup effects on PMF water surface elevations is inconsequential. The applicant stated that the ESP analyses retained the design wind speeds to be consistent with the previously completed CPS USAR analyses.

The applicant stated that a review of the more recent ANSI/ANS-2.8-1992 information indicated that a wind speed of somewhat greater magnitude (i.e., 52 mph) is more appropriate for estimating wave runup height coincident with PMF water surface elevation. The applicant provided a revision to SSAR Sections 2.4.3.6 and 2.4.10 in the RAI response, using a wind speed of 52 mph.

In Revision 4 of the SSAR, the applicant stated that the maximum hydrostatic PMF water surface elevation is 709.8 ft MSL and, combined with other effects, the maximum water level of Clinton Lake near the ESP facility is 716.5 ft MSL. The applicant noted that the ESP facility grade is approximately 19 ft above the maximum combined effects elevation and 25 ft above the hydrostatic PMF elevation. The applicant stated that the only safety-related equipment below these elevations is the new ESP intake structure, which would be designed with adequate flooding protection.

2.4.10.2 Regulatory Evaluation

As required by 10 CFR 100.20(c), the PMF must be estimated using historical data. Meeting this requirement provides reasonable assurance that the effects of flooding or a loss of flooding protection, resulting from severe natural phenomena, would pose no undue risk to the type of facility proposed for the site.

In those cases for which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting the limiting values of the relevant parameters.

To determine whether the applicant met the requirements of 10 CFR Parts 52 and 100, as they relate to flooding protection, the staff used the following specific criteria:

- The applicability (potential adverse effects) of a loss of flooding protection should be described.
- Historical incidents of shore erosion and flooding damage should be discussed.
- The topography and geology of the basin and its applicability to damage as a result of flooding should be addressed.
- If applicable, the safety consequences of a loss of flooding protection and the potential to adversely affect safety-related facilities, water supply, or the UHS should be addressed. RG 1.27 provides guidance on acceptable UHS criteria.

2.4.10.3 Technical Evaluation

During its review of the SSAR, the staff estimated the maximum water surface elevation at the site for the design-basis flood to be 721.7 ft MSL. The NRC staff independently estimated this value by combining the effects of PMF, coincident wind wave activity, and wind setup. Both coincident wave activity and storm surge require use of a wind speed, which was conservatively estimated by the staff to be 100 mph. This value was based upon the PMWS, as defined by ANSI/ANS 2.8-1992, and was recommended for the location of the site being within 150 miles of the Great Lakes. The staff estimated the local intense precipitation rate for the ESP site to be 18.15 in./h in Section 2.4.2.3 of this SER. Table 2.4-2 of this SER in this report provided the complete hyetograph for the 6-hour local intense precipitation. Except for the new ESP facility UHS intake structures, the ESP site grade (elevation 735 ft MSL) is above the design-basis flood elevation.

The staff's evaluation assumed that all safety-related SSCs would be placed at or above the applicant-stated ESP site grade, except for the new ESP facility UHS intake structures, which are known to be located below plant grade. As stated previously in Sections 2.4.2.3 and 2.4.3.3 of this SER, the COL applicant will need to design the ESP facility's intake structures to withstand the combined effects of PMF, coincident wind wave activity, and wind setup. This is COL Action Item 2.4-3 as stated in Section 2.4.2.3 of this SER.

2.4.10.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to identifying and evaluating flooding protection requirements at the site. SSAR Section 2.4.10 conforms to SRP Section 2.4.10 as applicable to an ESP site.

The review guidance in SRP Section 2.4.10 provides that the SSAR should address 10 CFR Parts 50 and 100, as they relate to identifying and evaluating flooding protection requirements at the site. Although the applicant did not specifically address the above regulations in SSAR Section 2.4.10, the staff concludes that by conforming to SRP Section 2.4.10 the applicant has met the requirements of flooding protection at the site with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c)(3), except as noted in Section 2.4.10.3 above. Further, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area in establishing design-basis information for flood protection, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

2.4.11 Low-Water Considerations

The ESP site is adjacent to Clinton Lake, which provides cooling water for the current CPS Unit 1 and would provide cooling water for the proposed ESP facility. Events, such as low lake elevation, seiches, wind-induced set down, and intake blockages from sediment or ice, may reduce or limit the availability of cooling water at the site.

Clinton Lake, created by the Clinton Dam, would provide the normal cooling makeup water supply for the ESP facility. The submerged UHS pond, created by a submerged dam across the North Fork of Salt Creek within Clinton Lake, would provide 30-day emergency cooling makeup water for the ESP facility's UHS system.

Normal operation of the ESP facility would use a cooling tower(s), operated with water drawn from a cooling tower basin(s). The basin(s) in turn would receive makeup water from the lake.

2.4.11.1 Technical Information in the Application

The applicant used a design drought with a recurrence interval of 100 years to determine the minimum water surface elevation in Clinton Lake. This analysis considered factors that affect the water surface elevation in Clinton Lake, such as runoff, evaporation, and forced evaporation.

The applicant stated that a drawdown analysis of Clinton Lake for the original CPS, which consisted of two 992 MWe units operating at a 70-percent load factor, was performed. The applicant's analysis assumed the starting water surface in Clinton Lake to be equal to the normal pool water surface elevation of 690 ft MSL. The drawdown analysis assumed a minimum reservoir release rate of 5 cfs. This analysis also assumed a seepage loss rate of 0.5 percent of the lake capacity per month. The applicant stated that the original CPS drawdown analysis evaluated the ability of Clinton Lake to provide cooling tower(s) makeup water to the ESP facility in addition to meeting the cooling water requirements of the existing CPS Unit 1. The applicant stated that the previous forced-evaporation rate estimate was based on heat rejection from CPS. In the ESP facility evaluation, the applicant adjusted this estimate by (1) dividing the original estimate by two, since only one of the two units originally planned was constructed, (2) dividing by 0.7 to conservatively adjust the forced-evaporation rate for a 100-percent load factor, and (3) multiplying by 1.2 to conservatively adjust for the additional heat load caused by the power uprate of the existing CPS Unit 1.

The applicant stated that the new drawdown analysis performed for the ESP facility determined that the quantity of water available for cooling tower(s) makeup during a 50-year drought would be 15,808 gpm, and the quantity available during a 100-year drought would be 10,222 gpm. These available water quantities would maintain the water surface elevation in Clinton Lake at or above the CPS minimum required water surface elevation of 677 ft MSL while both the CPS Unit 1 and the ESP facility were in operation.

The applicant stated that the available water quantity during drought conditions would be sufficient to provide makeup water for both the safety and nonsafety cooling systems' cooling towers for some of the reactor designs being considered for the site which use wet cooling. The applicant stated that the bounding reactor plant cooling system makeup demand would require the use of a wet/dry cooling tower for a turbine plant's cooling systems to reduce either the evaporation rate or the heat discharge to the lake, so that the demand would not exceed the available water supply from Clinton Lake.

The applicant stated that surges, seiches, or tsunami conditions were not likely to occur in Clinton Lake or the submerged CPS UHS pond because no large body of water exists near the ESP site. Therefore, the applicant concluded that these conditions would not produce or affect low-water conditions at the ESP site.

The applicant stated that it evaluated the effects of drought on water surface elevations in Clinton Lake to determine whether the operation of the existing CPS plant would be sustained during dry periods. This analysis established a minimum water surface elevation of 677 ft MSL in Clinton Lake for the safe operation of the CPS plant. The applicant stated that a water surface elevation below 677 ft MSL in Clinton Lake would require a shutdown of the CPS plant to avoid loss of safety-related plant cooling water.

The applicant stated that the drawdown analysis for the ESP site accounted for inflows generated from direct rainfall and storm runoff, normal evaporation, forced evaporation caused by plant cooling and resulting in increased lake water temperature, seepage losses, and a minimum discharge from the dam for downstream flow requirements. This drought analysis was based on the existing, uprated CPS, which consists of one 1138.5 MWe BWR operating at 100-percent load, as well as on the PPE value for ESP plant consumption.

The applicant stated that the results of the drawdown analysis established the minimum lake water surface elevation during 50- and 100-year droughts as 685 ft MSL and 681.4 ft MSL, respectively. The applicant stated that both of these minimum lake water surface elevations were above the CPS minimum safety-related lake water surface elevation of 677 ft MSL.

The applicant stated that, based on inquiries to Federal and State regulatory agencies, no future plans exist to use Salt Creek water upstream of Clinton Lake. The applicant also stated that any future use of Salt Creek water upstream of the ESP site would not affect the availability of safety-related cooling water supply because of the submerged condition of the UHS pond.

The applicant stated that a new intake structure located next to the existing CPS intake structure would supply the water required for the ESP facility. This new intake would use Clinton Lake as its source of water and would also have the capability to draw water from the existing submerged UHS pond as an alternate source of makeup water for the safety-related cooling tower(s). The new intake structure would house traveling screens, fire pumps, cooling tower makeup pumps, and safety-related cooling tower makeup pumps. The applicant stated that the makeup water pumps for the safety-related cooling tower(s) would be designed to operate with a suction water surface elevation at least 1 ft below the lowest water surface elevation to which the submerged UHS pond could fall after 30 days of operation without makeup water.

The applicant stated that, in the event of a severe drought that could reduce the water surface elevation in Clinton Lake to 677 ft MSL or below, the ESP facility would be shut down.

The applicant stated that the essential service water cooling tower(s) would provide the UHS cooling function for the ESP facility. These cooling tower(s) would require makeup water from Clinton Lake. The applicant stated that the makeup water requirements range from 250 gpm during normal operation up to a maximum of 700 gpm during a normal shutdown. The total makeup water requirement for postaccident shutdown and cooldown for a 30-day period is approximately 21.4 million gallons or an average makeup requirement of 495.2 gpm over the 30-day period.

The applicant stated that, in the unlikely event of a failure of the main dam and complete loss of Clinton Lake, the existing submerged UHS pond would supply makeup water to the ESP facility's safety-related cooling tower(s). The applicant stated that the existing CPS UHS pond is a submerged pond within Clinton Lake formed by the construction of a submerged dam across the North Fork of Salt Creek. The submerged UHS pond is adjacent to the ESP facility's intake structure where the makeup water pumps for the ESP facility's safety-related cooling tower(s) would be located. The applicant stated that the maximum return water temperature from the ESP facility's safety-related cooling tower(s) would be 94.7 °F, based on a 10 °F approach and a maximum wet bulb temperature of 84.7 °F. The applicant also stated that blowdown from the ESP facility's safety-related cooling tower(s) would be discharged to the existing CPS discharge flume. The applicant stated that credit was taken for return of the blowdown water volume to the submerged UHS pond when determining the capability of the submerged UHS pond to supply water to the CPS and the ESP facility.

The applicant stated that the submerged UHS pond has sufficient water storage capacity for shutdown operation of the CPS, as well as providing makeup water for the ESP facility shutdown for a period of at least 30 days and beyond, if necessary. The applicant stated that it might be necessary to reduce the allowable accumulated sediment volume in the submerged UHS pond to provide adequate additional capacity for makeup water to the ESP facility's safety-related cooling towers.

The applicant stated that it determined the amount of makeup water required by the ESP facility's safety-related cooling tower(s) for a 30-day period based on the reactor plant within the applicant's PPE possessing the bounding UHS heat load. The amount of water that would be evaporated to provide postaccident shutdown cooling is 2.87 million ft^3. The applicant conservatively increased this water quantity by one-third to provide allowance for blowdown to limit the concentration of impurities in the cooling tower basin to four times the concentration in the lake. The applicant stated that this number is conservative since blowdown would be terminated during an accident and normal operation would be at a concentration ratio higher than 4.

The applicant stated that the original design of the submerged UHS pond was based on the heat load from the shutdown of one CPS unit under LOCA conditions and one CPS unit under LOOP conditions, with a total integrated heat load of $180,455 \times 10^6$ BTU for 30 days. The heat load from the single, uprated CPS unit is $99,973 \times 10^6$ BTU for 30 days under LOCA or LOOP conditions. The applicant estimated that this value is approximately 55 percent of the CPS submerged UHS pond design heat load, thereby indicating that considerable margin is available. The applicant stated that a review of the original CPS submerged UHS pond design revealed that withdrawal of water to provide makeup for the ESP facility's safety-related cooling tower(s) would have only a small impact on heat transfer from the submerged UHS pond.

The applicant stated that the reliability of the submerged UHS pond to provide a supply of water during drought conditions is enhanced by the location of the pond with respect to the adjacent ground water table. The applicant stated that, because the pond is normally submerged in Clinton Lake and the normal water surface elevation sets the base level for the adjacent ground water during low flow or loss of the main dam, water stored in upstream alluvium would replenish water in the submerged UHS pond. The applicant further stated that the Salt Creek watershed would also provide a source of water for long-term cooling following loss of the Clinton Lake dam. The applicant estimated that the watershed can supply 400 gpm at the minimum mean daily flow and 16,150 gpm at the minimum mean monthly flow. The required makeup flow to the ESP facility's UHS cooling tower(s) during normal operation would be 250 gpm and would bound the requirement after shutdown was achieved.

The applicant stated that it monitors the submerged UHS pond for sediment accumulation periodically and after a major flood passes through Clinton Lake. The applicant stated that, after the ESP facility is constructed, it might reduce the allowable sediment accumulation in the submerged UHS pond.

In Revision 2 of the SSAR, the applicant described an assessment similar to the one described above in order to determine the amount of cooling water available during drought periods. The applicant stated that the excess available water on an annual average basis after satisfying CPS consumptive demand is 1,300 ac-ft/month (9,500 gpm) during the 100-year drought event and 2,000 ac-ft/month (15,100 gpm) during the 50-year drought event.

2.4.11.2 Regulatory Evaluation

SSAR Table 1.5-1 shows the applicant's conformance to the NRC RGs. In RAI 1.5-1, the staff asked the applicant to provide a comprehensive listing of NRC regulations applicable to its ESP SSAR. In its response to this RAI, the applicant indicated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. Section 2.4 of RS-002, Attachment 2, describes the methods of review and the applicable acceptance criteria that the staff uses to develop its findings and conclusions related to the hydrologic aspects of site characterization for an ESP. Although the applicant did not indicate how the individual sections of SSAR Section 2.4 address the hydrology-related site suitability criteria in RS-002, Attachment 2, the staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance, as identified below.

Acceptance criteria for this section relate to the following regulations and criteria:

- 10 CFR Parts 52 and 100 require that hydrologic characteristics be considered in the evaluation of the site.

- 10 CFR 100.23 requires, in part, that siting factors to be evaluated must include the cooling water supply.

The regulations in 10 CFR Parts 52 and 100 require, in part, that the evaluation of a nuclear power plant site consider hydrologic characteristics. To satisfy the requirements of 10 CFR

Parts 52 and 100, the applicant's SSAR should describe the surface and subsurface hydrological characteristics of the site and region. In particular, the UHS for the cooling water system may consist of water sources that could be affected by the site's hydrologic characteristics, resulting from river blockage or diversion, tsunami runup and drawdown, and dam failure. These characteristics may reduce or limit the available supply of cooling water for safety-related SSCs. Meeting the requirements of 10 CFR Parts 52 and 100 provides assurance that severe hydrologic phenomena, including low-water conditions, would pose no undue risk to the type of facility proposed for the site.

In those cases for which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting the limiting values of the relevant parameters.

As required by 10 CFR 100.23, siting factors, including cooling water supply, must be evaluated for a nuclear power plant site. The evaluation of the emergency cooling water supply for a nuclear power plant(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site should consider river blockages, diversions, or other failures that may block the flow of cooling water, tsunami runup and drawdown, and dam failures.

The regulations at 10 CFR 100.23 apply to this section because the UHS for the cooling water system consists of water sources that are subject to natural events that may reduce or limit the available supply of cooling water (i.e., the heat sink). Natural events, such as river blockages, diversions, or other failures that may block the flow of cooling water, tsunami runup and drawdown, and dam failures, should be conservatively estimated to assess the potential for these characteristics to influence the design of those SSCs important to safety for a nuclear power plant(s) of a type specified by the applicant (or falling within a PPE) that might be constructed on the proposed site. The available water supply should be sufficient to meet the needs of the plant(s) to be located at the site; those needs may fall within a PPE (e.g., the stored water volume of the cooling water ponds), if an applicant uses that approach. Specifically, those needs include the maximum essential design cooling water flow, as well as the maximum design flow for normal plant needs at power and at shutdown.

The staff uses the specific criteria discussed in the paragraphs below to assess the applicant's ability to meet the requirements of the hydrologic aspects of the above regulations. Acceptance is based primarily on the adequacy of the UHS to supply cooling water for normal operation, anticipated operational occurrences, safe shutdown, cooldown (first 30 days), and long-term cooling (periods in excess of 30 days) during adverse natural conditions.

Low Flow in Rivers and Streams

For essential water supplies, the low-flow/low-level design for the primary water supply source is based on the probable minimum low flow and low level resulting from the most severe drought that can reasonably be considered for the region. The low-flow/low-level site parameters for operation should not allow shutdowns caused by inadequate water supply to trigger the frequent use of emergency systems.

Low Water Resulting from Surges, Seiches, or Tsunami

For coastal sites, the applicant should postulate the appropriate probable maximum hurricane wind fields at the ESP stage to estimate the maximum winds blowing offshore, thus creating a probable minimum surge level. The applicant should estimate low water levels on inland ponds, lakes, and rivers caused by surges based on the probable maximum winds oriented away from the plant site. The same general analysis methods discussed in Sections 2.4.3, 2.4.5, and 2.4.6 of RS-002, Attachment 2, are applicable to low-water estimates resulting from the various phenomena discussed. If the site is susceptible to such phenomena, minimum water levels resulting from setdown (sometimes called runout or rundown) from hurricane surges, seiches, and tsunami should be verified at the COL or CP stage to be higher than the intake design basis for essential water supplies.

Historical Low Water

If historical flows and levels are used to estimate design values by inference from frequency distribution plots, the applicant should present the data used to allow an independent determination. The applicant may use the staff-accepted data and methods of NOAA, USGS, SCS, USBR, and USACE.

Future Controls

This section is acceptable if water use and discharge limitations (both physical and legal) that are already in effect or under discussion by the responsible Federal, State, regional, or local authorities, and that may affect the water supply for a nuclear power plant(s) of a type specified by the applicant (or falling within a PPE) that might be constructed on the proposed site, have been considered and are substantiated by reference to reports of the appropriate agencies. The design basis should identify and take into account the most adverse possible effects of these controls to ensure that essential water supplies are not likely to be negatively affected in the future.

2.4.11.3 Technical Evaluation

The staff performed two independent analyses to determine if the normal plant heat sink (NPHS) might suddenly and/or frequently fail, which would result in excessive reliance of the ESP facility on the UHS. Failure was defined as the lake water surface elevation dropping below the level that would require shutdown and possible reliance on the UHS. One analysis considered the frequency that the lake water surface elevation would drop below a specific level. The other analysis evaluated the maximum rate at which the lake water surface elevation could drop.

In response to RAI E5.2-1 (issued to request additional information related to the applicant's ER), the applicant described a numerical calculation of lake water surface elevation changes for the 24-year period of record from June 1, 1978, to April 31, 2002. The applicant provided information on the predicted pool elevation, assuming the ESP facility had been operating during this period. The applicant used a water budget approach, wherein the change in lake storage results from an imbalance between inflows and outflows. The applicant considered inflows from direct precipitation onto the lake and upstream drainage. Outflow was assumed to be the sum of natural evaporation, induced evaporation caused by the existing CPS Unit 1, and direct evaporation from the ESP facility operating with wet cooling towers.

To estimate the tributary inflows, the applicant's analysis estimated monthly average runoff yield coefficients (ratio of runoff to rainfall). These coefficients were multiplied by the recorded rainfall during the period of record to generate a runoff record. These estimates would not necessarily provide conservative estimates in warm dry years and, therefore, the staff applied a different approach.

The staff found an adjacent streamflow gauge on Kikapoo Creek at Waynesville, Illinois. The drainage of Kikapoo Creek is adjacent to the North Fork of Salt Creek and is located to the northwest of the ESP site. The distance of the Kikapoo Creek gauge at Waynesville from the Clinton Dam is approximately 15.3 miles. This gauge is minimally affected by streamflow regulation and is comparable in the size of its contributing area (227 mi^2) to that of the drainage area (289.2 mi^2) contributing flow to Clinton Lake. To estimate inflows into Clinton Lake, the staff scaled the streamflow observed at Kikapoo Creek by the ratio of contributing area at Clinton Dam to the contributing area at the Waynesville gauge. The time period of the estimated inflow record is January 28, 1948, to September 30, 2001.

The staff performed a bounding analysis and found the magnitude of low-water conditions to be more severe than those predicted by the applicant. However, the lack of pool elevation data made it impossible for the staff to perform an adequate calibration and verification of the approach. Because of this limitation, the staff considered the results to be inconclusive. The second analysis performed by the staff assessed the maximum rate at which the lake water surface elevation could be expected to drop.

The staff assumed that the induced evaporation rate caused by the existing CPS Unit 1 was equal to the total reject heat load (i.e., the reject heat load was entirely converted to latent heat of water vapor) or 38 cfs of evaporation. As some of the heat load would be lost to back radiation and conductive heat exchange, this is a conservative assumption. From the PPE table, the consumptive water loss of the ESP facility was estimated to be 70.2 cfs. The highest monthly evaporation rate recorded by Roberts and Stall (1967) was 8.38 in. for July 1936. After correcting for lake area, the staff's analysis resulted in a conservative estimate of the maximum drop in the lake water surface elevation of 4.85 ft/mo.

At this rate of decline, the staff determined that the drop of the lake water surface elevation would be gradual enough for the operators to react and safely shut down the ESP facility before the minimum operating threshold was reached.

The applicant stated in SSAR Section 2.4.11.1 that, for some of the reactor designs under consideration for the ESP facility, the available water in Clinton Lake would be sufficient for both safety-related and normal turbine cooling water requirements. However, the applicant stated that the cooling makeup water demand for the bounding reactor within the applicant's PPE would require the use of a wet/dry hybrid cooling tower system for normal turbine cooling. In Section 2.4.1.3 of this SER, the staff identified the need (DSER Open Item 2.4-2) for a schematic representation of the complete ESP facility UHS system including the intake, piping, any potential storage basins, the UHS cooling loop, and the cooling tower(s). The staff determined that this schematic should clearly show all components and the water flow, including discharges through these components.

The applicant stated in SSAR Section 2.4.11.5 that the makeup water pumps for the safety-related cooling tower(s) would be designed to operate with a suction water surface elevation at least 1 ft below the lowest water surface elevation that the submerged UHS pond could fall to after 30 days of operation without makeup to the pond. The staff identified several open items in DSER Section 2.4.8.3 related to the applicant's ESP facility water requirements and lake drawdown estimation, especially under severe drought conditions. The applicant stated that, in the event of a severe drought that may reduce the water surface elevation in Clinton Lake to 677 ft MSL or below, station shutdown operation would be followed for the ESP facility. The staff had planned to include the water surface elevation of 677 ft MSL in Clinton Lake as the shutdown water surface elevation for the ESP facility in a permit condition. The staff determined that the requirement for an ESP facility UHS is dependent on the selected reactor type, which has not been determined at the ESP stage. In the event that the reactor type selected for the ESP facility requires a UHS, the COL applicant will need to develop a plant shutdown protocol when the water surface elevation in Clinton Lake falls to 677 ft MSL. This is **COL Action Item 2.4-11.**

The staff independently estimated the volume of available water in the submerged UHS pond that may be used for the combined operation of the CPS and the ESP facility's UHS systems based on the applicant's response to DSER Open Items 2.4-9, 2.4-11, 2.4-14, 2.4-16, and 2.4-17. Resolution of the open items mentioned above resolves confirmatory Item 2.4-1. The staff's estimate of minimum excess water storage capacity in the submerged UHS pond after accounting for water required by the CPS UHS consumptive use, the ESP facility UHS makeup, sedimentation, fire protection, and icing was approximately 318 ac-ft, as stated in Section 2.4.8.3 of this SER. The monitoring and dredging frequencies for the submerged UHS pond will be determined at the COL stage, as stated by COL Action Item 2.4-10 in Section 2.4.8.3 of this SER.

2.4.11.4 Conclusions

As set forth above, the applicant provided sufficient information pertaining to the identification and evaluation of the low-water considerations of the site. SSAR Section 2.4.11 conforms to Section 2.4.11 of RS-002, Attachment 2 with regard to this objective.

Section 2.4.11 of RS-002, Attachment 2, provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the low-water considerations of the site. Although the applicant did not specifically address the above regulations in SSAR Section 2.4.11, the staff concludes that, by conforming to Section 2.4.11 of RS-002, Attachment 2, it has met the requirements for low-water conditions with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c), except as noted in Section 2.4.11.3 of this SER. Further, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area in establishing design-basis information for low-water conditions, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

2.4.12 Ground Water

The EGC ESP site lies within the Central Lowlands Physiographic Province. Aquifers in the Central Lowlands occur in unconsolidated sand and gravel of the Quaternary age and consolidated sandstone, limestone, and dolomite of the Paleozoic age. At the proposed EGC ESP site, alluvium along the floodplains overlays glacial drift deposits.

2.4.12.1 Technical Information in the Application

The applicant provided a description of regional and site hydrogeology and ground water conditions in Section 2.4.13 of the SSAR. The applicant generally used the CPS USAR to derive the information presented in the SSAR, including the subsurface site characterization performed for the two previously proposed CPS units, as well as the ongoing monitoring for the constructed CPS Unit 1. The applicant reported that it obtained an additional four borings within the ESP footprint as part of its pre-ESP application activities; these borings further confirm the site geologic conceptual model presented previously in the USAR.

The applicant described the regional geologic stratigraphy of unconsolidated alluvium and glacial drift and outwash over a consolidated sedimentary bedrock. Local ESP site conditions are consistent with the regional conditions. The following paragraphs summarize the applicant's description of the regional and local hydrogeologic characteristics of various strata.

The alluvium, composed of varying amounts of clay, silt, sand, and gravel, is located within floodplains around stream corridors. In locations where the alluvium contains relatively thick lenses of sand and gravel, it can represent a viable water-bearing aquifer. Water in the alluvium is generally unconfined. Borings in the vicinity where the submerged CPS UHS pond is now located recorded alluvial deposits from 6 ft to 48 ft.

A thick layer of glacial drift and outwash underlies much of the region. The total thickness of the glacial drift and outwash ranges from less than 50 ft to more than 400 ft. This stratum of Wisconsinan-aged, Illinoian-aged, and Kansan-aged deposits is composed of heterogeneous mixtures of clay, silt, sand, and gravel. Drift material is dominated by clayey silts or silty clays, whereas outwash materials are dominated by sand and gravel. Water in the drift and outwash is generally confined. Regional ground water movement is dominated by flow through unconsolidated glacial outwash in glacial bedrock valleys, such as the Mahomet Bedrock Valley, the axis of which lies near the ESP site. The glacial outwash provides the source of much of the ground water supply used regionally. At the ESP site, glacial drift and outwash occur a few feet below the surface. Based on strata exposed during excavation of the CPS facility and borings conducted for the CPS facility and the ESP application, the applicant identified the depth and thicknesses of the Wisconsinan, Illinoian, and Kansan strata. The Wisconsinan deposits extend from a few feet below the surface to about 698 ft MSL. The Illinoian deposits extend from the bottom of the Wisconsinan deposits to 572 ft MSL. The total thickness of the three drift layers average 237 ft. At the ESP site, water in the Wisconsinan stratum is unconfined, whereas water in the Illinoian and Kansan strata is confined.

The bedrock beneath the glacial drift and outwash is Pennsylvanian-aged shale, siltstone, limestone, and underclay. Valleys in the bedrock formed by geologic processes and filled with glacial drift and outwash are significant hydrogeologic structures throughout the region. Water in the bedrock formations is under confined conditions.

The dominant source of ground water for regional water use is from the glacial outwash in bedrock valleys. Based on the CPS USAR, the applicant stated that 65 percent of public ground water supplies are pumped from the Mahomet Bedrock Valley aquifer. Within 15 miles of the site, alluvial aquifers provide the public water supply only for Heyworth. No public water supply within the 15-mile radius of the proposed site uses bedrock wells. The applicant stated that the ESP facility will not use ground water for either normal or safety-related plant operations.

The applicant stated that the inundation of Salt Creek and the North Fork of Salt Creek resulted in changes to the local water table, with ground water flowing toward Clinton Lake. The presence of Clinton Lake's relatively stable pool elevation represents an important boundary condition in describing the flow of ground water in the upper strata from the ESP site towards the lake.

The applicant reported the results of field, as well as laboratory, estimates of permeability. Laboratory estimates of permeability were based on grain size analysis and constant-head or falling-head permeability tests with 18 soil samples from various locations and geologic units. The applicant used one of these permeability estimates with its associated porosity and the water table gradient near the ESP site to estimate the velocity in the upper aquifer to be 2.5×10^{-3} feet per day (ft/d).

The applicant proposed to maintain an inward piezometric gradient to any structure that may receive water to ensure ground water movement into the structure rather than out of the structure. The applicant also proposed a design in which inward gradients would not be reversed over the range of observed water table fluctuations.

The SSAR described the ground water flowpath from the ESP site in limited detail. The SSAR also did not specify precise locations of the ESP facility. The staff requested the applicant, in RAI 2.4.1-1, to provide locations for the proposed ESP facility. Section 2.4.1.1 of this SER discusses the applicant's response to the RAI.

No changes were made in Section 2.4.13 in Revision 4 of the application.

2.4.12.2 Regulatory Evaluation

SSAR Table 1.5-1 shows the applicant's conformance to the NRC RGs. In RAI 1.5-1, the staff asked the applicant to provide a comprehensive listing of NRC regulations applicable to its ESP SSAR. In its response to this RAI, the applicant indicated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. Section 2.4 of RS-002, Attachment 2, describes the methods of review and the applicable acceptance criteria that the staff uses to develop its findings and conclusions related to the hydrologic aspects of site characterization for an ESP. Although the applicant did not indicate how the individual sections of SSAR Section 2.4 address the hydrology-related site suitability criteria in RS-002, Attachment 2, the staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance, as identified below.

Acceptance criteria for this section relate to the following regulations and criteria:

- 10 CFR Parts 52 and 100 require that the site evaluation consider hydrologic characteristics.

- 10 CFR 100.23 sets forth the criteria to determine the suitability of design bases for a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site with respect to the seismic characteristics of the site. It also requires that the adequacy of the cooling water supply for emergency and long-term shutdown decay heat removal be ensured, taking into account information concerning the physical, including hydrological, properties of the materials underlying the site.

As specified in 10 CFR 100.20(c), the site's physical characteristics (including seismology, meteorology, geology, and hydrology) must be considered when determining its acceptability for a nuclear power reactor.

As required by 10 CFR 100.20(c)(3), the applicant must address factors important to hydrological radionuclide transport using onsite measurements. To satisfy the hydrologic requirements of 10 CFR Part 100, the staff's review of the applicant's safety assessment should verify the description of ground water conditions at the proposed site, as well as how those conditions could be affected by the construction and operation of a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the site. Meeting this requirement provides reasonable assurance that ground water at or near a proposed site will not be significantly affected by the release of radioactive effluents from a plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site.

The regulation at 10 CFR 100.23 requires that geologic and seismic factors be considered when determining the suitability of the site and the acceptability of the design for each nuclear power plant. In particular, 10 CFR 100.23(d)(4) requires that the physical properties of materials underlying the site be considered when designing a system to supply cooling water for emergency and long-term shutdown decay heat removal. The regulation at 10 CFR 100.23 is applicable to Section 2.4.12 of RS-002, Attachment 2, because it addresses the requirements for investigating vibratory ground motion, including the hydrologic conditions at and near the site. The applicant should determine the static and dynamic engineering properties of the materials underlying the site, including the properties (e.g., density, water content, porosity, and strength) needed to determine the behavior of those materials in transmitting earthquake-induced motions to the foundations of a plant(s) of specified type (or falling within a PPE) that might be constructed on the site. Meeting this requirement provides reasonable assurance that the effects of a safe-shutdown earthquake would not pose an undue risk to the type of facility proposed for the site.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting the limiting values of parameters. Important PPE parameters for safety assessment described in SSAR Section 2.4 include, but are not limited to, precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami surge level and maximum allowable ground water level).

To determine whether the applicant met the requirements of the hydrologic aspects of 10 CFR Parts 52 and 100, the staff used the following specific criteria:

- A full, documented description of regional and local ground water aquifers, sources, and sinks is necessary. In addition, the type of ground water use, wells, pump and storage facilities, and the flow needed for a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the site should be described. If ground water is to be used as an essential source of water for safety-related equipment, the design basis for protection from natural and accident phenomena should be compared to the RG 1.27 guidelines. The bases and sources of data should be adequately described and referenced.

- A description of present and projected local and regional ground water use should be provided. Existing uses, including amounts, water levels, location, drawdown, and source aquifers should be discussed and tabulated. Flow directions, gradients, velocities, water levels, and the effects of potential future use on these parameters, including any possibility for reversing the direction of ground water flow, should be indicated. Any potential ground water recharge area within the influence of a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the site and any potential effects of construction, including dewatering, should be identified. The influence of existing and potential future wells with respect to ground water beneath the site should also be discussed. The bases and sources of data should be described and referenced. References 6 through 12 of RS-002, Attachment 2, discuss certain studies of ground water flow problems.

- The need for and extent of procedures and measures to protect present and projected ground water users, including monitoring programs, should be discussed. These items are site-specific and will vary with each application.

2.4.12.3 Technical Evaluation

Based on a review of a USGS document (Lloyd and Lyke, 1995), the staff determined that the applicant's description of regional hydrogeologic conditions is accurate. The staff further determined that the SSAR adequately describes onsite and offsite ground water use. The applicant stated that ground water would not be used for either normal or safety-related plant operations. In the DSER, the staff planned to include a condition in any ESP that might be issued for the applicant's proposed ESP site to prohibit such use. The staff had planned to include this requirement as DSER Permit Condition 2.4-8. However, the staff determined that normal and safety-related requirements for the ESP facility depend on the selected reactor type, which has not been determined at the ESP stage. The staff concluded, therefore, that a COL action item is sufficient to ensure that ground water will not be used in normal or safety-related plant operations for the ESP facility and it is not necessary to impose DSER Permit Condition 2.4-8. This is **COL Action Item 2.4-12.**

Prior construction for the CPS facility has altered, and future construction for the ESP facility would again alter, the subsurface environment. The replacement of existing soils with fill and cement would alter the current subsurface environment, and these changes would likely alter the local ground water flow patterns. The staff requested, in RAI 2.4.1-1, that the applicant define the extent of the region (including elevation) of the ESP facility. While the applicant provided the coordinates of the areal extent of the facility, it did not provide information as to the depth of the facility or associated disturbance, as discussed previously in DSER Open Item 2.4-1 (Section 2.4.1.3 of this SER).

To characterize the local subsurface environment sufficiently to understand the ground water flowpaths, the staff requested, in RAI 2.4.13-1, more information regarding the local subsurface environment. Based on the location of the plant relative to the piezometric boundary condition represented by Clinton Lake, as well as the applicant's commitment to avoid using ground water for normal or safety-related plant uses, the staff concluded that any direct impacts to the ground water system during plant operation would be small and very localized. However, the applicant did not bound the possible indirect impact of an overall drop in the lake pool elevation caused by the additional consumptive use of water associated with the ESP facility. Such a drop in elevation might alter the piezometric surface in the vicinity of the ESP facility. It was also unclear to the staff that construction down to the PPE embedment depth could be performed without dewatering systems that could possibly reverse the piezometric gradient for the existing CPS unit. The staff determined that the applicant needed to provide the potential impact of future construction for the ESP facility on the piezometric gradient for the ESP site. This was DSER Open Item 2.4-18.

In response to DSER Open Item 2.4-18, the applicant stated, in its submission to the NRC dated April 4, 2005, that if dewatering were to be used during construction, the potential impact on the piezometric gradient at the ESP site would be expected to be a localized, short-term impact to ambient ground water elevations. The applicant stated that it used site hydrogeology, water surface elevation information obtained during the CPS site investigations, and impacts during lake filling to anticipate the impact during operation and construction of the ESP facility. The applicant stated that, based on measured water surface elevations, ground water gradients, and occurrence of springs, the North Fork of Salt Creek and Salt Creek have been in the past, and continued to be after the construction of Clinton Lake, the discharge zone for shallow ground water at the ESP site.

The applicant stated that ER Section 5.2.1.2.4 discusses the estimated change in water surface elevation in Clinton Lake after the addition of the ESP facility. The applicant stated that its estimates for reduction in annual average water surface elevation in Clinton Lake are 0.2 ft with a cooling system for the ESP facility and 0.7 ft with a wet cooling system. The applicant stated that the estimated reduction in water surface elevation in Clinton Lake after addition of the ESP facility is within the observed seasonal variation of water surface elevations in wells located in the Wisconsinan deposits, which is 5 ft, as reported in SSAR Section 2.4.13.3. Therefore, the applicant concluded that the predicted reduction in water surface elevation in Clinton Lake after addition of the ESP facility would not significantly change the piezometric surface in the vicinity of the ESP facility.

The applicant stated that if dewatering is required during construction of the ESP facility, the ground water elevations and gradients are expected to be impacted during the construction up to a depth equal to the PPE embedment depth. However, the applicant argued, once construction of the ESP facility is completed, the ground water in the vicinity of the ESP facility would return to equilibrium and the regional ground water flow pattern would be reestablished towards the lake. The applicant also stated that because of the low permeability of the shallow glacial material at the ESP site, sudden changes in ground water would be minimal at the ESP site. The applicant also stated that since no permanent dewatering system would be installed at the ESP site, there would be no long-term impact to ground water conditions at the ESP site.

The applicant stated that design of the excavation and the dewatering system would consider the amount of water to be removed based on the embedment depth and the lateral extent of the depression in ground water table caused be dewatering. The impacts resulting from this dewatering on the ground water system would be evaluated during preconstruction monitoring for the ESP facility. The applicant stated that the preconstruction monitoring program, identified as preapplication in the SSAR and the ER, will include the following:

- installation of additional shallow and deep piezometers spaced at suitable intervals away from the ESP facility, between the ESP facility and the CPS facility, and use of piezometers located near Clinton Lake to help define the lateral continuity of sand layers

- monthly monitoring of water surface elevations in the piezometers to verify hydrostatic loading on power plant foundation and flow directions and to estimate dewatering volume

- installation of a 12-in. test well to perform a long-term pumping test to evaluate potential impact of dewatering and dewatering volume

The applicant stated that the number, depths, and locations of the piezometers and the test well would be determined after the design of the ESP facility is better defined. The data collected from the piezometers and the test well would be used to define baseline ground water conditions at the ESP site and to determine ground-water-related design elevations. The applicant stated that these data would also be used to identify additional locations where ground water conditions may need to be monitored during the construction of the ESP facility.

The staff reviewed the applicant's response to DSER Open Item 2.4-18 and carried out its own independent estimation of the time required for ground water at the ESP site to return to 95 percent of its initial predewatering elevation. The staff used the unconfined one-dimensional ground water flow equation with the conservative assumption of no additional recharge into the soil during this time. The staff's conservative estimate for the time required for ground water to return to 95 percent of its predewatering elevation exceeded 5 years.

The applicant's description of the effluent-holding facility presumed (see Sections 2.4.13.1 and 2.4.13.3 of this SER) that no scenario will exist in which liquid radioactive effluent could be released above the ambient ground water table, including the scenario in which the effluent-holding facility could be flooded, raising the release point above the ambient ground water table. The staff agreed that under these assumptions, release of liquid radioactive effluent to ambient ground water can be precluded. Therefore, the staff determined that it is necessary to ensure that the hydraulic gradient will always point inwards into the radwaste holding and storage facility from ambient ground water during construction and operation of the ESP facility, including the time during which recovery of ground water occurs to near its predewatering elevation. This is **Permit Condition 3.** Based on the above review, the staff considers DSER Open Item 2.4-18 resolved.

The applicant estimated the average ground water velocity in the following manner:

velocity = hydraulic gradient x saturated hydraulic conductivity/effective porosity.

While the staff agreed that the equation is technically accurate, the applicant used very limited data to estimate the three values required to derive the velocity. Based on one of two field permeability tests, the applicant selected the higher of the two values, 2.6×10^{-6} ft/d. For the porosity value, only one value (25 percent) was available for the Wisconsinan Till. The hydraulic gradient value (0.086) was based on the maximum head loss from the site to the floodplain of the North Fork of Salt Creek. The staff required the applicant to explain why such limited data represent a basis for a velocity estimate. In addition, the staff asked the applicant to provide values for the hydraulic gradient, saturated hydraulic conductivity, and effective porosity measured at the ESP site. This was DSER Open Item 2.4-19.

In response to DSER Open Item 2.4-19, the applicant stated, in its submission to the NRC dated April 26, 2005, that it conducted a geotechnical investigation in July and August of 2002 within the footprint of the ESP facility. The applicant stated that the results of this investigation indicated that the geotechnical conditions at the ESP site were consistent with those reported previously by CPS investigations. Based on this information, the applicant concluded that the CPS data were representative of the ESP site.

The applicant stated that it based its estimation of the ground water gradient on a maximum head loss of 55 ft over a distance of 640 ft from the site to the edge of the floodplain of the North Fork of Salt Creek. The applicant stated that according to the CPS USAR, the impoundment created by the Clinton Dam resulted in a shift of the ground water-surface water interface southeast of its original location towards the CPS. However, the resulting hydraulic gradient from CPS to the lake was reduced, even though the water level in the North Fork of Salt Creek rose to 690 ft MSL after the impoundment. The applicant thus argued that use of the CPS hydraulic gradient is conservative.

The applicant stated that it took the hydraulic conductivity and effective porosity values from the CPS USAR, and, although there were just a few measurements for Wisconsinan Till, the values used in the SSAR are relatively consistent with field and laboratory measurements for Illinoian Till, also collected during the CPS investigations. The applicant concluded that for this reason, the soil properties used in the SSAR are representative of the ESP site.

The applicant stated that it will collect additional hydrogeologic data as part of the COL preconstruction monitoring program; it will use these data to verify the hydraulic gradient, flow directions, and ground water velocity, if these parameters are needed for the COL evaluations.

The staff reviewed the applicant's response to DSER Open Item 2.4-18 and determined that the applicant did not provide additional data to verify the conservativeness of the ground water hydraulic gradient or that of soil properties. The CP or COL applicant will need to undertake additional geotechnical characterization to establish conservative ground water flow velocities and conservative soil properties representative of the hydrogeologic conditions at the ESP site. This is **COL Action Item 2.4-13.** Therefore, the staff considers DSER Open Item 2.4-18 resolved.

The staff had planned to include DSER Permit Condition 2.4-9 for the ESP holder to demonstrate that an inward pointing hydraulic gradient will be maintained for all credible water table conditions and for the applicant to implement a monitoring plan to ensure the maintenance of this gradient condition. This requirement is now stated as Permit Condition 3 above.

2.4.12.4 Conclusions

As set forth above, the applicant provided sufficient information pertaining to the identification and evaluation of the ground water characteristics at the site. SSAR Section 2.4.12 conforms to Section 2.4.12 of RS-002, Attachment 2, with regard to this objective.

Section 2.4.12 of RS-002, Attachment 2, provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the ground water characteristics at the site. Although the applicant did not specifically address the above regulations in SSAR Section 2.4.12, the staff concludes that, by conforming to Section 2.4.12 of RS-002, Attachment 2, it has met the requirements to identify and evaluate ground water characteristics at the site with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c), except as noted in Section 2.4.12.3 above.

2.4.13 Accidental Releases of Liquid Effluents to Ground and Surface Waters

The EGC ESP site lies within the Central Lowlands Physiographic Province. Aquifers in the Central Lowlands occur in unconsolidated sand and gravel of the Quaternary age and consolidated sandstone, limestone, and dolomite of the Paleozoic age. At the proposed EGC ESP site, alluvium along the floodplains overlays glacial drift deposits.

The requirements of 10 CFR 100.20(c)(3) provide the site suitability determination factors related to accidental releases to the liquid pathway. This regulation outlines factors important to hydrologic radionuclide transport, such as soil, sediment, and rock characteristics; adsorption and retention coefficients; ground water velocity; and distances to the nearest body of surface water, which must be obtained from onsite measurements.

2.4.13.1 Technical Information in the Application

In the two paragraphs comprising SSAR Section 2.4.12, the applicant stated that it is extremely unlikely that effluents can move out of facilities containing liquid radioactive wastes because of the high water table elevation. The applicant's position is that the high water table results in an inward-directed hydraulic gradient that would allow ground water into the facility but not out of the facility.

The applicant identified the closest surface water withdrawal for drinking water purposes to be 242 miles downstream at Alton, Illinois.

In Revision 4 of SSAR Section 2.4.12, the applicant states that the issue of a possible groundwater pathway for liquid effluents will be reviewed at the COL stage.

2.4.13.2 Regulatory Evaluation

SSAR Table 1.5-1 shows the applicant's conformance to the NRC RGs. In RAI 1.5-1, the staff asked the applicant to provide a comprehensive listing of NRC regulations applicable to its ESP SSAR. In its response to this RAI, the applicant indicated that RS-002, Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. Section 2.4 of RS-002, Attachment 2, describes the methods of review and the applicable acceptance criteria that the staff uses to develop its findings and conclusions related to the hydrologic aspects of site characterization for an ESP. Although the applicant did not indicate how the individual sections of SSAR Section 2.4 address the hydrology-related site suitability criteria in RS-002, Attachment 2, the staff reviewed this portion of the application for conformance with the applicable regulations, and considered the corresponding regulatory guidance, as identified below.

Acceptance criteria for this section relate to the following regulations and criteria:

- 10 CFR Parts 52 and 100, as they relate to the evaluation of a site's hydrologic characteristics with respect to the consequences of the escape of radioactive material from the facility

Compliance with 10 CFR Parts 52 and 100 requires that local geological and hydrological characteristics be considered when determining the acceptability of a nuclear power plant site. The geological and hydrological characteristics of the site may have a bearing on the potential consequences of radioactive materials escaping from a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site. The applicant should plan for special precautions if a reactor(s) were to be located at a site where a significant quantity of radioactive effluent could accidentally flow into nearby streams or rivers or find ready access to underground water tables.

These criteria apply to Section 2.4.13 of RS-002, Attachment 2, because the reviewer evaluates site hydrologic characteristics with respect to the potential consequences of radioactive materials escaping from a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site. The staff reviews radionuclide transport characteristics of the ground water and surface water environments with respect to accidental releases to ensure that current and future users of ground water and surface water are not adversely affected by an accidental release of radioactive materials. RGs 1.113, Revision 1, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," issued April 1977, and 4.4, "Reporting Procedure for Mathematical Models Selected to Predict Heated Effluent Dispersion in Natural Water Bodies," issued May 1974, provide guidance in selecting and using surface water models for analyzing the flow field and dispersion of contaminants in surface waters.

Meeting the requirements of 10 CFR Parts 52 and 100 provides reasonable assurance that accidental releases of liquid effluents to ground water and surface water, as well as their adverse impact on public health and safety, will be minimized.

In those cases for which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting the limiting values of parameters. Important PPE parameters for safety assessment described in SSAR Section 2.4 include, but are not limited to, precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami surge level and maximum allowable ground water level).

To determine whether the applicant met the requirements of 10 CFR Parts 52 and 100 with respect to accidental releases of liquid effluents, the staff used the following specific criteria in accordance with Section 2.4.13 of RS-002:

- Radionuclide transport characteristics of the ground water environment with respect to existing and future users should be described. The estimates and bases for the coefficients of dispersion, adsorption, ground water velocities, travel times, gradients, permeabilities, porosities, and ground water or piezometric levels between the site and existing or known future surface water and ground water users should be described and be consistent with site characteristics. Potential pathways of contamination to ground water users should also be identified. Sources of data should be described and referenced.

- Transport characteristics of the surface water environment with respect to existing and known future users should be described for conditions which reflect worst-case release mechanisms and source terms for use in postulating the most pessimistic contamination from accidentally released liquid effluents. Estimates of physical parameters necessary to calculate the transport of liquid effluent from the points of release to the site of existing or known future users should be described. Potential pathways of contamination to surface water users should be identified. Sources of information and data should be described and referenced. Acceptance is based on the staff's evaluation of the applicant's computational methods and the apparent completeness of the set of parameters necessary to perform the analysis.

- Mathematical models are acceptable to analyze the flow field and dispersion of contaminants in ground water and surface water, providing that the models have been verified by field data and that conservative, site-specific hydrologic parameters are used. Furthermore, conservatism should be the guide in selecting the proper model to represent a specific physical situation. Radioactive decay and sediment adsorption may be considered, if applicable, providing that the adsorption factors are conservative and site specific. RG 1.113 provides guidance in selecting and using surface water models. References 7 through 15 of RS-002, Attachment 2, discuss the transport of fluids through porous media.

2.4.13.3 Technical Evaluation

The two paragraphs comprising SSAR Section 2.4.12 stated that it is extremely unlikely that effluents can move out of facilities containing liquid radioactive wastes because of the high water table elevation. The applicant's position is that the high water table results in an inward-directed hydraulic gradient that would allow ground water into the facility but not out of the facility.

In RAI 2.4.12-1, the staff requested additional information regarding the likelihood for liquid effluents to reach a surface water body. The applicant provided data on the historical water surface elevations in the two upper till strata (i.e., the Wisconsinan and Illinoian). The lowest value recorded was 710.8 ft MSL in the Illinoian. The applicant reported the site grade as 735 ft MSL and the maximum embedment depth from the PPE. However, the staff determined that the applicant should also specify the maximum elevation at which any liquid radioactive waste releases can occur in the proposed ESP facility. This was DSER Open Item 2.4-20.

In response to DSER Open Item 2.4-20, the applicant stated, in its submission to the NRC dated April 4, 2005, that the maximum elevation at which any radioactive releases can occur within the ESP facility would depend on the chosen reactor design. The applicant also stated that the associated minimum ground water elevation would also depend on the chosen reactor design and the final location of the ESP structures. The applicant noted that the COL applicant would address how the chosen design will preclude any liquid radioactive releases above the ground water table.

The staff reviewed the applicant's response to DSER Open Item 2.4-20. The staff's concern in Open Item 2.4-20 related to the release of liquid radioactive effluent to ground water such that it could be carried to Clinton Lake along with the regional ground water flow from the ESP site to the lake. The applicant's position on this issue is that the facility containing the radioactive effluent would be located below the ambient ground water table and would be maintained at atmospheric pressure. The applicant argued that because of this design, ground water in contact with the effluent-holding facility would be under hydrostatic pressure greater than atmospheric pressure. Therefore, ground water adjacent to the walls of the effluent-holding facility would tend to flow into the facility, and ground water in contact with the base of the effluent-holding facility would also tend to flow into the facility, thereby precluding any release of radioactive effluent into the ground water at the ESP site.

The staff determined that the applicant's description of the effluent-holding facility presumed that no scenario would exist in which the liquid radioactive effluent could be released above the ambient ground water table, including the scenario in which the effluent-holding facility could be flooded, raising the release point above the ambient ground water table. The staff agreed that under these assumptions, release of liquid radioactive effluent to ambient ground water can be precluded. However, the COL or CP applicant would need to demonstrate that there will be no likely scenario that could lead to liquid radioactive release to the ambient ground water, either above the ambient ground water table or below it. This is **COL Action Item 2.4-14**. Further, the COL or CP applicant would be required to put a ground water monitoring system in place to ensure that the hydraulic gradient would always point inwards into the radwaste holding and storage facility from ambient ground water during construction and operation of the ESP facility, including the time during which recovery of ground water occurs to near its predewatering elevation. This is Permit Condition 3, as stated in Section 2.4.12.3 of this SER. The staff also determined that a permit condition requiring a radwaste facility design for a future reactor with features to preclude any and all accidental releases of radionuclides into any potential liquid pathway is necessary. This is **Permit Condition 4.** Based on the above review, the staff considers DSER Open Item 2.4-20 resolved.

The staff had planned to include a requirement that the COL applicant would need to utilize a design in which radioactive liquid waste releases would not occur at any elevation greater than the minimum design water table elevation outside the facility as DSER Permit Condition 2.4-10. However, Permit Condition 4, stated above, requires a radwaste facility design that will preclude any and all accidental releases of radionuclides into any potential liquid pathway and, therefore, sets more restrictive criteria than that stated by DSER Permit Condition 2.4-10. Thus, the staff concluded that it is not necessary to impose DSER Permit Condition 2.4-10.

The staff concluded that the applicant needed to provide a thorough description of the local hydrologic setting, both that which exists currently and that which is expected after the disruption associated with the ESP construction activities, to assure the staff that an inward gradient will be maintained. This was DSER Open Item 2.4-21.

In response to DSER Open Item 2.4-21, the applicant stated, in its submission to the NRC dated April 4, 2005, that SSAR Section 2.4.13.3 and Section 5 of Appendix A to the SSAR thoroughly describe the local hydrologic setting that currently exists at the ESP site. The applicant stated that the local hydrologic setting after the disruption associated with the construction of the ESP facility is expected to be similar to the existing hydrologic setting. The applicant stated that localized, short-term impacts to ambient ground water elevations may occur during the construction of the ESP facility, but the applicant expects that the relatively low permeability of the shallow glacial material that exists at the ESP site would help minimize these impacts during the construction.

The applicant stated that, since the final ground water elevations at the ESP site would depend on the plant design for and the location of the ESP facility within the identified ESP footprint, the ground water system would be monitored during the COL preconstruction and construction phases, as well as during the preoperation and operation phases of the ESP facility. The applicant listed the following objectives for the ground water monitoring program:

- measurement of ground water elevations at a monthly frequency to verify hydrostatic loadings and flow directions before construction of the ESP facility (preconstruction monitoring)
- daily measurements of ground water elevations during the active construction phase to determine the impact of dewatering (construction monitoring)
- monthly measurements of ground water elevations after the construction of the ESP facility to evaluate any hydrologic changes caused by operation of the ESP facility (preoperational monitoring)
- extension of preoperational monitoring for 5 years or until ground water conditions stabilize (operational monitoring)

The applicant stated that these monitoring programs were also discussed in ER Sections 6.3.1.3, 6.3.2.3, 6.3.3.3, and 6.3.4.3, respectively.

The staff reviewed the applicant's response to DSER Open Item 2.4-21. The staff's concern in Open Item 2.4-21 was related to ensuring that the hydraulic gradient of the ambient ground water at the ESP site was always directed inwards towards the effluent-holding facility to preclude any scenario in which a discharge of radioactive effluent from the effluent-holding facility could reach the regional ground water flow system and thus eventually the accessible environment (The Clinton Lake). Based on the applicant's response to DSER Open Items 2.4-20 and 2.4-21, the staff determined that the preclusion of radioactive effluent discharge into the ambient ground water system at the ESP site is primarily and crucially dependent on the hydraulic gradient pointing from the ambient subsurface into the effluent-holding facility. The staff also determined that it is essential to institute a ground water monitoring program at the ESP site to continuously monitor and verify that the central assumption for the preclusion of radioactive releases to ground water is not violated. The staff stated this requirement as Permit Condition 3 in Section 2.4.12.3 of this SER. The staff will also require that this monitoring system be kept in place and the monitoring program be kept in operation for the life of the ESP facility, including its decommissioning. This is **Permit Condition 5.** Therefore, the staff considers DSER Open Item 2.4-21 to be resolved.

2.4.13.4 Conclusions

As set forth above, the applicant provided sufficient information pertaining to the identification and evaluation of accidental release of liquid effluents in ground water and surface water at the site. SSAR Section 2.4.13 conforms to Section 2.4.13 of RS-002, Attachment 2, with regard to this objective.

Section 2.4.13 of RS-002, Attachment 2, provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the accidental release of liquid effluents in ground water and surface water at the site. Although the applicant did not specifically address the above regulations in SSAR Section 2.4.13, the staff concludes that, by conforming to Section 2.4.13 of RS-002, Attachment 2, it has met the requirements to identify and evaluate the accidental release of liquid effluents to ground water and surface water at the site with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c), except as noted in Section 2.4.13.3 of this SER.

2.4.15 Thermal Discharges

2.4.15.1 Normal Plant Heat Sink

The ESP site is adjacent to Clinton Lake, which provides cooling water for the current CPS Unit 1. Events that may reduce or limit the availability of additional cooling water at this site include low lake elevation, seiches, wind-induced set down, and intake blockages from sediment or ice. Section 2.4 of this SER discusses these events.

The NPHS water supply for the ESP facility would be obtained from Clinton Lake, created by the Clinton Dam. Normal operation of the ESP facility would use a cooling tower(s) operated with water drawn from a cooling tower basin(s).

2.4.15.1.1 Technical Information in the Application

In Section 3.2.1 of the SSAR, the applicant provided a brief description of the NPHS.

In SSAR Section 3.2.1.2, the applicant stated that the flow from the normal cooling system to the cooling towers would be 1,200,000 gpm. This slow rate reflects the recirculation of water within the cooling system. Water would be withdrawn from Clinton Lake to make up for water lost from evaporation and to limit the concentration of impurities in the cooling water. The applicant stated that the cooling tower blowdown would normally be 12,000 gpm, with a maximum of 49,000 gpm.

The applicant stated that the maximum NPHS load during normal operation would be 15.08×10^9 Btu per hour (Btu/h), with a maximum discharge temperature of 100 °F. The staff had intended to identify these values as DSER) Permit Conditions 3.2-1 and 3.2-2. Section 2.4.15.1.3 of this SER provides a more detailed discussion of this issue.

The discharge temperature is based on a design approach of 15 °F and a maximum wet bulb temperature of 85 °F. The applicant stated that a wet bulb temperature of 77.2 °F would only be exceeded 1 percent of the time and that the maximum wet bulb temperature is 84.7 °F.

2.4.15.1.2 Regulatory Evaluation

In RAI 1.5-1, the staff asked the applicant to provide a comprehensive listing of NRC regulations applicable to its ESP SSAR. In its response to RAI 1.5-1, the applicant stated that SSAR Section 3.2 addresses thermal discharges as required by 10 CFR 52.17(a)(1)(iv), which states that an ESP should describe the anticipated maximum levels of thermal effluents each facility will produce.

The staff maintains that additional regulatory guidance for the purposes of ESP are found in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing and Production and Utilization Facilities," and in 10 CFR 100.23(c). Two general design criteria (GDC) are particularly relevant—GDC 2, "Design Bases for Protection Against Natural Phenomena," and GDC 44, "Cooling Water." The staff also maintains that two RGs are applicable—RGs 1.27 and 1.70, Revision 3. Also, an ESP applicant need not demonstrate compliance with the GDC.

Acceptance criteria for this section relate to the following regulations:

- 10 CFR Parts 52 and 100 require that a site evaluation consider hydrological characteristics.
- 10 CFR 100.23 requires that siting factors to be evaluated must include the cooling water supply.

The regulations in 10 CFR Parts 52 and 100 require that the hydrological characteristics of a potential nuclear power plant site be considered in the site evaluation. In particular, the UHS for the cooling water system may consist of water sources affected by, among other things, site hydrological characteristics that may reduce or limit the available supply of cooling water for safety-related SSCs. Such characteristics include those resulting from river blockage or diversion, tsunami runup and drawdown, and dam failure.

Meeting the requirements of 10 CFR Parts 52 and 100 provides reasonable assurance that severe hydrological phenomena, including low-water conditions, will pose no undue risk to the type of facility proposed for the site.

The regulation at 10 CFR 100.23 requires the evaluation of siting factors, including the cooling water supply, for a potential nuclear power plant site. The evaluation of the emergency cooling water supply for a nuclear power plant(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site should consider river blockages, diversion, or other failures that may block the flow of cooling water, tsunami runup and drawdown, and dam failures.

This regulation also applies to SSAR Section 3.2 because the UHS for the cooling water system consists of water sources that are subject to natural events that may reduce or limit the available supply of cooling water (i.e., the heat sink). Natural events, such as river blockages or diversion or other failures that may block the flow of cooling water, tsunami runup and drawdown, and dam failures, should be conservatively estimated to assess the potential for these characteristics to influence the design of SSCs important to safety for a nuclear power plant(s) of a type specified by the applicant (or falling within a PPE) that might be constructed on the proposed site. The available water supply should be sufficient to meet the needs of the plant(s) to be located at the site; such needs may fall within a PPE (e.g., the stored water volume of the cooling water ponds), if an applicant uses that approach. Specifically, these needs include the maximum essential design cooling water flow, as well as the maximum design flow for normal plant needs at power and at shutdown.

2.4.15.1.3 Technical Evaluation

The NPHS has no safety function and is not required for shutdown or accident mitigation. However, in the event that the NPHS fails frequently and suddenly, there would be excessive reliance on the UHS. This is the only safety-related consideration associated with the NPHS. Section 2.4.15.2 of this SER discusses the UHS.

The staff performed two independent analyses to confirm whether the NPHS could be expected to fail both suddenly and frequently. Failure was defined as a situation in which the lake water surface elevation drops below the level that would require shutdown and possible reliance on the UHS. One staff analysis considered the frequency that the lake water surface elevation would drop below a specific level. The other analysis evaluated the maximum rate at which the lake water surface elevation could drop.

In response to RAI E5.2-1 (issued to request additional information related to the applicant's environmental report), the applicant described a numerical calculation of the changes in lake water surface elevation for the 24-year period of record from June 1, 1978, to April 31, 2002. The applicant provided information on the pool elevation that would be predicted if the ESP facility had operated during this period. The applicant used a water budget approach in which the change in lake storage results from an imbalance between inflows and outflows. The applicant considered inflows from direct precipitation onto the lake and upstream drainage. The applicant assumed outflow to be the sum of natural evaporation, induced evaporation caused by the existing CPS Unit 1, and direct evaporation from the EPS facility operating with wet cooling towers.

To estimate the tributary inflows, the applicant's analysis estimated monthly average runoff yield coefficients (i.e., the ratio of runoff to rainfall). The applicant then multiplied these coefficients by the recorded rainfall during the period of record to generate a runoff record. By considering only rainfall (and not snowfall), the applicant's approach resulted in conservative annual water yield estimates. However, this approach would not necessarily provide conservative estimates in warm, dry years. Therefore, the staff applied a different approach.

The staff found an adjacent streamflow gauge on Kikapoo Creek in Waynesville, Illinois. The drainage of Kikapoo Creek is adjacent to that of the North Fork of Salt Creek and is located to the northwest. The distance of the Kikapoo Creek gauge at Waynesville from the Clinton Dam is approximately 15.3 miles. This gauge is minimally affected by streamflow regulation and is comparable in the size of its contributing area,(i.e., 227 square miles (mi^2)), to that of the drainage area contributing flow to Clinton Lake (i.e., 289.2 mi^2). The staff scaled the streamflow observed at Kikapoo Creek by the ratio of the contributing area at Clinton Dam to the contributing area at the Waynesville gauge to estimate inflows into Clinton Lake. The staff used a time period for the estimated inflow record of January 28, 1948, to September 30, 2001.

The staff analysis found the frequency and magnitude of low-water conditions to be more severe than those predicted by the applicant. However, the lack of pool elevation data made it impossible for the staff to perform an adequate calibration and verification of the applicant's approach, thus rendering the results nonconclusive. However, the staff's second analysis did adequately assess the rate at which the lake water surface elevation could be expected to drop.

The staff assumed that the induced evaporation caused by the existing CPS Unit 1 was equal to the total reject heat load (i.e., the reject heat load was entirely converted to latent heat of water vapor) or 38 cfs of evaporation. This assumption is conservative because some of the heat load would be lost to back radiation and conductive heat exchange. From the PPE table, the consumptive water loss of the ESP facility was estimated to be 70 cfs. The highest monthly evaporation rate recorded by Roberts and Stall (1967) is 8.38 in. for July 1936. Correcting for the lake area, this results in a conservative estimate of the drop in the lake water surface elevation of 4.85 ft/mo. Even at this rate of decline, the drop of the lake water surface elevation would be gradual enough for the plant to react well before the UHS system would be required.

As noted above in Section 2.4.15.1.1 of this SER, the staff had intended to impose the applicant-stated maximum NPHS load during normal operation equal to 15.08×10^9 Btu/h and the maximum discharge temperature of 100 °F as DSER Permit Conditions 3.2-1 and 3.2-2. As explained above, the staff used the total reject heat load from the NPHS and assumed that all of it is lost as evaporation. During this analysis, discharge temperature was not a limiting factor. The staff's analysis showed that at the conservatively estimated rate of evaporation, a drop in Clinton Lake's water surface elevation would be gradual. Based on this conclusion, the staff determined that it is not necessary to impose DSER Permit Conditions 3.2-1 and 3.2-2.

2.4.15.1.4 Conclusions

As set forth above, the staff concludes that the applicant provided sufficient information to show that the NPHS is likely to be able to perform its function consistent with the maximum thermal discharge assumed in the PPE) (SSAR Table 1.4) and that the consequences of the NPHS operation on the UHS are acceptable and do not lead to frequent plant shutdown or frequent use of the UHS.

2.4.15.2 Ultimate Heat Sink

The ESP site is adjacent to Clinton Lake, which provides cooling water for the current CPS Unit 1. The applicant proposed that the ESP facility's UHS would share the same source of water as the existing plant. Events that might potentially reduce or limit the availability of cooling water for the ESP facility's UHS at this site include low lake elevation, seiches, wind-induced set down, and intake blockages from sediment or ice. Section 2.4 of this SER discusses these events.

Although the UHS provides a critical safety function, the NPHS has no safety function and is not required for shutdown or accident mitigation. The only safety-related consideration associated with the NPHS relates to a situation in which the NPHS fails suddenly and frequently enough that the ESP facility would be required to rely excessively on the UHS. Section 2.4.15.1 of this SER discusses the NPHS.

2.4.15.2.1 Technical Information in the Application

In Section 3.2.2 of the SSAR, the applicant provided a brief description of the UHS. In Section 3.2.2.1, the applicant stated that, in accordance with RG 1.27, the UHS system would consist of a minimum of two redundant cooling trains. In response to RAI 3.2.2-1, the applicant provided a schematic of the water circulation in the UHS system.

In Section 3.2.2.2, the applicant further stated that the maximum discharge flow from the UHS cooling system to the cooling towers would be 26,125 gpm during normal operation and 52,250 gpm during shutdown. This flow rate reflects the recirculation of water within the cooling system. Water would be withdrawn from Clinton Lake to make up for water lost from evaporation and to limit the concentration of impurities in the cooling water. The applicant stated that the cooling tower evaporation rate would normally be 411 gpm, with a maximum of 700 gpm.

The applicant stated that the maximum UHS load during normal operation would be 225×10^6 Btu/h and 411.4×10^6 Btu/h during shutdown, with a maximum discharge temperature of 95 °F in both cases.

The applicant indicated that the UHS pond is a submerged pond created by a submerged dam across the North Fork of Salt Creek downstream of the plant intake. This submerged pond maintains adequate capacity for 30 days of UHS operation in case the Clinton Lake Dam fails. This UHS pond would be shared with the existing CPS Unit 1. A baffle in the UHS pond is part of the UHS system design for the existing unit. In response to RAI 3.2.2-2, the applicant stated that the maintenance of the integrity of the UHS baffle is not required for the ESP facility's UHS operation.

2.4.15.2.2 Regulatory Evaluation

In RAI 1.5-1, the staff asked the applicant to provide a comprehensive listing of the NRC regulations applicable to its ESP SSAR. In its response to RAI 1.5-1, the applicant stated that SSAR Section 3.2 addresses thermal discharges as required by 10 CFR 52.17(a)(1)(iv), which states that an ESP should describe the anticipated maximum levels of thermal effluents each facility will produce.

The staff believes that additional applicable regulations are GDC 2 and 44, as well as 10 CFR 100.23(c), and the applicable regulatory guides are RGs 1.27 and 1.70. However, an ESP applicant need not demonstrate compliance with the GDC.

Acceptance criteria for this section relate to the following regulations:

- 10 CFR Parts 52 and 100 require that the evaluation of a site consider hydrological characteristics.
- 10 CFR 100.23 requires, in part, that the cooling water supply be included in the siting factors to be evaluated.

The regulations at 10 CFR Parts 52 and 100 require that the evaluation of a nuclear power plant site consider the hydrological characteristics of the site. To satisfy the requirements of

10 CFR Parts 52 and 100, the SSAR should describe the surface and subsurface hydrological characteristics of the site and region. In particular, the UHS for the cooling water system may consist of water sources affected by, among other things, site hydrological characteristics that may reduce or limit the available supply of cooling water for safety-related SSCs. Site hydrological characteristics that may reduce or limit the flow of cooling water include those resulting from river blockage or diversion, tsunami runup and drawdown, and dam failure.

Meeting the requirements of 10 CFR Parts 52 and 100 provides reasonable assurance that severe hydrological phenomena, including low-water conditions, will pose no undue risk to the type of facility proposed for the site.

The regulation at 10 CFR 100.23 requires the evaluation of siting factors, including the cooling water supply, for a potential nuclear power plant site. The evaluation of the emergency cooling water supply for a nuclear power plant(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site should consider river blockages, diversion, or other failures that may block the flow of cooling water, tsunami runup and drawdown, and dam failures.

The regulation at 10 CFR 100.23 applies to this section because the UHS for the cooling water system consists of water sources that are subject to natural events that may reduce or limit the available supply of cooling water (i.e., the heat sink). Natural events, such as river blockages or diversion or other failures that may block the flow of cooling water, tsunami runup and drawdown, and dam failures, should be conservatively estimated to assess the potential for these characteristics to influence the design of SSCs important to safety for a nuclear power plant(s) of a type specified by the applicant (or falling within a PPE) that might be constructed on the proposed site. The available water supply should be sufficient to meet the needs of the plant(s) to be located at the site; such needs may fall within a PPE (e.g., the stored water volume of the cooling water ponds), if an applicant uses that approach. Specifically, these needs include the maximum essential design cooling water flow, as well as the maximum design flow for normal plant needs at power and at shutdown.

2.4.15.2.3 Technical Evaluation

The staff reviewed the capacity requirements for the UHS pond in Section 2.4 of this SER. In addition, the staff independently evaluated the evaporation rates estimated for the UHS system based on the latent heat of water and the reject heat load stated in the PPE and found the applicant's estimates to be consistent with a conservative value of consumptive water requirements for a UHS pond.

The applicant stated that the maximum UHS load during normal operation is 411.4×10^6 Btu/h, with a maximum discharge temperature of 95 °F. The staff had intended to identify these values as DSER Permit Conditions 3.2-3 and 3.2-4. However, at the ESP stage, a specific reactor type for the ESP facility is not known. Therefore, it is also not known whether a UHS will be required by the ESP facility. In the event that the ESP facility does require a UHS, the staff used the PPE evaporation rate for the UHS equal to 411 gpm for 30 days to establish excess capacity within the submerged UHS pond. As discussed in Section 2.4.8.3 of this SER, the staff determined that the submerged UHS pond has an excess capacity of approximately 318 ac-ft. Based on this review, the staff concluded that DSER Permit Conditions 3.2-3 and 3.2-4 are not required.

2.4.15.2.4 Conclusions

As set forth above, the applicant provided sufficient information pertaining to the NPHS to determine that the consequences of the NPHS operation on the UHS are acceptable and should not lead to frequent plant shutdown or frequent use of the UHS. Therefore, the staff concludes that the applicant has met the requirements of 10 CFR 52.17(a) and 10 CFR 100.20(c). Further, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area in establishing design-basis information for the UHS with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

2.4.16 Site Characteristics Related to Hydrology

Based on the staff review of SSAR Section 2.4, the following site characteristics should be incorporated in any ESP that might be issued for the proposed site.

Table 2.4-7 Proposed Site Characteristics Related to Hydrology

SITE CHARACTERISTIC	VALUE
Proposed Facility Boundaries	Figure 2.4-15
Site Grade	735 ft MSL
Highest Ground Water Elevation	733.5 ft MSL
Probable Maximum Flood (PMF) maximum hydrostatic water surface elevation	709.8 ft MSL
Coincident Wind Wave Activity (to add to the PMF water surface elevation)	6.4 ft
Storm Surge (to add to the PMF water surface elevation)	0.3 ft
Combined Effects Maximum Water Surface Elevation	716.5 ft MSL
Local Intense Precipitation	18.15 in. during 1 hour
Lake Surface Icing	27.0 in.
Maximum Cumulative Degree-Days	1141.5 in Fahrenheit
Frazil and Anchor Ice	The ESP site is subject to frazil and anchor ice formation.

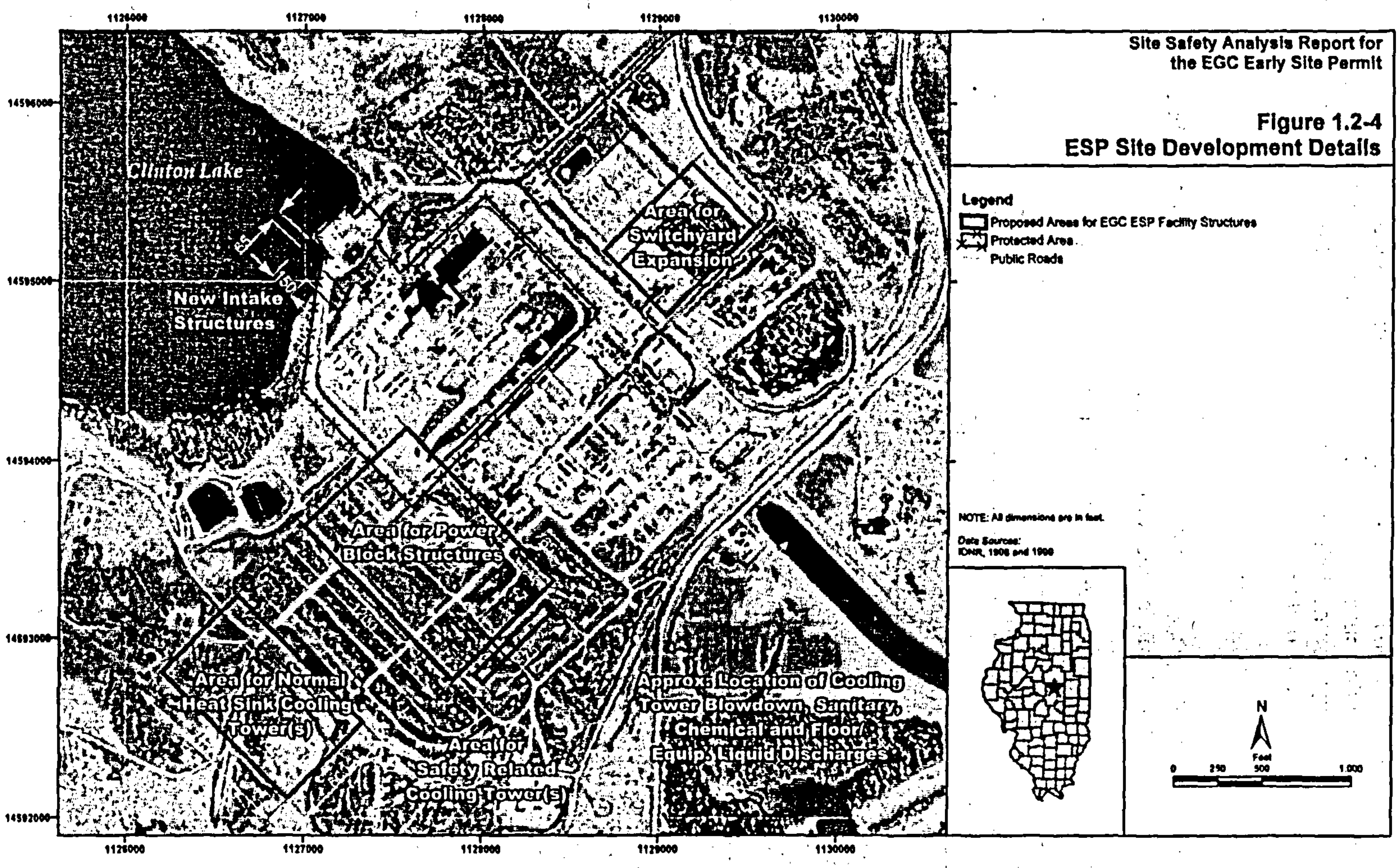


Figure 2.4-15 The proposed facility boundary for the ESP site

2.5 Geology, Seismology, and Geotechnical Engineering

In Section 2.5, "Geology, Seismology, and Geotechnical Engineering," of the site safety analysis report (SSAR), the applicant described the geological, seismological, and geotechnical engineering properties of the early site permit (ESP) site. SSAR Section 2.5.1, "Site and Regional Geology," describes the basic geological and seismological data for the site and region surrounding the site. SSAR Section 2.5.2, "Vibratory Ground Motions," describes the vibratory ground motion for the ESP site through a probabilistic seismic hazard analysis (PSHA) and develops the safe-shutdown earthquake (SSE) ground motion. SSAR Section 2.5.3, "Surface Faulting," describes the potential for surface faulting at or near the surface of the ESP site. SSAR Section 2.5.4, "Stability of Subsurface Materials and Foundations," presents information on the stability of the ESP site's subsurface materials. SSAR Section 2.5.5, "Stability of Slopes," defers the analysis of slope stability to the combined license (COL) application. Similarly, SSAR Section 2.5.6, "Embankments and Dams," defers the reanalyses of the Clinton Power Station (CPS) ultimate heat sink (UHS) under the updated SSE to the COL application. Appendices A, "Geotechnical Report for the [Exelon Generation Company, LLC (EGC)] ESP," and B, "Seismic Hazard Report for the EGC ESP," to the SSAR provide further detail in support of each of the above sections.

Since the ESP site is located within 700 feet (ft) of the CPS site, the applicant stated in SSAR Section 2.5 that its starting point for the characterization of the geology, seismology, and engineering properties of the ESP site was the previous site investigations for the CPS site. As such, the material in Section 2.5 of the ESP application focuses on any newly published information since the publication of the CPS updated safety analysis report (USAR) in the 1970s, as well as recent geological, seismological, geophysical, and geotechnical investigations performed for the ESP site.

The applicant also used the seismic source and ground motion models published by the Electric Power Research Institute (EPRI) for the central and eastern United States (CEUS), "Seismic Hazard Methodology for the Central and Eastern United States," issued in 1986. As such, SSAR Section 2.5 focuses on those data developed since publication of the 1986 EPRI report. Regulatory Guide (RG) 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion," issued March 1997, indicates that applicants may use the seismic source interpretations developed by Lawrence Livermore National Laboratory (LLNL) in the "Eastern Seismic Hazard Characterization Update," published in 1993, or the EPRI document as inputs for a site-specific analysis.

2.5.1 Site and Regional Geology

SSAR Section 2.5.1 describes the regional and site geology for the ESP site. The geologic settings of the region and the site are presented in Section 2.5.1.1, "Regional Geology," and in Section 2.5.1.2, "Site Geology," of the application, respectively. Additional descriptions of the regional and site geology are presented in Chapters 2 and 5 of SSAR Appendices A and B.

2.5.1.1 Technical Information in the Application

2.5.1.1.1 Regional Geology

SSAR Section 2.5.1.1 summarizes the regional geologic history and structural geology, with an emphasis on the Quaternary Period. Section 2.2 of SSAR Appendix A provides additional detail on the regional (1) physiography, (2) stratigraphy, and (3) structural geology. In addition, Section 2.1 of SSAR Appendix B provides a description of the regional (1) tectonic setting, (2) tectonic features, (3) prehistoric earthquakes, and (4) seismic sources. Finally, Attachment 1 to SSAR Appendix B describes the applicant's regional paleoliquefaction investigations. The applicant concluded that the ESP site is one of the most geologically stable areas in the United States and that the geologic conditions at the ESP site are the same as those at the CPS site.

Regional Physiography. The applicant described the regional physiography in Section 2.2.1 of SSAR Appendix A. The ESP site is located in the Till Plains section of the Central Lowland physiographic province. The terrain in central Illinois is typical of the province and consists of undulating, low-relief topography formed by the glacial drift cover, which ranges in thickness from a few tens of feet to several hundreds of feet. The applicant stated that much of the Till Plains section is characterized by landforms of low, commonly arcuate ridges, called moraines, interspersed with relatively flat intermorainal areas. The development of postglacial streams has led to the dissection of the glacial drift mantle and in some areas bedrock is exposed; however, there are no bedrock exposures near the site area.

Regional Geologic History and Stratigraphy. The applicant described the Quaternary geologic history and stratigraphy in SSAR Section 2.5.1.1 and Section 2.2.2 of SSAR Appendix A. During the Quaternary (mainly Pleistocene time), continental glaciation left widespread glacial deposits in the regional area. There were four major episodes of glaciation in the region, which from the youngest to the oldest are the Wisconsinan, Illinoian, Kansan, and Nebraskan. Wisconsinan deposits are found throughout the ESP site, and Illinoian deposits are present beyond the limit of Wisconsinan deposits in northern and central Illinois. Kansan- and Nebraskan-age glacial deposits are present at the surface and in the subsurface in areas of Iowa, Missouri, and part of western and east-central Illinois. These Quaternary deposits consist predominantly of glacial or glacial-derived sediments of glacial till, outwash, loess (a windblown silt), and glacialacustrine deposits, as well as alluvium.

Regional Structural Geology. The applicant described the structural geology in SSAR Section 2.5.1.1 and Section 2.2.3 of SSAR Appendix A. The Quaternary glacial deposits in the region are underlain by thick sequences of gently dipping Paleozoic sedimentary rocks. The bedrock surface throughout Illinois is of Paleozoic age, and the Paleozoic rocks are relatively thicker at the centers of the structural basins, such as the Illinois basin. During Paleozoic sedimentation, several discontinuations of regional importance occurred because of the widespread advances and retreats of the Paleozoic seas across the interior of North America. At a depth of about 2,000 to 13,000 ft below the ground surface, the basement complex of the Precambrian igneous and metamorphic rocks underlies the Paleozoic rocks. Throughout the Paleozoic era, the area underwent intermittent slow subsidence and gentle uplift, which resulted in broad regional geologic basins of gently dipping sedimentary rocks and intervening broad arches or highs. Locally, folds and faults are superimposed on this pattern.

Regional Tectonic Setting. The applicant described the tectonic setting in Section 2.1.1 of SSAR Appendix B. The ESP site is located within the Illinois basin in the stable continental region (SCR) of the North American craton. The Illinois basin is a spoon-shaped depression, covering parts of Illinois, Indiana, and Kentucky. The basin is bounded on the north by the Wisconsin arch, on the east by the Kankakee and Cincinnati arches, on the south by the Mississippi embayment, and on the west by the Ozark dome and Mississippi River arch. The east-west-trending Rough Creek-Shawneetown fault system divides the Illinois basin into two unequal parts. The northern part of the Illinois basin is larger but shallower, a typical cratonic depression with basement elevations ranging from approximately 2,950 ft below sea level in the northern part of the basin to 14,100 ft below sea level in southeastern Indiana. In the northern part of the basin, Paleozoic sedimentary strata overlie the Proterozoic-age basement rocks of the Eastern Granite-Rhyolite Province. The southern part of the Illinois basin is relatively smaller but deeper, with about 23,000 ft of Paleozoic sedimentary rocks. The southern part of the basin is underlain by portions of the Reelfoot rift and Rough Creek graben, which is a rift system that formed during late Precambrian to middle Cambrian time (800 to 500 million years ago (mya)).

The applicant stated that the ESP site lies within a compressive midplate stress province characterized by a relatively uniform compressive stress field with a maximum horizontal stress oriented northeast to east-northeast. However, within this relatively uniform stress field, the applicant cited recent studies that show a geographic shift from an east-west maximum horizontal compressive stress at the latitude of the New Madrid seismic zone (NMSZ) to a stress that trends just north of east in southern Illinois and Indiana.

Regional Tectonic Features. Section 2.1.2 of SSAR Appendix B describes the major geologic structures (folds, faults, and lineaments) in the region surrounding the ESP site as follows:

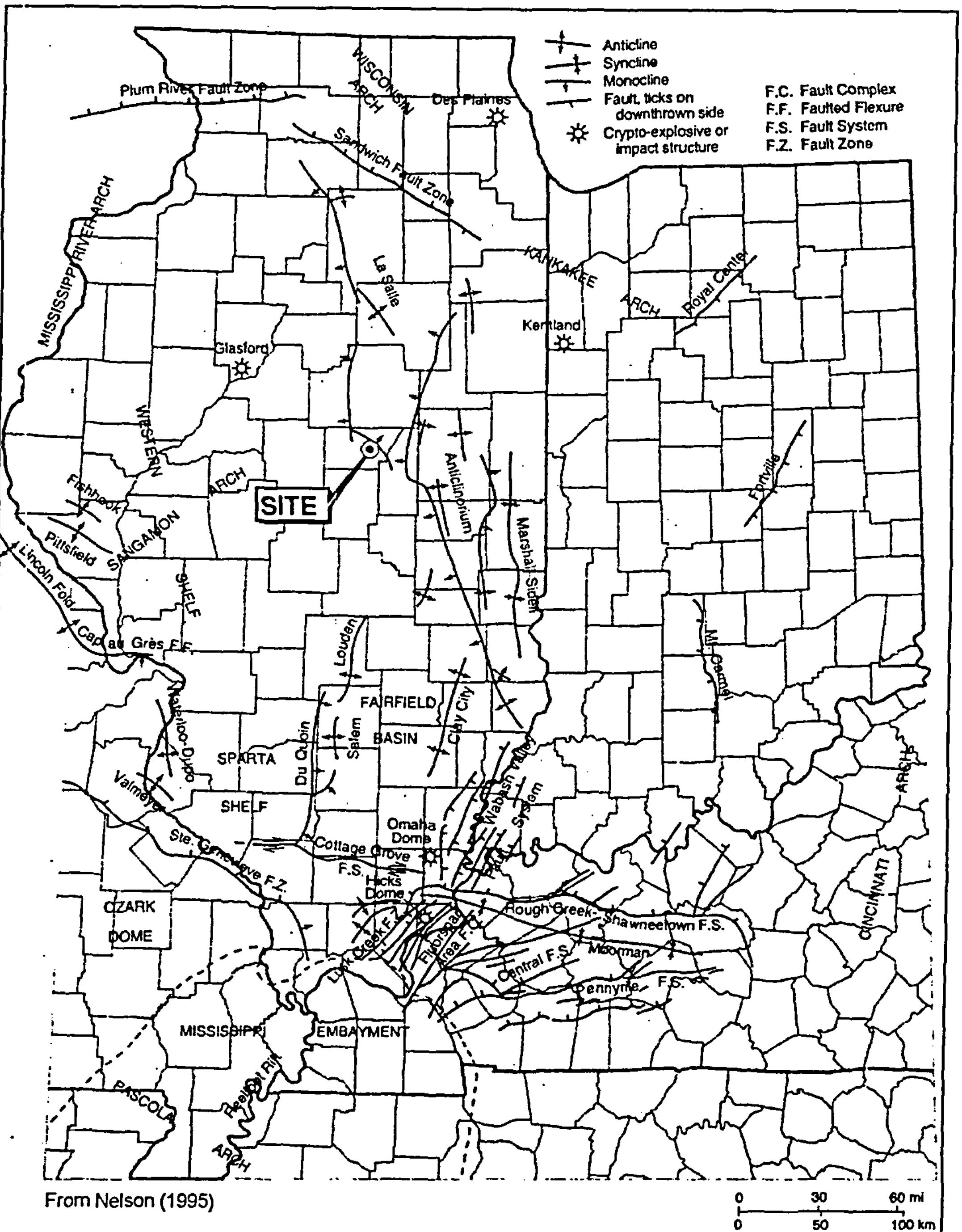
- folds
  - La Salle anticlinorium
  - Peru monocline
  - Du Quoin monocline
  - Louden anticline
  - Waterloo-Dupo anticline
  - Farmington anticline-Avon block
  - Peoria folds
- faults
  - Sandwich fault zone
  - Plum River fault zone
  - Centralia fault zone
  - Rend Lake fault zone
  - Cap au Gres faulted flexure
  - St. Louis fault
  - Eureka-House Springs structure
  - Ste Genevieve fault zone
  - Simms Mountain fault system
  - Bodenschatz-Lick fault system

- Cape Girardeau fault system
- Wabash Valley fault system (WVFS)
- Fluorspar Area fault complex (FAFC)
- Rough Creek graben faults
- Cottage Grove fault system

• lineaments

- Commerce geophysical lineament (CGL)
- St. Charles lineament
- South-Central magnetic lineament

Among the above-mentioned geologic features, the structures discussed below are described by the applicant as either (1) coinciding with recorded earthquake trends, (2) characterized by Quaternary deformation, or (3) attributed as potential sources of paleoliquefaction during the Quaternary. Many of these geologic features are shown below in Figure 2.5.1-1, reproduced from Figure 2.1-3 in Appendix B to the SSAR.



Seismic Hazards Report for the EGC ESP Site

Major Structural Features in Illinois and Neighboring States

Figure 2.1-3

Figure 2.5.1-1 Major structural features in Illinois and neighboring States

Folds

The regional folds that the applicant considered to be potential Quaternary features are the (1) Peru monocline, (2) Du Quoin monocline, (3) Waterloo-Dupo anticline, and (4) Farmington anticline-Avon block.

The Peru monocline is a 65-mile-long northwest trending fold belt in which the rocks dip steeply to the southwest into the Illinois basin. The distance between the Peru monocline and the ESP site is about 50 to 55 miles. Three earthquakes occurring in September 1972 (body wave magnitude (m_b) 4.6), September 1999 (m_b 3.5), and possibly May 1881 (magnitude unknown) are assumed to be related to this structure, and, as such, the applicant concluded that the Peru monocline may be a reactivated Paleozoic structure.

The Du Quoin monocline, which is located about 90 to 100 miles south of the ESP site, is a north-south trending structure, which warps Paleozoic strata downwards on its eastern flank. Normal faults of the Dowell and Centralia fault zones are coincident with the dipping flank of the Du Quoin monocline. The applicant cited research that postulates that the Centralia fault zone represents extensional activation of the basement structure beneath the Du Quoin monocline, and these two structures may connect at depth. The Du Quoin monocline and related Centralia fault zone are considered as a potential source for an earthquake that produced middle Holocene paleoliquefaction features in southwestern Illinois and southeastern Missouri.

The Waterloo-Dupo anticline, which is located about 130 miles southwest of the ESP site, is a north-northwest-trending, asymmetrical anticline that may be a southern continuation of the Cap au Gres faulted monocline, located in Missouri and Illinois. The applicant stated that the Waterloo-Dupo anticline may be the seismic source for the paleoliquefaction features in eastern Missouri.

The Farmington anticline-Avon block is a broad (as much as 12 miles wide), northwest-trending, low-relief structure. Weak to moderate seismicity is clustered around this structure, which is located about 170 miles south of the ESP site.

Faults

The regional faults and fault zones that the applicant considered to be potential Quaternary features are the (1) Centralia fault zone, (2) St. Louis fault, (3) Ste Genevieve fault zone, (4) WVFS, and (5) FAFC.

The Centralia fault zone is a north-trending structure zone, composed of normal faults that dip 70° to 75° toward the west, with a consistent displacement of 100 to 160 ft for strata from the upper Mississippian to Ordovician periods. The fault zone is located about 100 miles south of the ESP site. The applicant stated that earthquakes with strike-slip focal mechanisms located near the structural axis of the Centralia fault are probably associated with the Du Quoin monocline.

The St. Louis fault, which is located about 130 miles from the ESP site, is a northeast-trending fault located along the border between Missouri and Illinois. The applicant cited recent studies which show that the St. Louis fault (1) appears to offset the Waterloo-Dupo anticline in the right-lateral sense, and (2) is considered as a possible candidate for the paleoearthquake features found in eastern Missouri.

The Ste Genevieve fault zone, which is located about 165 miles south of the ESP site, extends for approximately 120 miles along strike from southeast Missouri into southwest Illinois. The fault zone consists of numerous en echelon strands (separate faults having parallel but steplike trends) and braided segments with variable deformation styles and a complex history of reactivation. Diffuse seismicity occurs in the block between the Ste Genevieve fault zone and Simms Mountain fault system, located in southeast Missouri, but the applicant stated that no documented evidence for Quaternary deformation or paleoliquefaction has been observed in the area.

The WVFS is a major zone of northeast-trending, high-angle normal and strike-slip faulting bordering Illinois, Kentucky, and Indiana. The fault system is about 55 to 60 miles long and as much as 30 miles wide; the closest point of the fault system is about 130 miles from the ESP site. The predominant normal movement along the fault system is post-Late Pennsylvanian with a vertical offset of about 480 ft. The applicant cited studies that suggest that the WVFS most likely developed in the early Permian by reactivation of a Precambrian rift zone that was the northern extension of Reelfoot rift. The WVFS is located inside the Wabash Valley/Southern Illinois seismic zone (WVSZ), a potential source for abundant paleoliquefaction features in the region.

The FAFC includes the faults that bound the grabens and horsts within the Fluorspar mining district. The nearest point of the fault complex is about 175 miles from the ESP site. The FAFC is predominately a normal fault with dip-slip as much as 2460 ft. The applicant cited the results of shallow drilling, trenching, outcrop mapping, and seismic reflection acquisition in southern Illinois that show evidence for Quaternary-age faulting on the FAFC in the northern Mississippi embayment.

Lineaments

Of the three regional lineaments, the applicant only considered the CGL to be a potential Quaternary feature.

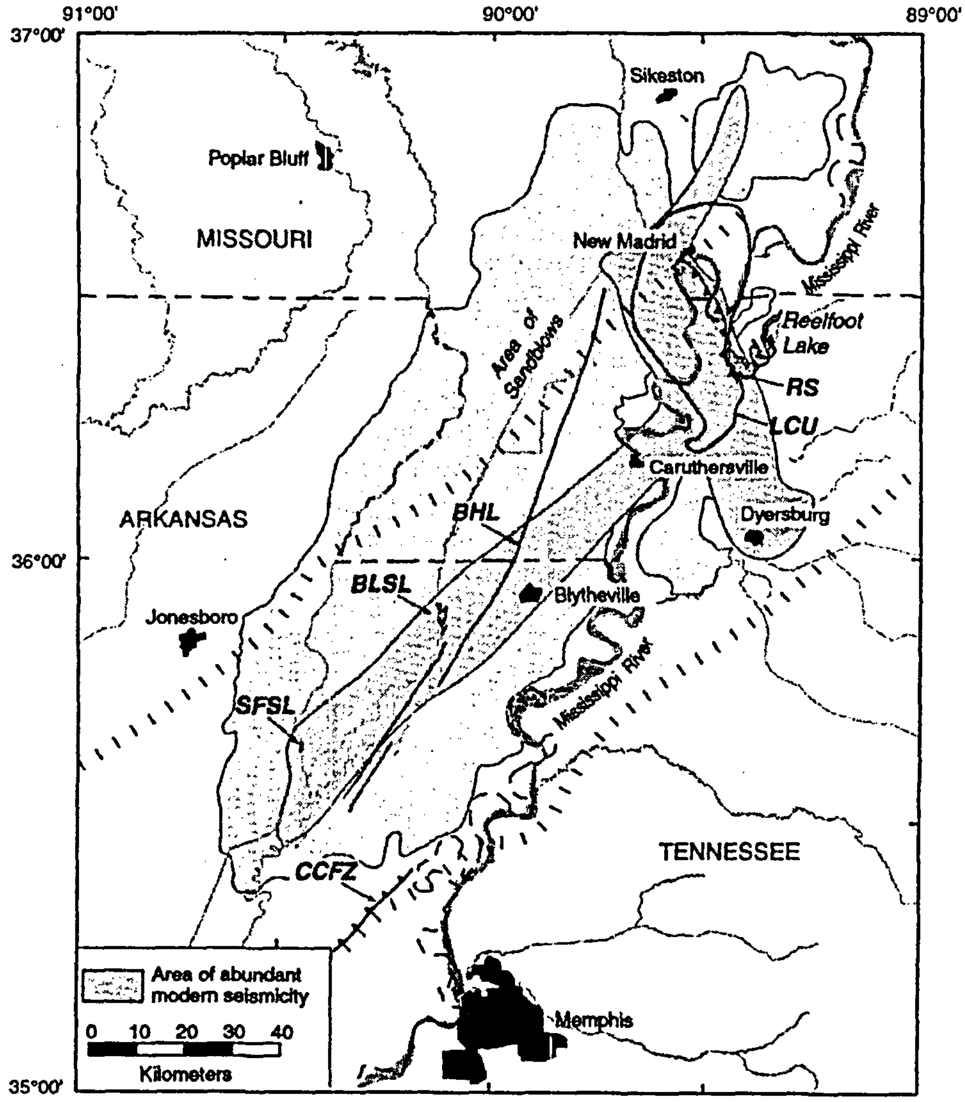
The CGL is a northeast-trending basement magnetic and gravity anomaly that extends from northeast Arkansas to at least Vincennes, Indiana (more than 240 miles). The CGL is a significant, continental-scale linear feature that is apparent in topography, geophysical data, and remote sensory imagery. Quaternary deformation and paleoliquefaction have been associated with the CGL at several sites. These sites are all located inside the WVSZ, which is described below. Well-developed northeast- to north-northeast-trending strike-slip faults, which have a long-lived tectonic history, including Pleistocene and Holocene, occur over the lineament. In addition, the applicant noted that about 16 earthquakes with magnitudes of m_b 3.0 to 5.5 have occurred on or near the lineament.

<u>Regional Seismic Sources</u>. Section 2.1.5 of SSAR Appendix B describes the regional seismic sources. Rather than characterizing the seismic potential of each of the above regional tectonic features, the applicant used the EPRI-Seismicity Owners Group (SOG) seismic hazard study, which groups these potential sources into large areal seismic source zones. Within a 200-mile radius of the site (or just beyond), the three major sources of potential earthquakes are (1) the

NMSZ, (2) the WVSZ in southern Illinois and southern Indiana, and (3) the central Illinois basin/background source. A summary of each of these three seismic source zones is presented below.

New Madrid Seismic Zone

The New Madrid region was the location of three earthquakes in 1811–1812, which are the largest historical earthquakes in the CEUS. Estimates of the magnitudes of these three events generally range between 7.3 and 8.3. The northern boundary of the source region for New Madrid earthquakes is generally considered to lie at or just beyond the 200-mile radius of the ESP site. The NMSZ extends about 150 miles from northeastern Arkansas into western Tennessee and southwestern Kentucky. The applicant summarized the results of several geological, geophysical, and seismological studies, which have been conducted to characterize the location and extent of the likely causative faults of each of these earthquakes and to assess the maximum magnitude and recurrence of earthquakes in this region. Figure 2.5.1-2, reproduced from Figure 2.1-21 in Appendix B to the SSAR, shows a schematic diagram of the NMSZ, including areas of modern seismicity and the locations of liquefaction features.



Light shaded area shows location of abundant sand blows and medium shaded area shows location of abundant modern seismicity. Selected features are: LCU, Lake County uplift; RS, Reelfoot scarp; BLSL, Big Lake sunklands; SFSL, St. Frances sunk-lands ; BHL, Bootheel lineament ; CCFZ, Crittenden County fault zone.

From Crone and Wheeler (2000).

Seismic Hazards Report for the EGC ESP Site Schematic Diagram Showing the Reelfoot Scarp and Selected Features in the Area of the New Madrid Seismic Zone	Figure 2.1-21

Figure 2.5.1-2 Schematic diagram showing the Reelfoot scarp and selected features in the area of the NMSZ

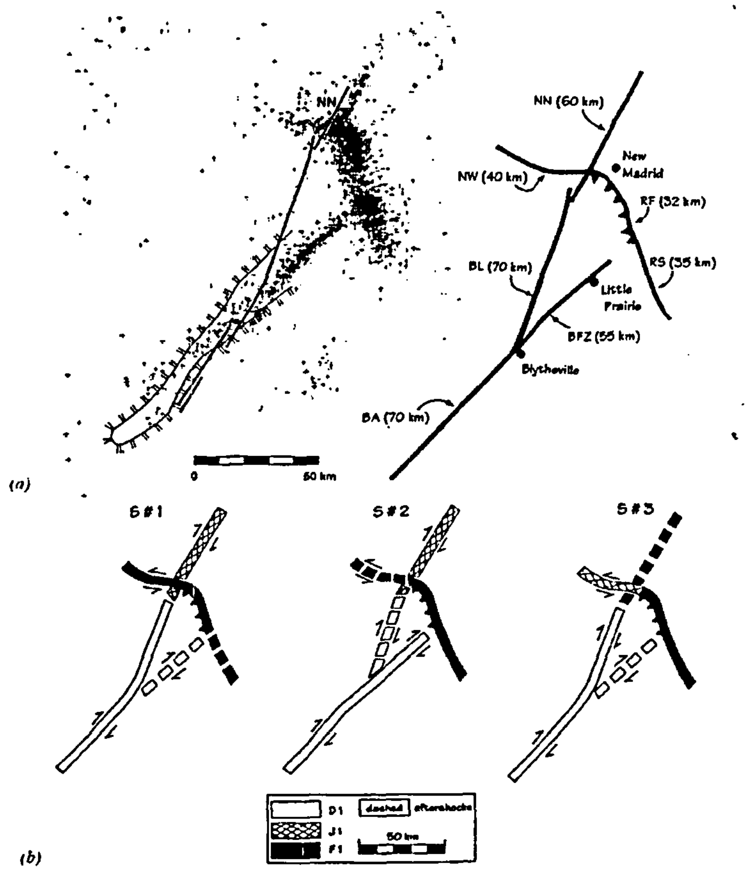
In Request for Additional Information (RAI) 2.5.1-1, the staff asked the applicant to clarify its magnitude estimates for the three 1811–1812 New Madrid earthquakes. In response, the applicant updated its magnitude estimates to include the latest research findings. Section 2.5.1.3.1 of this safety evaluation report (SER) provides further detail on the applicant's response to RAI 2.5.1-1 and the staff's evaluation of the applicant's response.

Seismicity within the New Madrid region is generally located along the Reelfoot rift, which is an ancient failed rift zone that has its long axis oriented to the northeast and runs parallel to the CGL. The applicant cited research which postulates a time-dependent model for the generation of repeated intraplate earthquakes that incorporates a weak lower crustal zone within an elastic lithosphere. According to this model, relaxation of this weak zone in the lower crust after tectonic perturbations (i.e., the recession of glacial ice sheets from central North America 14,000 years ago) transfers stress to the upper crust, triggering slip on overlying faults and generating a sequence of earthquakes that continues until the weak zone reaches its fully relaxed state. Coseismic slip, in turn, partially reloads the lower crust, causing cyclic stress transfer, which prolongs the relaxation process. The applicant stated that this source model is consistent with earthquake magnitude, coseismic slip, recurrence intervals, and surface deformation rates in the NMSZ. The applicant stated that this model is also supported by studies that show that the removal of the Laurentide ice sheet approximately 20,000 years ago changed the stress field in the vicinity of New Madrid, causing seismic strain rates to increase by about three orders of magnitude. This modeling predicts that the high rate of seismic energy release observed during the late Holocene time is likely to continue for the next few thousand years.

The principal seismic activity within the upper Mississippi embayment is interior to the Reelfoot rift along the NMSZ. The NMSZ consists of three principal trends of seismicity—two northeast-trending arms with a connecting northwest-trending arm. The NMSZ is considered to be a northeast-trending, right-lateral strike-slip fault system with a compressional left-stepover zone. Earthquakes in the NMSZ are produced by a network of intersecting faults. The applicant identified the following fault segments within the NMSZ:

- Blytheville arch (BA)
- Blytheville fault zone
- Bootheel lineament
- New Madrid west
- New Madrid north (NN)
- Reelfoot fault (RF)
- Reelfoot south

Each of these fault segments is shown in Figure 2.1-22 of SSAR Appendix B and reproduced below as SER Figure 2.5.1-3.



(a) Fault segmentation of the NMSZ. Seismicity of the NMSZ, the Blytheville arch, and the Bootheel lineament/NN fault (*left*) yield the seven segments (*right*) identified as: BA, Blytheville arch; BFZ, Blytheville fault zone; BL, Bootheel lineament; NW, New Madrid west; NN, New Madrid north; RF, Reelfoot fault; RS, Reelfoot south. Segments NW and RS are defined solely from seismicity.

(b) Possible fault rupture scenarios (S#1, S#2, S#3) for the 1811-1812 D1, J1, and F1 earthquake sequences, using the seven fault segments of (a). Based on historical and physical constraints, the D1 principal event must rupture BA, and the F1 principal event must rupture RF in all scenarios. S#1 is the favored scenario.

From Johnston and Schweig (1996)

Seismic Hazards Report for the EGC ESP Site Central Fault System of New Madrid Seismic Zone	Figure 2.1-22

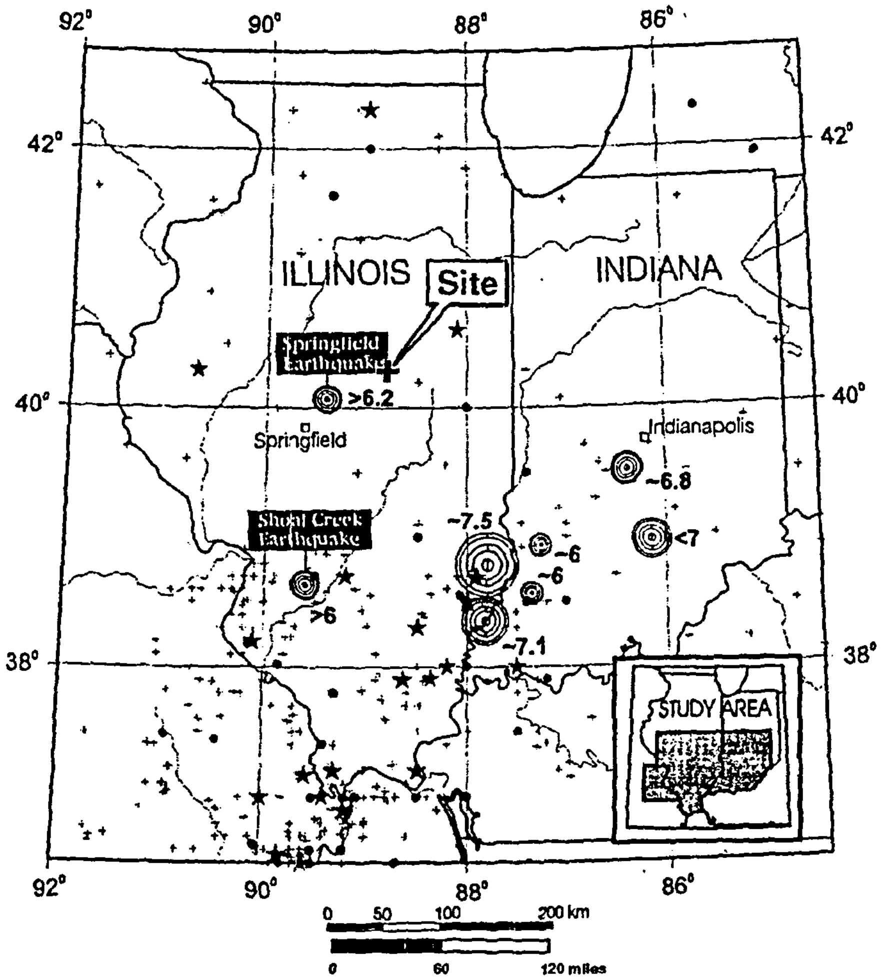
Figure 2.5.1-3 Central fault system of NMSZ

Based on historical accounts and geologic evidence, geologists have postulated that the December 16, 1811, earthquake occurred primarily along the BA, which is the southernmost fault segment. Similarly, geologists have concluded that the causative fault for the January 23, 1812, earthquake is along the NN fault segment, and the February 7, 1812, earthquake occurred on the RF, which connects the two other fault zones through the stepover region.

Geologists have determined the maximum earthquake potential of the NMSZ based largely on the analysis of damage-intensity data and liquefaction features from the 1811–1812 earthquake sequence. The applicant found that recent analyses favor lower magnitudes (7.5 to 8.0) for the NMSZ, suggesting that site effects and population distribution biased earlier interpretations, which postulated higher magnitudes (7.8 to 8.4). To determine the recurrence interval for the maximum earthquakes in the NMSZ, geologists have used paleoliquefaction studies and the evaluation of fault-related deformation along the Reelfoot scarp. The applicant cited paleoliquefaction events with dates of AD 1450 ± 150, AD 900 ± 100, AD 490 ± 50, AD 300 ± 200, and BC 1370 ± 970, based on its review of the literature. As such, the applicant concluded that the occurrence interval of a New Madrid-type earthquake may have been as short as 200 years or as long as 800 years, with an average of about 500 years.

Wabash Valley/Southern Illinois Seismic Zone

The WVSZ is located in southeastern Illinois and southwestern Indiana to the northeast of the NMSZ. The WVSZ is a zone of moderate seismicity, with the strongest event (moment magnitude (M_w) 5.4) occurring in 1968 in southern Illinois. Other notable recent events occurring in the WVSZ include a magnitude 5.0 earthquake near Lawrenceville, Illinois, in 1987 and a magnitude 4.5 earthquake in 2002 near Evansville, Indiana. Much larger earthquakes have occurred in the WVSZ during the past 10,000 years. The applicant cited research that demonstrates, based on paleoliquefaction data, the existence of repeated large-magnitude (M_w 7.0 to 7.8) earthquakes in the Wabash Valley region. The applicant stated that the causative structure for these earthquakes may be basement thrust faults beneath the Illinois basin that coincide with an area of broad flexure in the CGL. The location of the 1968 M_w 5.4 earthquake in southern Illinois supports this hypothesis. Figure 2.5.1-4, reproduced from Figure 2.1-14 in SSAR Appendix B, shows the historical seismicity and estimated centers of the large prehistoric earthquakes in the WVSZ.



A star represents a magnitude of 5 or higher. A solid circle represents a magnitude between 4.5 and 5. A plus sign represents a magnitude between about 2.3 and 4.5. Historical earthquake data are from USGS/NEIC Global Hypocenter Data Base CD-ROM (Version 3.0). Concentric circles show estimated energy centers of large prehistoric earthquakes. The estimated moment magnitude, M, for a prehistoric earthquake is located near the circle.

Note:
Epicenters of historical earthquakes are shown for the time period 1804-1992

From McNulty and Obermeier (1999)

Seismic Hazards Report for the EGC ESP Site

Historical Seismicity and Estimated Centers of Large Prehistoric Earthquakes in Site Region

Figure **2.1-14**

Figure 2.5.1-4 Historical seismicity and estimated centers of large prehistoric earthquakes in site region

The applicant stated that the maximum-magnitude distribution for the WVSZ is based on the analysis of paleoliquefaction features in the vicinity of the lower Wabash Valley of southern Illinois and Indiana. The applicant cited research showing that the largest paleoearthquake occurred 6101 ± 200 years ago with an estimated M_w range between 7.0 to 7.5. The next largest earthquake occurred 12,000 ± 1,000 years ago with an estimated magnitude between 7.1 to 7.3. Both of these earthquakes occurred close to one another in the lower Wabash Valley of Indiana and Illinois.

Central Illinois Basin/Background Source

In addition to the NMSZ and WVSZ, evidence from recent paleoliquefaction studies and seismic reflection data show that significant earthquakes may occur in parts of the central Illinois basin where there are no obvious folds or faults at the surface. The applicant stated that the location, size, and recurrence of such events are not well constrained by available data. However, because of the paleoliquefaction evidence, the applicant has developed a background source zone for this region. The central Illinois basin/background source covers the area to the west and north of the WVSZ and encompasses the ESP site. The applicant stated that one or two prehistoric earthquakes may have occurred near Springfield, Illinois, approximately 35 miles southwest of the ESP site (see SER Figure 2.5.1-4 above) between about 5900 to 7400 years ago. These earthquakes were apparently large enough to generate liquefaction features, with magnitude estimates ranging between 6.2 and 6.8. The applicant was unable to associate the Springfield earthquakes with any known geologic structure or local seismic activity. In addition to the Springfield events, the applicant stated that additional liquefaction features were discovered further south near the confluence of the Shoal Creek and Kaskaskia River. The estimated magnitude and date for this event is about 6.0 and 5700 before present (BP).

To further characterize the seismic potential of the central Illinois basin/background source, the applicant investigated the banks of several streams (Sangamon River, Salt Creek, North Fork of Salt Creek, and the Mackinaw River) near the ESP site for evidence of liquefaction features resulting from strong ground motion. These paleoliquefaction investigations are described in Attachment 1 to SSAR Appendix B. Figure 2.5.1-5, reproduced from Figure B-1-6 in Attachment 1 to SSAR Appendix B, shows the streams that the applicant surveyed during its paleoliquefaction reconnaissance.

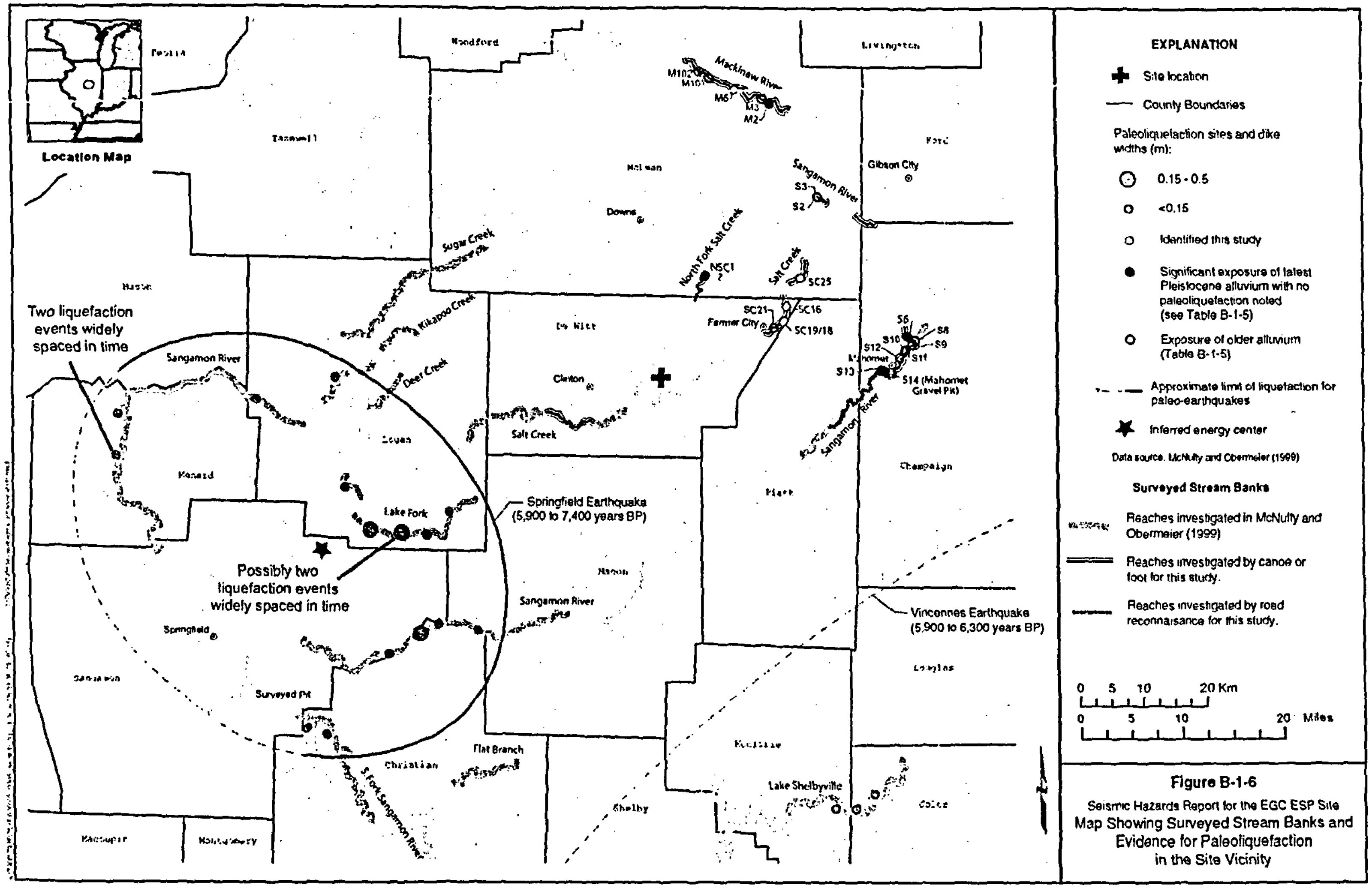


Figure 2.5.1-5 Map showing surveyed stream banks and evidence for paleoliquefaction in the site vicinity

Although the applicant discovered some small liquefaction features, which suggest possible local seismic sources, the applicant stated that these features could also be related to more distant sources, such as the WVSZ or NMSZ. The applicant concluded by stating the following:

> Given the low rate of historical seismicity in this region, the apparent long recurrence between events suggested by the paleoliquefaction data, and the lack of clearly defined seismogenic structures close to the inferred energy centers, it is unlikely that distinct seismic sources can be defined for these paleoliquefaction events.

For the central Illinois basin/background source, the applicant stated that the results of its paleoliquefaction investigations show that there have not been repeated moderate to large events, comparable to the magnitude (M) 6.2 to 6.8 Springfield earthquake in the vicinity of the ESP site, in the late Holocene time (approximately 6 to 7 thousand years). However, because of the uncertainty in the paleoliquefaction data, the applicant stated that the range in maximum magnitude assigned to a random earthquake in the background source should include events comparable to that estimated for the Springfield earthquake.

In RAI 2.5.2-6, the staff asked the applicant to explain its selected paleoliquefaction study area along the streams near the ESP site. Specifically, the staff asked the applicant why it did not examine the streams northwest and southeast of the site as part of its study. In response, the applicant stated that it selected its study area to supplement previous liquefaction studies along portions of the Sangamon River, portions of Salt Creek, and similar drainages west and northwest of the site. SER Section 2.5.1.3.1 provides further detail on the applicant's response to RAI 2.5.2-6 and the staff's evaluation of the applicant's response.

In RAI 2.5.1-4, the staff asked the applicant to provide better annotated photographs of the liquefaction features found along the Salt Creek. In response, the applicant provided photographs that clearly indicate the locations of the sand dikes. In RAI 2.5.1-5, the staff asked the applicant to substantiate the reliability of its methods to determine the size and location of paleoearthquakes based on liquefaction features. In response, the applicant demonstrated how it used the paleoliquefaction data and analyses to characterize the regional and local seismic potential of these paleoearthquake centers. SER Section 2.5.1.3.1 provides further detail on the applicant's response to RAIs 2.5.1-4 and 2.5.1-5 as well as the staff's evaluation of these responses.

2.5.1.1.2 Site Geology

SSAR Section 2.5.1.2 summarizes the local geologic history and structural geology, with an emphasis on the Quaternary Period. Section 2.2 of SSAR Appendix A provides additional detail on the local (1) physiography, (2) stratigraphy, and (3) structural geology. In addition, Chapter 5 of SSAR Appendix A provides a description of the site ground water conditions and other geologic considerations, such as potential topographic depressions caused by karst terrain and mine subsidence. Chapter 5 of SSAR Appendix A also describes regional natural gas production and oil fields, ground water springs, landslides, and the overall geologic suitability.

Site Physiography. The ESP site lies within the Bloomington Ridged Plain physiographic subsection of the Till Plains physiographic section in Central Illinois. The site is located in an upland area ground moraine that is dissected by the Salt Creek and the North Fork of the Salt Creek. The local relief of the uplands is about 10 ft, except near the drainage ways, and the average elevation of the uplands is approximately 740 ft above mean sea level (msl). The applicant concluded that the physiography of the ESP site is the same as that of the CPS site.

Site Stratigraphy. The ESP site is located a few miles inside the extent of the Wisconsinan glaciation. The surface deposits in the upland site area consist of a thin layer of loess (silt with some fine sand) over glacial till. Other stratigraphic units beneath the glacial till include organic silt, under which lie glacial till deposits of the Illinoian Stage and pre-Illinoian Stage. Bedrock in the vicinity of the ESP site is from the Bond and Modesto formations, which generally consist of alternating bands of limestone, shale, siltstone, sandstone, and some coal seams. At the base of the Bond formation is a layer of limestone, which corresponds to the top of the Modesto formation (495 ft above msl). The applicant concluded that the site stratigraphy across the ESP and CPS sites is very similar in terms of soil consistency and layering. The primary difference between the two sites is that the depth to bedrock is approximately 50 ft deeper at the ESP site than at the CPS site.

Site Structural Geology. The ESP site is located in a tectonically stable area of North America. The applicant stated that although the ESP site is within several miles of structural features, there is no evidence of surface faulting at the site or the area surrounding the site within a 25-mile radius. In addition, the applicant stated that no evidence of faulting was observed based on interpretations of borehole data at the ESP and CPS sites, excavations for CPS, or during geologic reconnaissance for this study. The applicant found that although differences in bedrock unit elevations can be attributed to structural deformation, the relatively flat-lying and undeformed Pleistocene drift overlying the bedrock demonstrates that the stresses that would have been responsible for the deformation have been inactive since at least Illinoian time (~185 to 128 ka). The applicant concluded that its understanding of the CPS and ESP site structural geology and geologic history has not changed since the geology work done for the CPS site.

Site Ground Water Conditions. The applicant found that the ground water elevations at the ESP site are consistent with those of the CPS site. As indicated by the ESP site piezometers, the ground water generally exists in a perched water table condition a few feet below the ground surface in the shallow Wisconsinan till soils. A downward gradient of about 20 ft in the ground water elevation was observed by the applicant across the ESP site. SSAR Section 2.4.13.2, "Sources," presents a detailed discussion of the hydrogeologic conditions at the ESP site.

Other Geologic Conditions. Chapter 5 of SSAR Appendix A covers additional geologic conditions that the applicant investigated as part of its ESP application. These additional geologic conditions include (1) karst terrain, (2) mine subsidence, (3) natural gas production and oil fields, (4) ground water springs, (5) landslides, and (6) overall geologic suitability.

Karst terrain includes topographic depressions (sinkholes), caves, large springs, fluted rocks, blind valleys, and swallow holes that develop in areas of high rock solubility and permeability. These features have the potential to affect the foundation support for buildings and other structures. The applicant stated that the Illinois State Geologic Survey (ISGS) identified some areas in Illinois that are susceptible to karst development; however, the ISGS assessment of DeWitt County found no susceptibility.

Mine subsidence is the sinking of the ground surface after the collapse of an underground mine, which can damage overlying structures. Although ISGS has identified areas susceptible to mine subsidence in Illinois, the applicant found no historic mines in DeWitt County. As such, the applicant concluded that there is no potential for mine subsidence at the ESP site.

Natural gas production from organic matter in deep valleys filled with glacial material has occurred in Illinois since the early 1900s. Five gas-producing wells are located in the western part of DeWitt County; however, the applicant did not identify any wells near the ESP or CPS sites and concluded that the occurrence of gas-producing strata is not a concern. The applicant did note the locations of two oil-well fields, more than 4 miles northeast of the CPS site, and concluded that they do not pose a hazard to the ESP site.

The Weldon Springs State Recreation Area is located about 5 miles southwest of the ESP site. This spring originates in the near-surface Wisconsinan silty sands and gravels and discharges to a small lake in the recreation area. The applicant stated that the recreation area will not be impacted by ground water extraction activities in the ESP site because the ground water springs are hydraulically separated from the ESP site by Clinton Lake and Salt Creek.

The applicant used the ISGS landslide potential map for Illinois to determine that the landslide potential for DeWitt County is low. The only slopes near the ESP site are those associated with Clinton Lake. These slopes are located approximately 800 ft northwest of the ESP site. The applicant stated that they have been very stable for the past 30 years, and therefore landsliding does not pose a hazard. In addition, the applicant concluded that the distance between the ESP site and the slopes is such that, if landsliding were to occur, it would not extend to the ESP site. The applicant stated that further slope stability studies may be necessary during the COL stage in the area of the outfall pipe, if a new outfall is constructed. At the ESP stage, the applicant stated that it has not yet determined the need for an outfall.

Regarding the overall geologic suitability, the applicant stated that the surficial materials present few serious problems to construction. The most common problem is poor drainage caused by the relatively flat, dense glacial deposits.

2.5.1.2 Regulatory Evaluation

SSAR Section 2.5.1 presents information on the geological characteristics of the ESP site region and area. The applicant stated that SSAR Section 2.5.1 addresses Title 10 of the *Code of Federal Regulations* (10 CFR), Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," and 10 CFR Part 100, "Reactor Site Criteria." SSAR Sections 3.4.1 and 3.4.2 describe the applicant's compliance with the geological and seismological requirements of 10 CFR 100.21, "Non-seismic Siting Criteria," and 10 CFR 100.23, "Geologic and Seismic Siting Criteria," respectively. In addition, in response to RAI 1.5-1, the applicant stated that it complied with all of the regulations listed in Review Standard (RS)-002, "Processing Applications for Early Site Permits," for each of the pertinent SSAR sections. This statement by the applicant implies that SSAR Section 2.5.1 conforms with the requirements of General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," in Appendix A, "General Design Criteria," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." In SSAR Section 1.5, "USNRC Regulatory Guides," the applicant provided a list of the RGs that it used in developing each of the SSAR sections. For SSAR Section 2.5.1, the applicant listed RG 1.132, "Site Investigations for Foundations of Nuclear Power Plants," and RG 1.165. The staff reviewed this portion of the application for conformance with the regulatory requirements and guidance applicable to the geological and seismological characterization of the proposed site, as identified below. The staff notes that GDC 2 applies to this portion of the review of an ESP application only with regard to consideration of the most severe natural phenomena reported for the site (in this case earthquakes), including margin.

In reviewing the SSAR, the staff considered the regulations at 10 CFR 52.17(a)(1)(vi) and 10 CFR 100.23(c), which require that the applicant for an ESP describe the seismic and geologic characteristics of the proposed site. In particular, 10 CFR 100.23(c) requires that an ESP applicant investigate the geological, seismological, and engineering characteristics of the proposed site and its environs with sufficient scope and detail to support evaluations to estimate the SSE ground motion and to permit adequate engineering solutions to actual or potential geologic and seismic effects at the site. Section 2.5.1 of NUREG-0800, "Standard Review Plan" (SRP), issued 1997; RG 1.165; and Section 2.5 of RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Revision 3, issued November 1978, provide specific guidance concerning the evaluation of information characterizing the geology and seismology of the proposed site.

2.5.1.3 Technical Evaluation

This section of the SER provides the staff's evaluation of the geological and seismological information submitted by the applicant in SSAR Section 2.5.1. The technical information presented in SSAR Section 2.5.1 resulted from the applicant's surface and subsurface geological, seismological, and geotechnical investigations performed in progressively greater detail as they moved closer to the site. Through its review, the staff determined whether the applicant had complied with the applicable regulations and conducted its investigations with an appropriate level of thoroughness in accordance with the four areas designated in RG 1.165, which are based on various distances from the site (i.e., 320 km (200 mi), 40 km (25 mi), 8 km (5 mi), and 1 km (0.6 mi)).

SSAR Section 2.5.1 contains the geologic and seismic information gathered by the applicant in support of the vibratory ground motion analysis and site SSE spectrum provided in SSAR Section 2.5.2. According to RG 1.165, applicants may develop the vibratory design ground motion for a new nuclear power plant using either the EPRI or LLNL seismic source models for the CEUS. However, RG 1.165 recommends that applicants update the geological, seismological, and geophysical database and evaluate any new data to determine whether revisions to the EPRI or LLNL seismic source models are necessary. As a result, the staff focused its review on geologic and seismic data published since the late 1980s that could indicate a need for changes to the EPRI or LLNL seismic source models.

To thoroughly evaluate the geological and seismological information presented by the applicant, the staff obtained the assistance of the U.S. Geological Survey (USGS). The staff and its

USGS advisors visited the ESP site to confirm the interpretations, assumptions, and conclusions presented by the applicant concerning potential geologic and seismic hazards. The staff's review of SSAR Section 2.5.1 focused on (1) tectonic or seismic information, (2) nontectonic deformation information, and (3) conditions caused by human activities, with respect to both the regional geology and site geology.

2.5.1.3.1 Regional Geology

The staff focused its review of SSAR Section 2.5.1.1 on the applicant's description of the regional tectonics, with emphasis on the Quaternary Period, structural geology, seismology, paleoseismology, physiography, geomorphology, stratigraphy, and geologic history within a distance of 200 miles from the site. The applicant provided additional detail, beyond that presented in SSAR Section 2.5.1.1, in Section 2.2 of SSAR Appendix A and Section 2.1 of SSAR Appendix B. In addition, Attachment 1 to SSAR Appendix B describes the applicant's regional paleoliquefaction investigations.

In SSAR Section 2.5.1.1 and Appendices A and B, the applicant described the regional physiography, the Quaternary geologic history and stratigraphy, structural geology, and regional tectonic setting and features. The applicant concluded that the ESP site is one of the most geologically stable areas in the United States, and the geologic conditions at the ESP site are the same as those at the CPS site. Based on its review of SSAR Section 2.5.1.1 and the pertinent portions of Appendices A and B, the staff concludes that the applicant provided a thorough and accurate description of these geologic features and characteristics in support of the ESP application. In addition, SSAR Section 2.5.1.1 and Appendices A and B describe well-documented geologic information, and the staff concludes that the applicant's description fulfills the requirements of 10 CFR 52.17, "Contents of Applications," and 10 CFR 100.23.

In Section 2.1.5 of SSAR Appendix B, the applicant described the regional seismic sources. Rather than characterizing the seismic potential of each of the regional tectonic features (folds, faults, lineaments), the applicant used the EPRI-SOG seismic hazard study, which groups these potential seismic sources into large areal seismic source zones. Within a 200-mile radius of the site (or just beyond), the three major sources of potential earthquakes are (1) the NMSZ, (2) the WVSZ in southern Illinois and Indiana, and (3) the central Illinois basin/background source. For each of these three seismic source zones, the applicant updated the original EPRI-SOG seismic hazard characterization. These updates are described in SSAR Section 2.5.2 and evaluated by the staff in Section 2.5.2 of this SER.

The New Madrid region was the location of three large earthquakes in 1811–1812, which the applicant estimated (based on its review of the geologic literature) to be between 7.0 and 8.0. The NMSZ consists of three principal trends of seismicity—two northeast-trending arms with a connecting northwest-trending arm. These seismicity trends coincide with what researchers believe to be the causative faults for the three 1811–1812 earthquakes, as well as previous earthquake sequences occurring around AD 1450 ± 150, AD 900 ± 100, AD 490 ± 50, AD 300 ± 200, and BC 1370 ± 970. These three causative faults are the RF, NN fault, and New Madrid south (NS) fault. In addition, the applicant modeled the large seismic events within the NMSZ as characteristic earthquakes, which means that these three faults repeatedly generated earthquakes of similar size during each of the previous earthquake sequences. In RAI 2.5.1-1, the staff asked the applicant to evaluate the publication of Bakun and Hooper (2004), which estimates the magnitudes of the New Madrid earthquake sequence to be M 7.6, 7.5, and 7.8. The applicant used the preliminary magnitude estimates by Bakun and Hooper (2003, in press), which were M 7.2, 7.1, and 7.4. In its response to RAI 2.5.1-1, the applicant stated that its review of the recent literature as well as discussion with researchers indicated that "there still remains uncertainty and differing views within the research community regarding the size and location of the 1811–12 earthquakes." Based on its review of the recent literature concerning the magnitudes for New Madrid earthquake sequences, the applicant added two new models (rupture sets) and revised its previous model based on the Bakun and Hooper (2003, in press) magnitude estimates. The applicant stated that these revisions to the magnitude distributions for characteristic New Madrid earthquakes produced approximately 3 to 4 percent higher ground motions at the mean 10^{-4} and mean 10^{-5} hazard levels. Table 2.5.1-1, reproduced from the applicant's response to RAI 2.5.1-1, provides the six different models (rupture sets) for the New Madrid characteristic earthquakes.

Table 2.5.1-1 Updated Magnitude Distributions for Characteristic New Madrid Earthquakes

Rupture Set	NS Magnitude	Reelfoot Magnitude	NN Magnitude	Weight
1	7.8	7.7	7.5	0.1667
2	7.9	7.8	7.6	0.1667
3	7.6	7.8	7.5	0.2500
4	7.2	7.4	7.2	0.0833
5	7.2	7.4	7.0	0.1667
6	7.3	7.5	7.0	0.1667

The staff considers the applicant's response to RAI 2.5.1-1 to be an adequate assessment of the latest geologic literature concerning the magnitudes for New Madrid characteristic earthquakes. The applicant revised its magnitudes for rupture set number 3 to reflect the changes made by Bakun and Hooper (2004). In addition, the applicant added two new models based on its review of the latest literature and communications with researchers. The applicant assessed the impact of these additions and revisions by reevaluating its PSHA and found an increase (3 to 4 percent) in the 1 Hertz (Hz) ground motion hazard curve at the mean 10^{-4} and mean 10^{-5} hazard levels. However, the applicant did not incorporate this new information into its PSHA or subsequent SSE ground motion spectrum and indicated that the ESP application did not need to be updated as a result of its response to RAI 2.5.1-1. In Open Item 2.5.1-1, the staff asked the applicant to incorporate this information into its PSHA or SSE and to update the SSAR to reflect the corrected magnitude estimates. In response, the applicant updated its source characterization of the New Madrid earthquakes including the final published assessments of Bakun and Hooper (2004). These changes have been incorporated into the ESP application. Therefore, the staff considers Open Item 2.5.1-1 to be resolved.

In RAIs 2.5.1-3 and 2.5.1-4, the staff asked the applicant to provide an improved regional seismicity map and better annotated photographs of the regional liquefaction features, respectively. In response, the applicant revised Figure 2.1-13 in SSAR Appendix B and

Figures B-1-13, B-1-14, and B-1-15 in Attachment 1 to SSAR Appendix B. The staff reviewed these revised SSAR figures and concludes that they provide more detail and support for the applicant's characterization of the regional seismic sources.

In RAI 2.5.1-5, the staff asked the applicant to describe, given the heterogeneous nature of the glacial till deposits, how it used the size of paleoliquefaction features (i.e., dike width) to estimate the locations and magnitudes of paleoearthquakes in the Wabash Valley region and within the Illinois basin. In addition, the staff asked the applicant to account for possible differences in the ground water level, compaction, and overburden pressures between the time of the paleoearthquakes and the present. In response, the applicant stated that the width of dikes provides information that can be used to estimate the level of shaking at the specific site. The applicant used this information in conjunction with regional data on the spatial pattern and distribution of dike size to estimate the location and magnitude of the prehistoric earthquakes. Concerning the uniformity and quantity of susceptible sediments in the study region, the applicant stated that deposits of latest Pleistocene and Holocene age, which have been laid down by moderate to large streams in the CEUS, are generally moderately susceptible. Finally, regarding how potential differences in the geoenvironment are accounted for in determining the size of paleoearthquakes, the applicant stated that researchers have developed recommendations for accounting for uncertainties related to these factors in analyses to back calculate the strength of the earthquake shaking at individual sites.

The staff notes that the applicant acknowledged the uncertainties of using paleoliquefaction analyses to determine the size and location of prehistoric earthquakes by its characterization of these regional seismic sources. Rather than specifically using the inferred locations and magnitudes of paleoearthquake sources, the applicant characterized the Wabash Valley and Illinois basin/background seismic zones as large areal source zones that encompass all of the paleoearthquake locations. In addition, the applicant assumed that the earthquakes within these source zones can occur over large areas as part of its PSHA. The applicant also assumed a conservative range of maximum magnitudes for both source zones. As such, the staff concludes that the applicant has effectively used the paleoliquefaction data and analyses to characterize the regional and local seismic potential of the Wabash Valley and Illinois basin/background source zones.

In RAI 2.5.2-6, the staff asked the applicant to explain its selected paleoliquefaction study area along the streams near the ESP site. Specifically, the staff asked the applicant why it did not examine the streams northwest and southeast of the ESP site as part of the paleoliquefaction study. In addition, the staff asked the applicant if it used other locations besides river bank exposures to confirm the absence of liquefaction features in the vicinity of the ESP site. In response, the applicant stated that it did not conduct reconnaissance investigations in the areas to the northwest and southeast for both logistical and technical reasons. The applicant stated that it selected locations along the Salt Creek, North Fork of the Salt Creek, Sangamon River, and Mackinaw River to supplement previous liquefaction studies in this area. The applicant determined that the Mackinaw River, in the northern part of the study area, was a good candidate to evaluate the evidence for paleoearthquakes because of an abundance of accessible exposures. In addition, McNulty and Obermeier (1999) previously surveyed portions of the Sangamon River. Concerning reconnaissance of regions southeast and northwest of the ESP site, the applicant stated that it considered coverage of these areas to be unnecessary because of the absence of liquefaction-susceptible deposits as well as difficulties in accessing the drainage areas. The applicant provided the following technical rationale for its selected study area:

> Although there are regions to the northwest and southeast of the site within 25 miles of the site that have not been examined, the coverage provided by the previous mapping and the mapping done as part of this study provides sufficient coverage to support the conclusion that paleoearthquakes comparable to the postulated Springfield event have not occurred within a radius of approximately 25 miles of the site post-hypsithermic time (post-6-7 ka). A moderate to large event located within the 25-mile radius to the southeast of the site likely would have been recorded along the examined reaches of Salt Creek and the Sangamon River. A moderate to large event within the 25-mile radius northwest of the site also likely would have been recorded along the examined reaches of the Mackinaw River, Salt Creek, or Sugar Creek.

Regarding the confirmation of the absence of liquefaction features in the vicinity of the ESP site at locations other than riverbank exposures, the applicant stated that it examined gravel pits in the region southwest of the ESP site. However, the applicant stated that there are more abundant exposures along riverbanks, and searching along riverbanks provides for a more efficient method for covering an extensive area.

Based on its review of the applicant's response to RAI 2.5.2-6, the staff concludes that the applicant adequately surveyed the site area for liquefaction features. The staff concurs with the applicant's conclusion that the few liquefaction features indicate that there has not been a paleoearthquake comparable to the Springfield earthquake in the site area during the past 6000 to 7000 years. An earthquake of this size (M 6.2 to 6.8) would most likely have produced liquefaction features along many of the stream banks in the site area that were examined by the applicant. In addition, the staff finds that the applicant has conservatively modeled the seismic potential of the site area by defining a broad areal seismic source zone (Illinois basin/background) as part of its PSHA.

Based upon its review of SSAR Section 2.5.1.1 and the supporting appendices and attachments, as set forth above, the staff concludes that the applicant has provided a complete and accurate description of the regional geology, as required by 10 CFR 52.17 and 10 CFR 100.23.

2.5.1.3.2 Site Geology

The staff focused its review of SSAR Section 2.5.1.2 on the applicant's description of the site-related geologic features and structure, as well as conditions caused by human activities. In addition to SSAR Section 2.5.1.2, the staff reviewed Chapters 2 and 5 of SSAR Appendix A, which provides supporting information on the local geologic features. Based on its review of SSAR Section 2.5.1.2, described below, the staff concludes that the applicant has provided a thorough and accurate description of the local geology in support of the ESP application.

In SSAR Section 2.5.1.2 and Chapters 2 and 5 of SSAR Appendix A, the applicant described the site physiography, stratigraphy, structural geology, ground water conditions, and other geologic conditions. The ESP site is located in an upland area with a local relief of about 10 ft that is dissected by the Salt Creek and the North Fork of the Salt Creek. The site is located within the extent of the Wisconsinan glaciation with surface deposits consisting of a thin layer of loess over glacial till. The top of bedrock is about 300 ft below the ground surface. The ESP site is located in a tectonically stable area of North America, and there is no evidence of surface faulting at the site or in the local site area. The ESP site area is part of the Illinois/basin background seismic source zone, which includes the presumed epicenter of the Springfield earthquake (M 6.2 to 6.8) in central Illinois as well as the few liquefaction features that the applicant discovered to the northeast of the site. The ground water at the ESP site exists in a perched water table condition a few feet below the ground surface in the shallow Wisconsinan till soils. Concerning other geologic conditions, the ESP site is not susceptible to karst development or mine subsidence, and the landslide potential is low.

Based on its review of SSAR Section 2.5.1.2 and Chapters 2 and 5 of SSAR Appendix A, the staff concludes that the applicant has provided an accurate and thorough description of the local site geology as required by 10 CFR 52.17 and 10 CFR 100.23. SSAR Section 2.5.1.2 and Chapter 2 of SSAR Appendix A accurately describe readily observable local geologic features, and Chapter 5 of SSAR Appendix A provides an adequate description of the local site conditions. Because of limited ground water withdrawal, the distance of any mining activity from the site, and the absence of karst terrain, the staff concludes that there is no potential for the effects of human activity, such as subsidence or collapse, that could compromise the safety of the site.

2.5.1.4 Conclusions

As set forth above, the staff reviewed the geological and seismological information submitted by the applicant in SSAR Section 2.5.1. On the basis of its review, the staff finds that the applicant provided a thorough characterization of the geological and seismological characteristics of the site, as required by 10 CFR 100.23. These results provide an adequate basis to conclude that no capable tectonic sources exist in the plant site area that have the potential to cause near-surface fault displacement. In addition, the staff concludes, as described above, that the applicant has identified and appropriately characterized the seismic sources significant to determining the SSE for the ESP site, in accordance with RG 1.165 and SRP Section 2.5.1, and therefore satisfied 10 CFR 100.23(c) and GDC 2 in this respect. Based on the applicant's geological investigations of the site vicinity and the site area, the staff concludes that the applicant has properly characterized the site lithology, stratigraphy, geologic history, and structural geology. The staff also concludes that there is no potential for the effects of human activities (i.e., ground water withdrawal or mining activity) to compromise the safety of the site. Therefore, the staff concludes that the proposed ESP site is acceptable from a geological and seismological standpoint and meets the requirements of 10 CFR 100.23.

2.5.2 Vibratory Ground Motions

SSAR Section 2.5.2 describes the applicant's determination of the SSE ground motion at the ESP site from possible earthquakes in the site area and region. SSAR Section 2.5.2.1, "Seismicity," describes the earthquake catalog used for the ESP site; SSAR Section 2.5.2.2, "Geologic Structure and Tectonic Activity," summarizes the geologic structure and tectonic activity that could potentially result in ground motion at the ESP site; and SSAR Section 2.5.2.3, "Correlation of Earthquake Activity with Geologic Structure or Tectonic Province," describes the correlation of earthquake activity with geologic structures or tectonic provinces. SSAR Section 2.5.2.4, "Maximum Earthquake Potential," describes the maximum earthquake potential for seismic sources in the region surrounding the ESP site; SSAR Section 2.5.2.5, "Seismic Wave Transmission Characteristics of the Site," describes the seismic wave transmission characteristics of the site; SSAR Section 2.5.2.6, "Safe Shutdown Earthquake," provides the SSE ground motion spectrum; and SSAR Section 2.5.2.7, "Operating Basis Earthquake," provides the operating-basis earthquake (OBE) ground motion spectrum.

The applicant stated that the information provided in SSAR Section 2.5.2 of the ESP application uses the procedures recommended in RG 1.165 with certain exceptions. In addition, the applicant has decided to use the EPRI-SOG seismic source model for the CEUS as an input for its seismic ground motion calculations. RG 1.165 indicates that applicants may use the seismic source interpretations developed by LLNL (1993) or EPRI as inputs for a site-specific analysis. RG 1.165 also recommends a review and update, if necessary, of both the seismic source and ground motion models used to develop the SSE ground motion for the ESP site.

To determine if an update of the 1989 EPRI-SOG seismic source and ground motion models was necessary, the applicant reviewed the literature published since the mid-to-late 1980s. This literature review identified the need for changes in some of the seismic source characterization parameters, such as maximum magnitudes and recurrence intervals. In addition, the applicant determined that the ground motion modeling used for the 1989 EPRI-SOG seismic study needed to be updated. To assess the impact of each of these updates on the site hazard, the applicant performed sensitivity studies.

2.5.2.1 Technical Information in the Application

2.5.2.1.1 Seismicity

SSAR Section 2.5.2.1 describes the development of a current earthquake catalog for the ESP site. The applicant started with the original EPRI-SOG earthquake catalog, which covers the time period from 1777 to the beginning of 1985. To update the earthquake catalog, the applicant used information from the (1) National Center for Earthquake Engineering Research (NCEER), (2) USGS, and (3) Advanced National Seismic System (ANSS), formerly the Council of the National Seismic System. Of these three catalogs, the applicant primarily used the USGS National Hazard Mapping Catalog for the period of 1985 through 1995 (Frankel, et al., 2002) and the ANSS catalog for 1995 through June 2002. As shown in Figure 2.5.2-1, reproduced from Figure 2.1-11 of SSAR Appendix B, a comparison of the geographic distribution of earthquakes contained in the EPRI-SOG earthquake catalog (1777–1985) and the earthquakes contained in the updated catalog (1985–2002) shows a very similar spatial distribution.

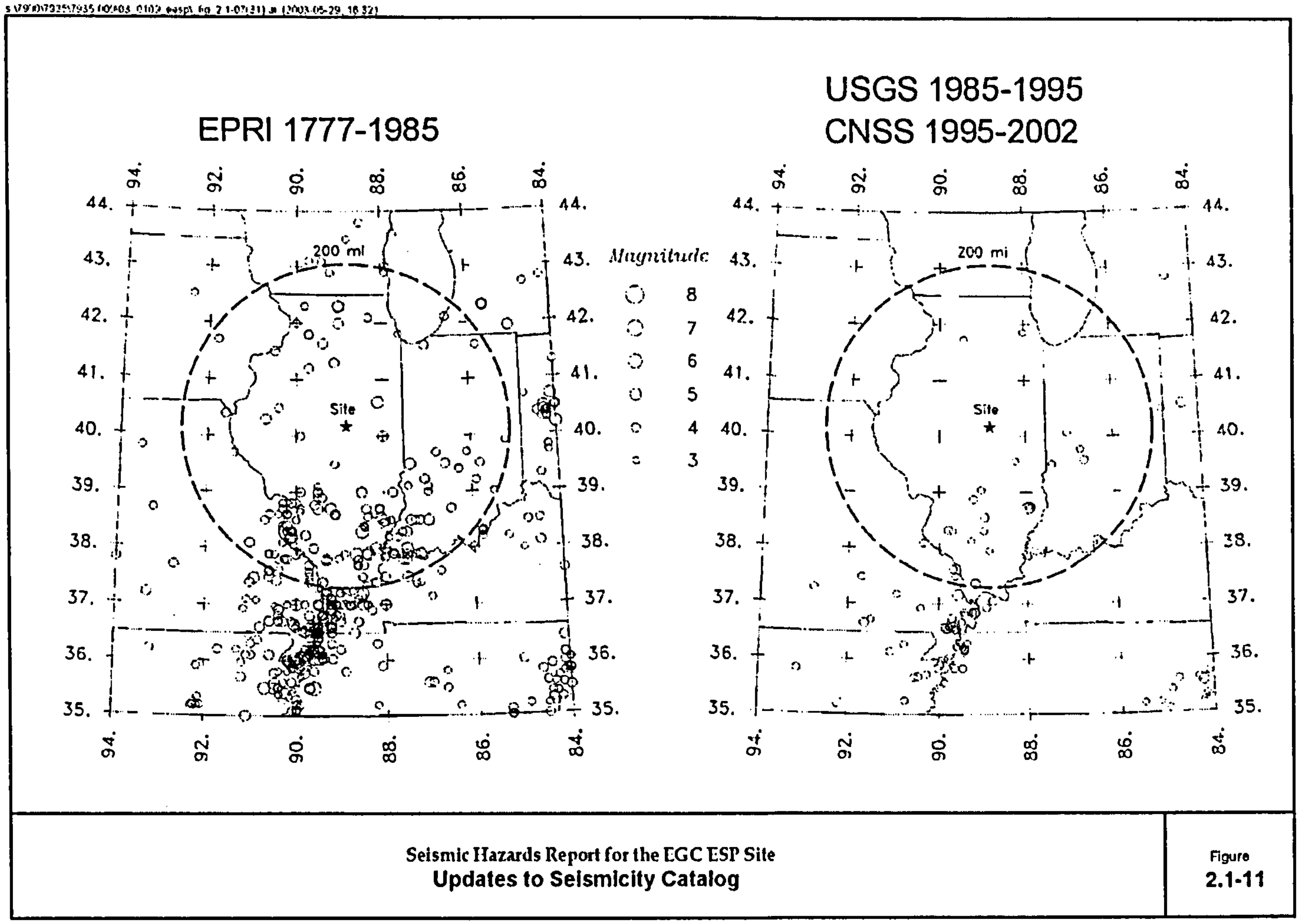


Figure 2.5.2-1 Updates to seismicity catalog

Significant additions to the original EPRI-SOG earthquake catalog include prehistoric earthquakes inferred from evaluation of prehistoric liquefaction information in the ESP site region. Paleoliquefaction features are generally identified along the cut banks of streams and include features such as sand boils or blows, dikes, and sills that intrude into an overlying layer of silt. By establishing the date and geographical distribution of these features, the applicant was able to estimate the earthquake magnitude that caused the paleoliquefaction features. Previous investigations of paleoliquefaction features at sites in the southern Illinois basin and parts of Indiana, Illinois, and Missouri have identified a number of episodes of paleoliquefaction that have been interpreted to have been caused by Holocene and latest Pleistocene earthquakes with estimated M_w of 6 to 7.8. The applicant stated that one set of these paleoliquefaction features was discovered approximately 30 miles southwest of the ESP site. These features are from an earthquake centered in the Springfield, Illinois, area that occurred between 5900 and 7400 years ago with an estimated magnitude range of 6.2 to 6.8.

To augment the paleoliquefaction studies covering the site region, the applicant performed additional field reconnaissance to search for additional paleoliquefaction features within a 25–30-mile radius of the ESP site. After analyzing the field reconnaissance results, the applicant concluded that evidence for an earthquake comparable to the postulated Springfield earthquake had not been observed in the study area. However, isolated features of mid-Holocene and latest Pleistocene age were observed in the study area and interpreted to be seismically induced. These features were discovered 11–13 miles from the ESP site; however, the small scale of the features and lack of evidence for similar features elsewhere in the study area led the applicant to conclude that they arose from a distant source or from a low-magnitude event. Additional older paleoliquefaction features were discovered 17 miles from the ESP site. In RAI 2.5.2-6, the staff asked the applicant to explain its selected paleoliquefaction study area along the streams near the ESP site. In response, the applicant stated that it selected locations along the Salt Creek, Sangamon River, and Mackinaw River to supplement previous liquefaction studies in this area. Further details of the applicant's field reconnaissance for paleoliquefaction features near the ESP site are provided in Section 2.1.4 and Attachment 1 to Appendix B to the ESP application.

As a result of the recent discoveries of prehistoric earthquakes in the site region and two recent earthquakes in the study region (M 5.0 in 1987 east of Olney, Illinois, and M 4.5 in 2002 in southern Indiana), the applicant determined that the range of maximum magnitudes assigned to the site region should be increased to include events comparable to the Springfield earthquake (M 6.2 to 6.8).

2.5.2.1.2 Geologic Structure and Tectonic Activity

SSAR Section 2.5.2.2 describes the geologic structure and activity that could result in seismically induced vibratory ground motions at the ESP site. The applicant's evaluation of the geologic structure and tectonic activity for the ESP site included a detailed update of the structural features (folds and faults) within the site region. The applicant indicated that the results of the information update on the structural features showed that the general structural picture remains the same. Table 2.1-1 in Chapter 2 of SSAR Appendix B provides a list of the status for each of the folds in the ESP site region. Similarly, Table 2.1-2 in Chapter 2 of SSAR Appendix B provides a list of the status for each of the faults in the ESP site region. In addition, each of the folds and faults are described by the applicant in Section 2.1.2 of SSAR

Appendix B. Rather than attempting to characterize the seismic potential of each of these folds and faults, the applicant defined broad seismic source zones that encompass many of these structural features. These broad seismic source zones are termed areal source zones. The staff's detailed evaluation of the seismogenic potential of the structural features is presented in Section 2.5.1.1.1 of this SER.

Within a 200-mile radius of the site (or just beyond), the two major sources of potential earthquakes are the NMSZ and the WVSZ in southern Illinois and southern Indiana. The New Madrid region was the location of three earthquakes in 1811–1812, which are the largest earthquakes recorded in the CEUS. The Wabash Valley region is a zone of elevated seismicity in which a number of paleoearthquakes have been identified. In addition to the NMSZ and WVSZ, evidence from recent paleoliquefaction studies and seismic reflection data show that significant earthquakes may occur in parts of the central Illinois basin where there are no obvious folds or faults at the surface. The applicant stated that the location, size, and recurrence of such events are not well constrained by available data. However, because of the paleoliquefaction evidence, the applicant developed a background source zone for this region, referred to as the central Illinois basin background source zone.

Since the EPRI-SOG seismic study for the CEUS, several studies have focused on the NMSZ and WVSZ. These studies include extensive paleoliquefaction investigations, acquisition and reprocessing of shallow seismic reflection data, paleoseismic trenching and mapping investigations, and seismological studies. These studies have used a variety of techniques to characterize the location, magnitudes, and seismic activity rates of the NMSZ and WVSZ. A complete description of the NMSZ and WVSZ is provided in Section 2.1 of SSAR Appendix B. In addition, the applicant's incorporation of the new information on the NMSZ and WVSZ into its PSHA is provided in Section 3.0 of SSAR Appendix B. The staff's evaluation of the applicant's characterization of the NMSZ and WVSZ is contained in Section 2.5.1.1.1 of this SER; the applicant's incorporation of the new information on these two source zones is provided below in Section 2.5.2.1.3 of this SER.

The ESP site is located within the Illinois basin in the SCR of the North American craton, which is characterized by low rates of historical seismicity. The Illinois basin is a spoon-shaped depression covering parts of Illinois, Indiana, and Kentucky. The Illinois basin is bounded on the north by the Wisconsin arch, on the east by the Kankakee and Cincinnati arches, on the south by the Mississippi embayment, and on the west by the Ozark dome and Mississippi River arch. Basement elevation ranges from approximately -2,950 ft in the northern end of the Illinois basin to -14,100 ft in southeastern Indiana.

The ESP site lies within a compressive midplate stress province characterized by a relatively uniform compressive stress field with the maximum horizontal stress oriented northeast to east-northeast. The applicant reported that preliminary results from a global positioning system (GPS) network in the southern Illinois basin provide evidence for present-day tectonic strain in the WVSZ. However, given the current level of error in individual GPS observations, an extended period of time will be required before these observations can fully characterize the strain field and confirm the postulated tectonic motions. Recent geodetic measurements in the NMSZ indicate that the rate of strain accumulation is below the current detection threshold. However, the applicant concluded that these observations are not inconsistent with a model of seismicity in intraplate regions as a transient phenomenon localized along weak zones in the crust.

2.5.2.1.3 Correlation of Earthquake Activity with Geologic Structure or Tectonic Province

SSAR Section 2.5.2.3 describes the evaluation of recent geological and seismological information and how this information was used to perform a new PSHA. Chapter 3 of SSAR Appendix B provides a more detailed account of the incorporation of new information for the ESP PSHA..

The original EPRI-SOG PSHA indicated that the most significant contributors to the seismic hazard at the ESP site are the NMSZ, the WVSZ, and the random background event in the local source zone (central Illinois basin background source zone). SER Section 2.5.1.1.1 provides a description of each of these three seismic source zones. After evaluating recent information on these three source zones, other potential sources in the site region, and ground motion estimation, the applicant made the following determinations regarding (1) earthquake recurrence rates, (2) maximum magnitudes, and (3) ground motion attenuation.

Earthquake Recurrence Rates. The applicant focused on the recurrence rates for the NMSZ, WVSZ, and central Illinois basin background source zone since these three source zones are the main contributors to the total seismic hazard at the ESP site. Comparing the updated catalog (with an additional 17 years of earthquake data) to the original EPRI-SOG catalog, the applicant concluded that the recurrence rates used for the EPRI-SOG study are still valid. In addition to the smaller recorded events over the past 17 years, the applicant also included the additional prehistoric events that have occurred in the three source zones as revealed by paleoliquefaction studies. The applicant found that for the central Illinois basin and the Wabash Valley source zones, the fit of the earthquake recurrence relationships to the recorded seismicity envelops the rates of larger earthquakes estimated from paleoliquefaction data. However, for the NMSZ, the applicant found that recent paleoliquefaction data provide evidence that large-magnitude earthquakes have occurred on the NMSZ faults more frequently than the seismicity rates specified in the EPRI-SOG source characterizations for the NMSZ.

New Madrid Seismic Zone Characteristic Earthquake Modeling

Recent seismologic, geologic, and geophysical studies have associated faults within the NMSZ with the three large-magnitude historical earthquakes (NM1, NM2, and NM3) that occurred during the 1811–1812 sequence. These three faults are (1) the NS fault, (2) the NN fault, and (3) the RF. These faults are also believed to be the causative faults for previous NMSZ earthquake sequences occurring around AD 1450 ± 150, AD 900 ± 100, AD 490 ± 50, AD 300 ± 200, and BC 1370 ± 970. The applicant modeled these large seismic events within the NMSZ as characteristic earthquakes, which means that these three faults repeatedly generated earthquakes of similar size during each of the previous earthquake sequences. The applicant found that these similarly sized characteristic earthquakes occur more frequently than would be implied by extrapolation of the recurrence of low-magnitude events in the NMSZ. As such, the applicant focused on the characterization of these characteristic large-magnitude events within the NMSZ. The key source parameters considered by the applicant for the NMSZ are (1) the fault source geometry, (2) characteristic earthquake magnitude, and (3) characteristic earthquake recurrence.

The three fault sources included in the updated characterization of the central fault system of the NMSZ are the NS, NN, and RF. The applicant characterized the uncertainty regarding the location and extent or length of the causative faults that ruptured during the 1811–1812 and other characteristic earthquake sequences by weighting alternative fault source geometries for each of the three fault sources of the NMSZ central fault system. These alternative geometries affect the distance from the earthquake rupture to the ESP site. The weights assigned to each of the alternative source geometries are based on recently published studies of the NMSZ.

Next, the applicant considered the magnitude for the characteristic earthquakes on the three New Madrid fault sources. The uncertainty in the magnitude estimates for the 1811–1812 earthquakes is largely caused by the subjective nature of interpretations of historical accounts, the lack of historical accounts in many areas (especially to the west of the NMSZ), and the lack of large recent earthquakes in the eastern United States that could be used to calibrate the intensity values from eyewitness accounts to actual ground motion values. For the ESP application, the applicant assigned weights for the characteristic earthquake magnitudes to each of the major faults within the central NMSZ. The magnitude estimates are weighted based on consideration of the published values estimated from intensity data and from estimates of rupture area for individual fault segments. For the NS fault, which is thought to be the source for NM1, the probability distribution for the characteristic magnitude is M 7.3 (0.4), M 7.7 (0.5), and M 8.1 (0.1). For the NN fault, which is thought to be the source for NM2, the probability distribution for the characteristic magnitude is M 7.0 (0.45), M 7.4 (0.45), and M 7.8 (0.1). Finally, for the RF, thought to be the source of NM3, the probability distribution for the characteristic magnitude is M 7.2 (0.2), M 7.4 (0.4), M 7.6 (0.3), and M 8.0 (0.1). For the earlier NMSZ characteristic earthquake sequences (pre-1811–1812), the applicant also assumed that these sequences consisted of multiple, large-magnitude earthquakes. As such, the applicant considered each characteristic earthquake to be the rupture of multiple (two to three) of the NMSZ fault sources.

In RAI 2.5.2-5, the staff asked the applicant to justify its modeling of the relative frequency of event sequences in the NMSZ. Specifically, the staff noted that Tuttle et al. (2002) concluded that all three sources (RF, NN, and NS) ruptured in each of the three sequences, but that one-third of the time the NN rupture may have been smaller than for the 1811–12 sequence, and one-third of the time NS may have been smaller than in 1811–1812. Tuttle et al. (2002) also concluded that these smaller earthquakes are at least magnitude M 7 events. This result differs from the event sequence modeling used by the applicant for NMSZ, which does not include NN or NS for some of the event sequences. The applicant responded to RAI 2.5.2-5 by stating that if the size of the 1811–1812 ruptures on these faults were in the low-magnitude M 7 range (e.g., values estimated by Bakun and Hooper (2003)), then the size of previous ruptures would have been below magnitude M 7. These smaller ruptures, which would be considered dependent events, were not included in the hazard calculations as characteristic earthquakes. SER Section 2.5.2.3.3 provides further detail on the applicant's response to RAI 2.5.2-5 as well as the staff's evaluation of the applicant's response.

After consideration of the magnitudes for characteristic earthquakes from the NMSZ, the applicant examined recently published studies dealing with the recurrence of the characteristic events. The best constraints on recurrence of characteristic NMSZ events are from paleoliquefaction studies throughout the New Madrid region and paleoseismic investigations of the RF scarp and associated fold. Paleoseismic studies of the NMSZ have found that the fault system responsible for the New Madrid seismicity generated temporally clustered, very large earthquakes in AD 900 ± 100 and AD 1450 ± 150, as well as during 1811–1812. In addition, these studies have found evidence for prehistoric sand blows that are compound structures, resulting from multiple earthquakes closely clustered in time (i.e., earthquake sequences) occurring around AD 490 ± 50, AD 300 ± 200, and BC 1370 ± 970. The applicant fit the time intervals between these dates with two recurrence models, a Poissonian model and a lognormal model. The applicant weighted each model equally. Figure 4.1-1 in SSAR Appendix B shows a logic tree with the different recurrence models and the intervals between NMSZ characteristic events. For example, the time intervals and weights for the Poisson model are 187 years (0.10), 294 years (0.24), 443 years (0.31), 704 years (0.24), and 1389 years (0.10).

As stated above, the applicant concluded, based on its review of the literature, that the RF has ruptured in each of the previous three characteristic earthquake sequences, but the NN and NS sources may not have produced large earthquakes in all three sequences. The applicant used these observations to set the relative frequency of event sequences in the NMSZ as (1) rupture of all three sources (NN, RF, and NS) one-third of the time, (2) rupture of NN and RF one-third of the time, and (3) rupture of NS and RF one-third of the time.

Maximum Magnitudes. The applicant focused on the maximum magnitude values for the NMSZ, WVSZ, and central Illinois basin background seismic source zone, since these three source zones are the main contributors to the total seismic hazard at the ESP site. For the NMSZ, the applicant compared the maximum magnitude range used for the EPRI-SOG study, which is 7.2 to 8.8, with the maximum magnitudes that have been published recently, which range from 7.4 to 8.2. As a result, the applicant concluded that the recent maximum magnitudes for the NMSZ are consistent with the EPRI-SOG experts' assessments. For the WVSZ, the maximum magnitudes used for the EPRI-SOG study range from 5.0 to 8.0, while recently published maximum magnitudes range from 7.0 to 7.8. Similarly, for the central Illinois background source zone, the maximum magnitudes used for the EPRI-SOG study range from 4.3 to 7.6, while recently published maximum magnitudes range from 6.0 to 7.0. As a result, the applicant concluded, as described below, that the maximum magnitude values for both the WVSZ and the central Illinois background source zone need to be increased to reflect the magnitudes implied by the new paleoliquefaction data.

Wabash Valley-Southern Illinois Source Zone—Maximum Magnitude Distribution

The applicant stated that the updated maximum magnitude distribution for the Wabash Valley-Southern Illinois source zone is based on recent analysis of paleoliquefaction features in the vicinity of the lower Wabash Valley of southern Illinois and Indiana. The magnitude of the largest paleoearthquake in the lower Wabash Valley (the Vincennes-Bridgeport earthquake), which occurred 6011 ± 200 years BP, was estimated to be between 7.2 to 7.8. The next largest earthquake occurred 12,000 ± 1,000 years BP. This earthquake is estimated to be an M 7.1 to 7.2. Both of these earthquakes were in proximity to one another and took place in the general vicinity of the more recent and strongest historical earthquakes (M 4 to 5.5) in the lower Wabash Valley. Based on the above information, the applicant used the following maximum magnitude range for earthquakes in the Wabash Valley region—M 7.0 (0.1), M 7.3 (0.4), M 7.5 (0.4), and M 7.8 (0.1). The highest weight is given to the range from M 7.3 to 7.5 where most of the magnitude estimates lie.

Central Illinois Basin/Background Source Zone—Maximum Magnitude Distribution

The applicant stated that evidence from recent paleoliquefaction studies suggests that significant earthquakes may occur in parts of the central Illinois basin where there are no obvious surface faults or folds. The location, size, and recurrence of these earthquakes are not well constrained by available data. One known earthquake is the M 6.2 to 6.8 prehistoric Springfield earthquake, located approximately 30 miles to the southwest of the ESP site. At present, the moderate-size prehistoric earthquakes in the central Illinois basin cannot be associated clearly with any known geologic structure, and no seismicity trends have been observed for this region. The applicant stated that paleoliquefaction evidence suggests that there may have been additional moderate-magnitude events in central and southern Illinois, such as the Shoal Creek earthquake which occurred about 5700 years BP. In addition to a literature review, the applicant conducted its own field reconnaissance north and east of the ESP site. Some paleoliquefaction features were discovered, but the applicant stated that the data are too limited to provide a basis for estimating the size or location of the event or events. The applicant also concluded that there have not been repeated moderate to large events (comparable to the Springfield earthquake) in the vicinity of the ESP site in the latest Pleistocene to Holocene time (6,000 to 7,000 years BP). A study of earthquakes in SCRs conducted by EPRI in 1994 (Johnston, et al., 1994) specifically addresses the problem of defining a maximum magnitude for regions that are characterized by the rare occurrence of maximum earthquakes and the lack of recognized surface expression or well-defined seismicity patterns associated with seismic sources, typical conditions over much of the CEUS. The 1994 EPRI study developed worldwide databases that could be used for assessments of maximum magnitudes for seismic sources in the CEUS. Using the database and method found in the 1994 EPRI study, the applicant developed the following maximum magnitude range for earthquakes in the central Illinois basin background source—M 6.2 (0.4), M 6.4 (0.3), M 6.6 (0.2), and M 6.8 (0.1).

In RAI 2.5.2-4, the staff asked the applicant to provide further detail and justification regarding its use of the 1994 EPRI study and accompanying worldwide database of earthquakes. Specifically, the staff requested the applicant to explain why its maximum magnitude for central Illinois should not be set at 6.8 since the two largest SCR earthquakes from nonextended crust are the Accra, Ghana, earthquake of 1862 (M 6.75 ± 0.35) and the Meeberrie, Western Australia, earthquake of 1941 (M 6.78 ± 0.25). In its response to RAI 2.5.2-4, the applicant stated that the method developed by the 1994 EPRI study does not start from the assumption that all SCR domains have the same maximum magnitude potential. Instead it assumes that there are characteristics that control the maximum size of an earthquake that can occur in an individual SCR domain, and these characteristics vary from domain to domain. SER Section 2.5.2.3.3 provides further detail on the applicant's response to RAI 2.5.2-4 as well as the staff's evaluation of the applicant's response.

<u>Ground Motion Attenuation</u>. The original EPRI-SOG study used three attenuation relationships, developed in the mid-1980s. Since the completion of the EPRI-SOG study, estimating ground motions in the CEUS has been the focus of considerable research. Following the guidance provided in NUREG/CR-6372, "Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and Use of Experts," prepared by the Senior Seismic Hazard Analysis Committee, EPRI completed in 2003 a study to characterize the distribution of ground motion prediction in the CEUS (EPRI 1008910, "CEUS Ground Motion Project: Model Development

and Results"). For the EPRI study, a panel of six ground motion experts was assembled, and, during a series of workshops, the experts provided advice on the available CEUS ground motion attenuation relationships. In addition, the experts provided information on the appropriate criteria for evaluating the ground motion attenuation relationships. The product of the EPRI study is a suite of ground motion relationships and associated relative weights that represent the uncertainty in predicting median levels of ground motion. The EPRI study grouped the selected ground motion attenuation relationships into four clusters, in which each cluster represents a group of models based on a similar approach for ground motion modeling. After comparing the three attenuation models used for the EPRI-SOG study with the new EPRI ground motion study, the applicant concluded that the recent median ground motion models are generally consistent with two of the three older models. However, the estimates of uncertainty or variability about the median ground motion predictions are considerably higher for the recent ground motion attenuation relationships compiled by the recent EPRI study compared to the uncertainty in the ground motion used for the original EPRI-SOG study.

In RAI 2.5.2-3, the staff asked the applicant to describe how the recent EPRI ground motion study converted the distance measure used for each of the attenuation relationships to a common measure. Specifically, the 13 CEUS attenuation relationships selected by the EPRI ground motion experts each use one of two different distance measures. In response to RAI 2.5.2-3, the applicant provided a description of the method it used to convert the "point-source" distance measure to the more commonly used "Joyner-Boore" distance measure. SER Section 2.5.2.3.3 provides further detail on the applicant's response to RAI 2.5.2-3 as well as the staff's evaluation of the applicant's response.

In summary, from the data obtained after the original EPRI-SOG study, the applicant concluded the following:

> (1) there are no additional specific seismic sources in the site region, (2) with the exception of large [characteristic] earthquakes occurring on the central faults in the NMSZ, the EPRI-SOG recurrence parameters provide a good estimate of the current rate of seismicity in the study region, (3) the maximum magnitude distributions for the central Illinois and Wabash Valley/Southern Illinois source zones developed by the EPRI-SOG expert teams likely underestimate what would be assessed give the present state-of-knowledge, and (4) current ground motion models for the CEUS are generally consistent with the median models used in the EPRI-SOG study. However, the aleatory variability about the median ground motions used in the EPRI-SOG study is generally lower than current estimates.

As a result of the above conclusions, the applicant made the following adjustments to the source parameters and ground motion relationships as part of sensitivity tests for the seismic hazard characterization of the ESP site:

- Set the mean return period for large characteristic earthquakes on the central faults of the NMSZ to 500–1000 years.
- Increase the maximum magnitude distributions of the WVSZ and central Illinois sources.

- Use updated attenuation models.

After implementing the above adjustments to the seismic source characterizations and ground motion models, the applicant concluded that the resulting seismic hazard curves are generally higher for the ESP site. The applicant implemented each of the above adjustments individually and then made comparisons with the earlier EPRI-SOG hazard curves for the ESP site. In addition, the applicant implemented each of the above adjustments simultaneously and made similar comparisons. For both cases, the applicant considered the change in the seismic hazard levels to be significant enough to perform an updated PSHA for the ESP site.

2.5.2.1.4 Maximum Earthquake Potential

SSAR Section 2.5.2.4 presents the maximum earthquake potential for the ESP site in terms of the controlling earthquake magnitudes and distances. The applicant determined the low- and high-frequency controlling earthquakes by deaggregating the PSHA results at selected probability levels. Before determining the controlling earthquakes, the applicant updated the original EPRI-SOG PSHA using the seismic source zone adjustments and new ground motion modeling described above in the previous SER subsection.

PSHA Results. The applicant performed the PSHA by combining the hazard from the EPRI-SOG seismic sources (with updated maximum magnitude distributions) with the hazard from the New Madrid characteristic earthquake sources. The applicant assumed that the characteristic earthquake ruptures on the New Madrid faults rupture along the entire length of the fault, and the closest approach of the fault to the ESP site was used as the distance to the rupture. In addition, the applicant assumed that the characteristic earthquakes occurring on the central New Madrid faults rupture as clustered events or as a sequence within a short time period relative to the return period for the events.

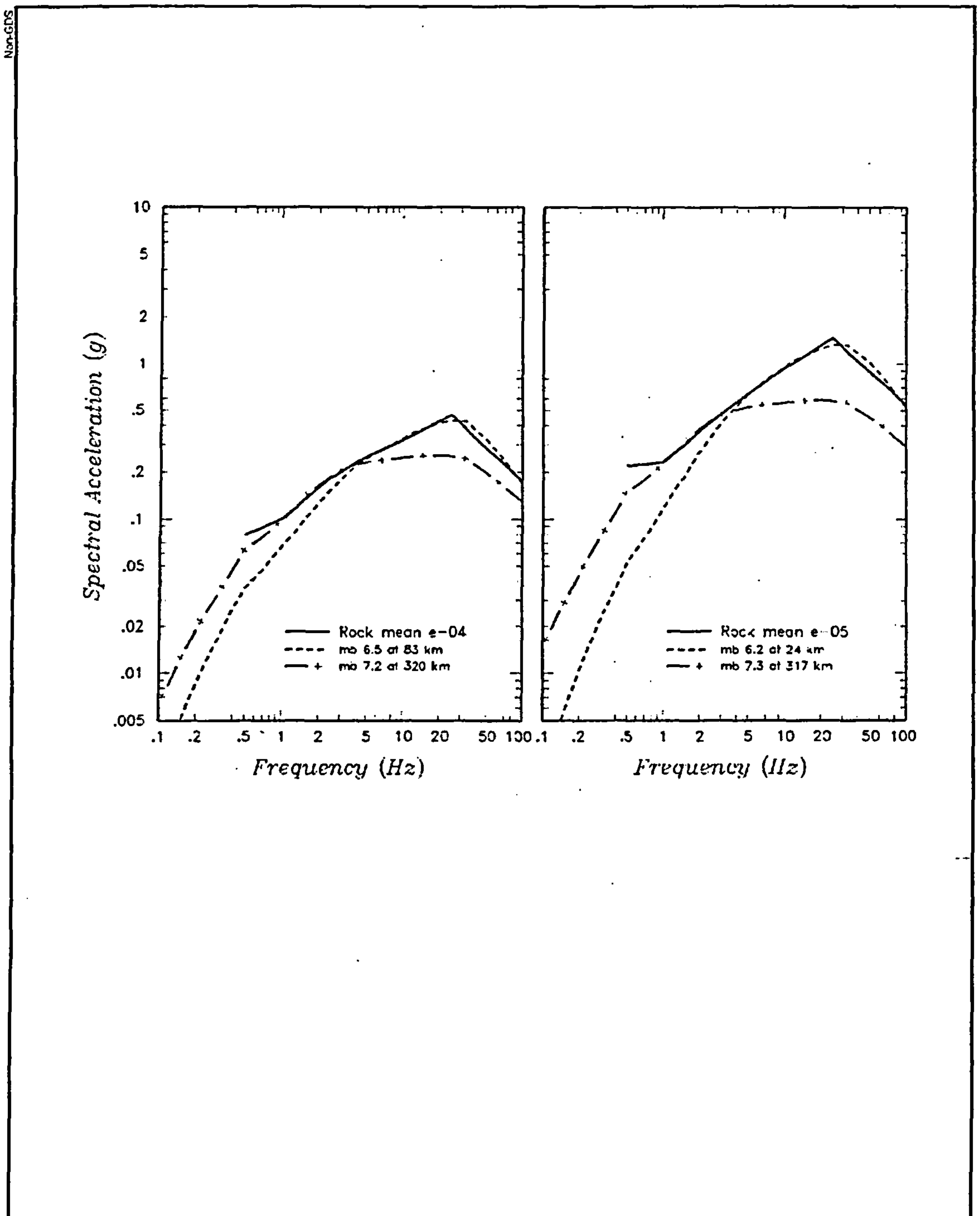
The applicant performed PSHA calculations for peak ground acceleration (PGA) and spectral acceleration at frequencies of 25, 10, 5, 2.5, 1, and 0.5 Hz. Following the guidance provided in RG 1.165, the PSHA calculations were performed assuming generic hard rock site conditions (i.e., a shear- (S-) wave velocity of 9200 ft/s). The actual local site characteristics are incorporated in the calculation of the SSE spectrum, which uses the hard rock PSHA hazard results as the starting point. To compare the relative contribution of each of the dominant seismic source zones to the total hazard, the applicant computed PSHA results for the central Illinois basin background source, Wabash Valley, and New Madrid individually. At low ground motion levels, the distant Wabash Valley and New Madrid characteristic earthquakes produce the highest hazard. As the ground motion level increases, the local central Illinois background source becomes the dominant contributor to the hazard for high-frequency ground motions.

Controlling Earthquakes. To determine the low- and high-frequency controlling earthquakes for the ESP site, the applicant followed the procedure outlined in Appendix C to RG 1.165. This procedure involves the deaggregation of the PSHA results at a target probability level to determine the controlling earthquake in terms of a magnitude and source-to-site distance. The applicant chose to perform the deaggregation of the mean 10^{-4} and 10^{-5} PSHA hazard results. The low- and high-frequency controlling earthquakes are shown below in Table 2.5.2-1.

Table 2.5.2-1 High- and Low-Frequency Controlling Earthquakes

Hazard	Magnitude (m_b)	Distance
Mean 10^{-4} High Frequency (5 and 10 Hz)	6.5	83 km (52 mi)
Mean 10^{-4} Low Frequency (1 and 2.5 Hz)	7.2	320 km (199 mi)
Mean 10^{-5} High Frequency (5 and 10 Hz)	6.2	24 km (15 mi)
Mean 10^{-5} Low Frequency (1 and 2.5 Hz)	7.2	320 km (199 mi)

For the high-frequency mean 10^{-4} hazard, the controlling earthquake is a magnitude 6.5 event occurring at a distance of 83 km (52 mi), corresponding to an earthquake from the Wabash Valley-southern Illinois source zone. In contrast, for the high-frequency 10^{-5} hazard, the controlling earthquake has a magnitude of 6.2 at a distance of only 24 km (15 mi). This controlling earthquake is from the nearby central Illinois background source zone. For the low-frequency mean 10^{-4} and 10^{-5} hazard, the controlling earthquake has a magnitude of 7.2 at a distance of 320 km (199 mi). This earthquake corresponds to an event in the NMSZ. The ground motion response spectra for these controlling earthquakes are shown below in Figure 2.5.2-2, which is reproduced from Figure 4.2-19 in SSAR Appendix B. The applicant used the EPRI 2003 ground motion relationships to estimate the ground motion response spectra for the controlling earthquakes.



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Reference Earthquake (RE) Response Spectra for Mean 10^{-4} and Mean 10^{-5} Hazard

Figure 4.2-19

Figure 2.5.2-2 Reference earthquake response spectra for mean 10^{-4} and mean 10^{-5} hazard

2.5.2.1.5 Seismic Wave Transmission Characteristics of the Site

SSAR Section 2.5.2.5 describes the method used by the applicant to develop the site free-field ground motion spectrum. The hazard curves from the PSHA are defined for generic hard rock conditions. According to the applicant, these hard rock conditions exist at the ESP site at a depth of several thousand feet or more below the ground surface. To determine the free-field ground motion, the applicant (1) developed soil/rock profile models for the ESP site, (2) selected seed earthquake time histories, and (3) performed the final site response analysis.

ESP Profile Model. The soil profile model used by the applicant for its site response analysis is shown in SSAR Figure 2.5-3. The profile consists of a thin layer of loess underlain by interbedded glacial tills and lacustrine (lake) deposits of Quaternary age to a depth of nearly 300 ft. For the 310-ft soil column at the ESP site, the applicant used the S-wave velocity (V_s) values from its ESP geophysical surveys, which are described in SER Section 2.5.4.1.4. SER Figure 2.5.4-5 shows the compressional- (P-) wave velocity (V_p) and V_s for each of the different soil layers to a depth of about 300 ft below the ground surface. As described in SER Section 2.5.4.1.2, the applicant conducted cyclic testing of the ESP site soils to determine the variation in soil shear strain modulus and material damping ratio with shearing strain amplitude. Based on the dynamic test results, the applicant selected appropriate shear modulus and damping curves for the ESP site.

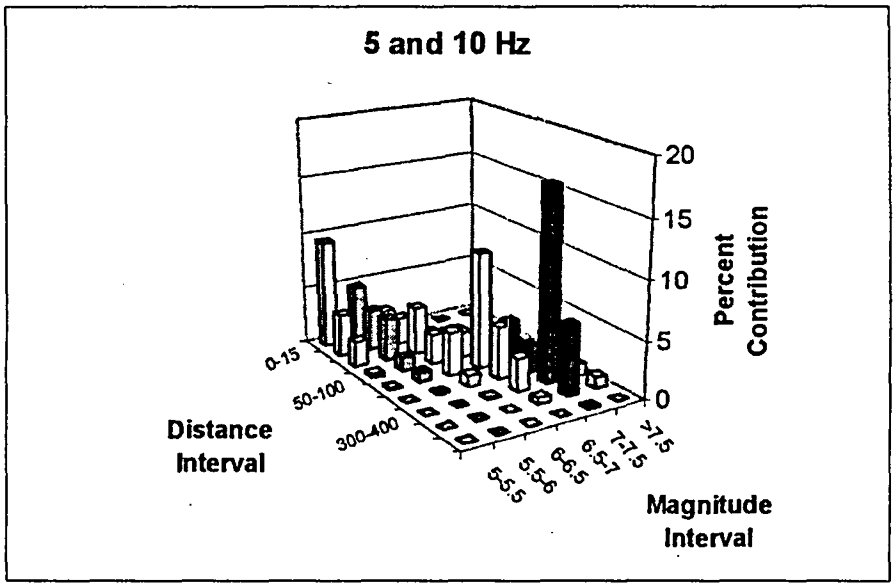
As a result of the large range in S-wave velocities for some of the soil layers (Table 5-2 in SSAR Appendix A) and the differences in standard penetration test (SPT) blowcount values for ESP borings B1 and B4 compared to those of B2 and B3, the staff in RAI 2.5.4-4 requested that the applicant justify the appropriateness of using a single "average" soil column for the site response analyses rather than including a number of different base-case soil columns. In response to RAI 2.5.4-4, the applicant stated that it modeled the variations in S-wave velocity and SPT blowcounts by statistically creating a large number of profiles, or realizations, and conducting the site response analyses using these profiles. SER Section 2.5.2.3.5 provides further detail on the applicant's response to RAI 2.5.4-4 as well as the staff's evaluation of the applicant's response.

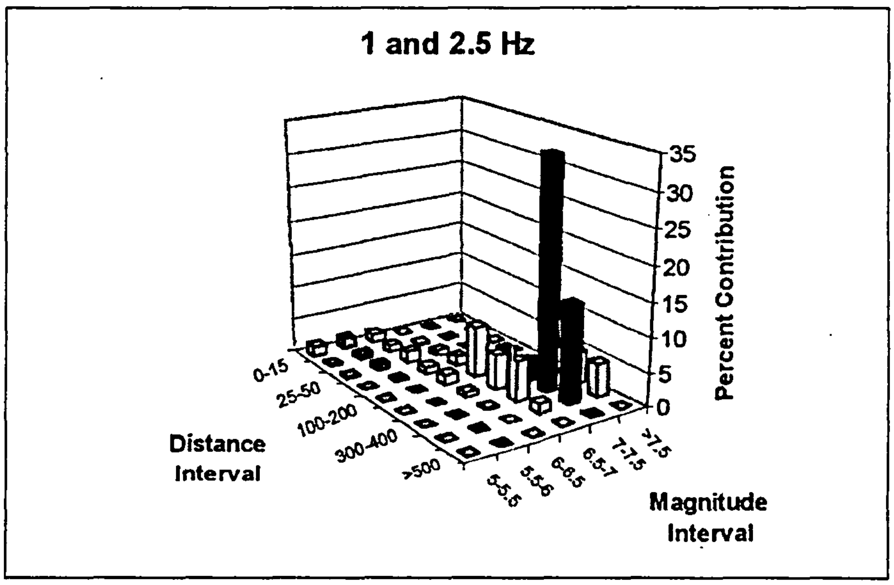
At a depth of approximately 300 ft is the top of the bedrock, which consists of limestone, shale, sandstone, siltstone, and a single 1-ft-thick interval of coal. The bedrock is of Pennsylvanian age. The applicant characterized the dynamic properties of this soil/bedrock profile during field and laboratory testing. These dynamic properties consisted of S-wave velocity data to a depth of 310 ft and a set of shear modulus reduction and damping data obtained from samples taken from boreholes drilled at the ESP site. Since the V_s at a depth of 310 ft below the ESP site is about 4000 ft/s, the applicant used nearby deep borehole V_p measurements to estimate the bedrock V_s profile. The applicant assumed V_p/V_s ratios of 1.73 and 2, which correspond to depths of 1900 ft and 3000 ft to reach the hard rock value of V_s = 9200 ft/s. In addition, for the sedimentary rocks below a depth of 310 ft, the applicant assumed a linear behavior during earthquake shaking. The damping values used by the applicant for the sedimentary rocks vary from 3.3 percent at depths ranging from 310 to 400 ft to 1.8 percent for rocks at a depth of 1200 to 1900 ft.

Once the applicant determined the appropriate soil and rock dynamic properties, it modeled the variability present in the site data by randomizing the soil and rock S-wave velocity profiles, soil shear modulus and damping relationships, and rock damping values. The applicant generated 60 soil/rock profiles to account for variability in the site properties.

To account for the variability in soil shear strain modulus and material damping ratio with shearing strain amplitude, the applicant randomized the shear modulus and damping curves used for the site response analysis. In RAI 2.5.4-7, the staff asked the applicant to explain how these curves were used in the randomization process with respect to both the different depth ranges and the soil types occurring within those depth ranges. In response to RAI 2.5.4-7, the applicant stated that the computation performed for the EGC ESP project resulted in 60 modulus reduction curves and 60 material damping curves for each of the depth intervals. The range represented by each of the 60 sets of curves is intended to cover the uncertainties in the shape and absolute value of the modulus reduction and material damping ratio curves resulting from a number of different effects, including the particular soil type, the stress history for the soil, sample disturbance associated with the laboratory testing of soil samples, and random variability that is typically observed in laboratory testing programs. SER Section 2.5.2.3.5 provides further detail on the applicant's response to RAI 2.5.4-7 as well as the staff's evaluation of the applicant's response.

Earthquake Time Histories. Using the controlling earthquake (low- and high-frequency) magnitudes and distances listed above in Table 2.5.2-1, the applicant developed hard rock site response spectra using the EPRI (2003) ground motion models and then scaled these spectra to match the ESP site rock spectral accelerations at 1 and 2.5 Hz (low frequency) and 5 and 10 Hz (high frequency). However, instead of using these two rock response spectra to develop the ESP site response, the applicant determined an additional three "deaggregation earthquakes" for each controlling earthquake. These three deaggregation earthquakes represent a more complete range of the earthquakes that contribute to the low-frequency (1 and 2.5 Hz) and high-frequency (5 and 10 Hz) hazard than just a single controlling earthquake. To illustrate, Figure 2.5.2-3, reproduced from Figure 4.1-20 in SSAR Appendix B, shows the deaggregation results for the mean 10^{-4} hazard. The high-frequency controlling earthquake has a magnitude of 6.5 and distance of 83 km (52 mi). The three high-frequency deaggregation earthquakes at the mean 10^{-4} hazard level and their weights are $m_b = 5.7$ at 15 km (0.377), $m_b = 6.7$ at 153 km (0.322), and $m_b = 7.2$ at 375 km (0.301). As shown below in Table 2.5.2-2, there are three deaggregation earthquakes for each controlling earthquake.





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Deaggregation Results for Mean 10^{-4} Hazard

Figure 4.1-20

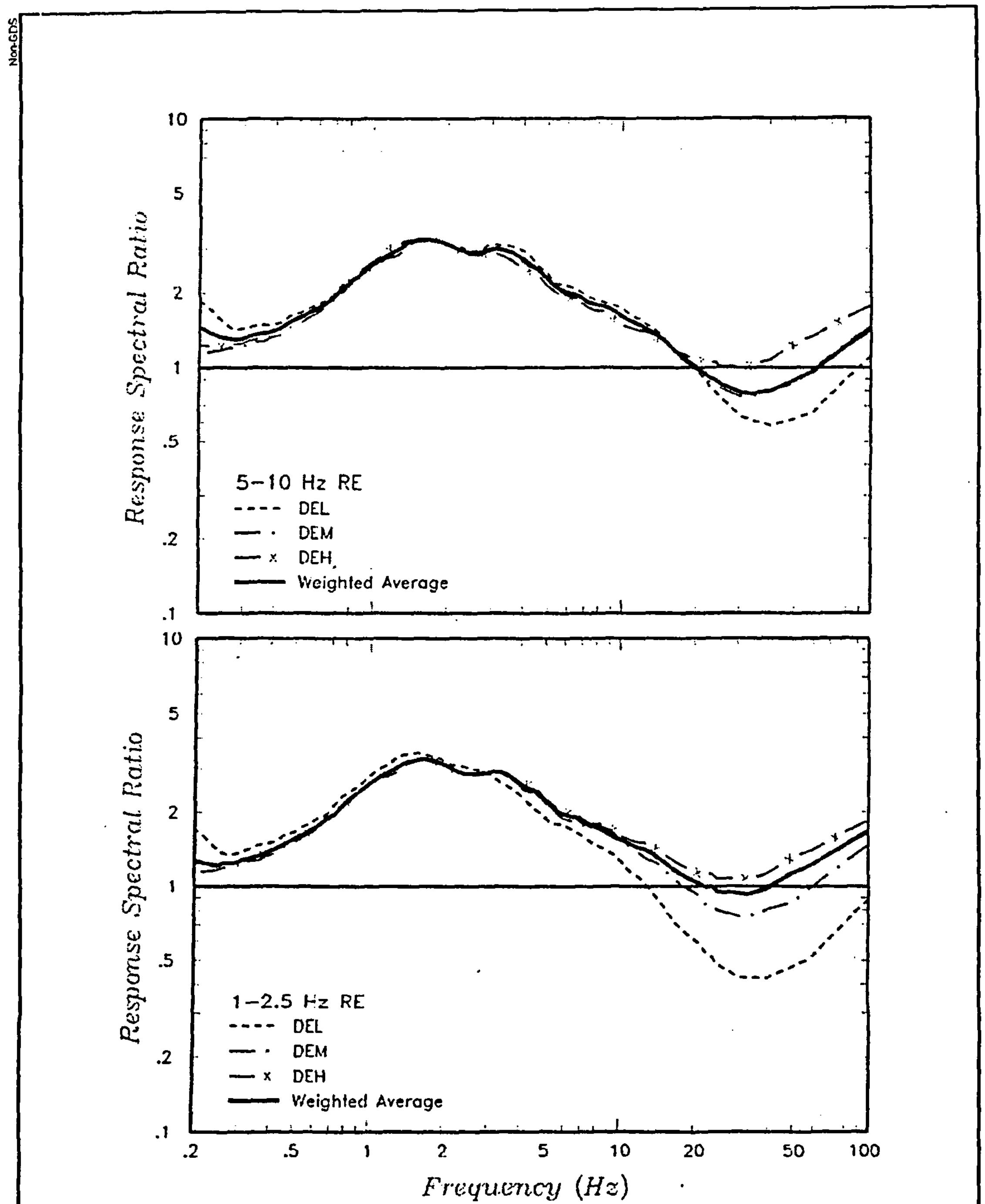
Figure 2.5.2-3 Deaggregation results for mean 10^{-4} hazard

Table 2.5.2-2 Controlling and Deaggregation Earthquakes

Hazard	Controlling Earthquake		Deaggregation Earthquakes		
	Magnitude (m_b)	Distance	Magnitude (m_b)	Distance	Weight
mean 10^{-4} 5 and 10 Hz	6.5	83 km (52 mi)	5.7 6.7 7.2	15 km (9 mi) 153 km (95 mi) 375 km (233 mi)	0.377 0.322 0.301
mean 10^{-4} 1 and 2.5 Hz	7.2	320 km (199 mi)	5.9 6.8 7.3	15 km (9 mi) 166 km (103 mi) 379 km (236 mi)	0.093 0.240 0.667
mean 10^{-5} 5 and 10 Hz	6.2	24 km (15 mi)	5.8 6.8 7.4	11 km (7 mi) 140 km (87 mi) 380 km (236 mi)	0.733 0.149 0.118
mean 10^{-5} 1 and 2.5 Hz	7.2	320 km (199 mi)	6.0 6.9 7.4	12 km (7 mi) 155 km (96 mi) 381 km (237 mi)	0.212 0.220 0.568

To determine the ESP dynamic site response, the applicant developed appropriate ground motion or earthquake time histories for each of the 12 deaggregation earthquakes. The applicant selected these earthquake time histories from the CEUS time history library provided with NUREG/CR-6728, "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard and Risk Consistent Ground Motion Spectral Guidelines." This library contains recordings divided into magnitude and distance ranges, each containing 30 time histories. The applicant scaled each of the 30 time histories to match the response spectrum for the corresponding deaggregation earthquake.

Site Response Analysis. To determine the final site response, the applicant used the program SHAKE to compute the site amplification function for each deaggregation earthquake. The applicant paired the 60 randomized velocity profiles with the 60 sets of randomized shear modulus and damping curves (i.e., one velocity profile with one set of modulus reduction and damping curves). To obtain a site amplification function, the applicant divided the response spectrum from the computed surface motion by the response spectrum from the input hard rock motion. The applicant then computed the arithmetic mean of these 60 individual response spectral ratios to define the mean amplification function for each deaggregation earthquake. Figure 2.5.2-4, reproduced from Figure 4.2-23 in SSAR Appendix B, shows the computed high- and low-frequency average site amplification functions for the mean 10^{-4} hazard level deaggregation earthquakes. As shown in Figure 2.5.2-4, the ESP site subsurface amplifies the input hard rock motion over the fairly wide frequency range of 0.5 to 10 Hz, with the maximum amplification of 3.3 at a frequency of 1.7 Hz. The thick line shown in Figure 2.5.2-4 is the final site amplification function for each controlling earthquake and represents the weighted average of the amplification functions for the associated deaggregation earthquakes. The weights, listed above in Table 2.5.2-2, represent the relative contribution of earthquakes represented by

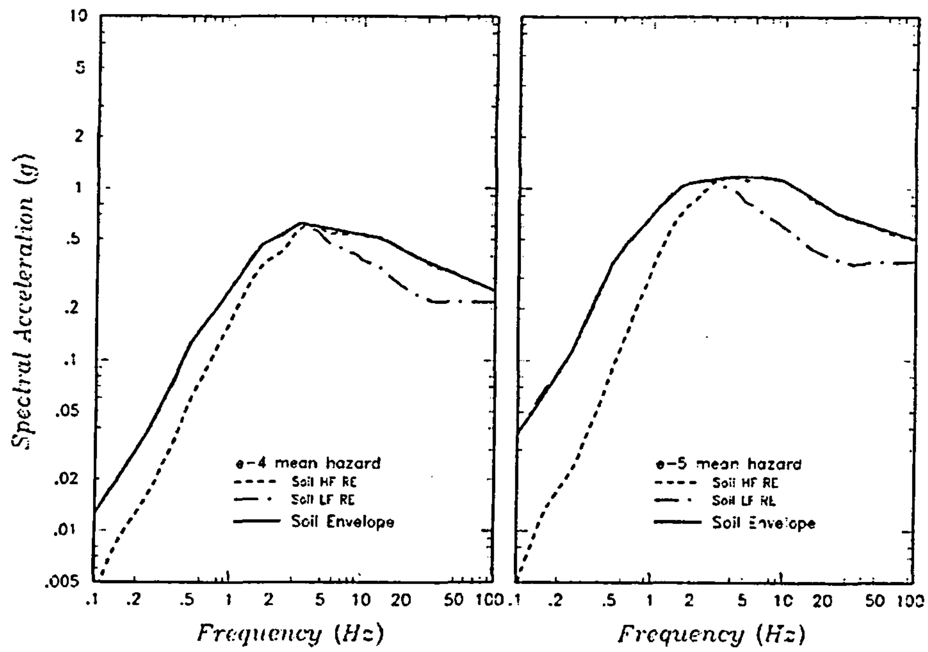


Seismic Hazards Report for the EGC ESP Site Mean Site Amplification Functions for Deaggregation Earthquakes and Weighted Average Site Amplification Functions for Reference Earthquakes for Mean 10^{-4} Hazard	Figure 4.2-23

Figure 2.5.2-4 Mean site amplification functions for deaggregation earthquakes and weighted average site amplification functions for reference earthquakes for mean 10^{-4} hazard

the deaggregation earthquakes to the hazard at the appropriate spectral frequency and hazard level.

The applicant determined the final soil surface spectra for the ESP site by scaling the rock-controlling earthquake spectra by the mean site amplification functions. These spectra are shown below in Figure 2.5.2-5, reproduced from Figure 4.2-26 in SSAR Appendix B. The applicant enveloped the low- and high-frequency soil surface spectra with smooth envelope spectra, as shown in Figure 2.5.2-5.



Seismic Hazards Report for the EGC ESP Site **Rock Reference Earthquake Spectra Scaled by Weighted Average Site Amplification Functions and Soil Envelope Spectra**	Figure **4.2-26**

Figure 2.5.2-5 Rock reference earthquake spectra scaled by weighted average site amplification functions and soil envelope spectra

2.5.2.1.6 Safe-Shutdown Earthquake

The method for determining the SSE for a site, as described in RG 1.165, is based on the use of a reference probability (R_p). The basis for the procedure in RG 1.165 and the determination of the reference probability is that existing nuclear power plants do not represent an undue risk to the health and safety of the public. As such, using existing plants as a reference, RG 1.165 recommends a procedure to determine the seismic design basis for future plants. The reference probability is the average probability of exceeding the SSE ground motion at 5 and 10 Hz using either the 1993 LLNL PSHA or the 1989 EPRI PSHA. A reference probability level was calculated for 29 nuclear power plant sites in the CEUS, and the median reference probability for these 29 sites, using median hazard results, is 10^{-5} per year. A similar value was obtained using both the 1993 LLNL and 1989 EPRI PSHAs; therefore, RG 1.165 endorses both the LLNL and EPRI PSHA results as being suitable for seismic hazard estimation for future siting. Concerning the R_p value, in SSAR Section 2.5.4.9, "Earthquake Design Basis," the applicant stated the following:

> These probabilities [Rp] were computed using ground motion models developed in the mid-to-late 1980's. As discussed in Regulatory Position 3 in Regulatory Guide 1.165, significant changes to the overall database for assessing seismic hazard in the CEUS warrants a change in the reference probability. The availability of the recently developed EPRI ground motion characterization for the CEUS (EPRI, 2003) represents a significant advancement in the seismic hazard database for the CEUS. Appendix B of Regulatory Guide 1.165 discusses that selection of another reference probability may be appropriate, such as one founded on risk-based considerations. That is the approach taken for developing the EGC ESP SSE design ground motions.

Rather than updating R_p and using the methodology described in RG 1.165 to determine the SSE ground motion, the applicant chose to use a different approach, which is described in the American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI) Standard 43-05, "Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities and Commentary." This new approach is referred to as a "performance-based" approach. The performance-based approach sets a goal or target of a mean annual frequency of 10^{-5} of unacceptable performance of nuclear structures, systems, and components (SSCs) as a result of seismically initiated events. Specifically, the performance-based approach is intended to achieve a mean 10^{-5} risk per year of core damage caused by seismic initiators. This safety performance goal is based on assuming a target 10^{-4} mean annual risk of core damage caused by all accident initiators and the assumption that seismic initiators contribute about 10 percent of the risk of core damage posed by all accident initiators.

To determine the SSE that achieves the annual performance goal of 10^{-5}, the performance-based approach scales the site-specific mean 10^{-4} uniform hazard response spectrum (UHRS), shown above in Figure 2.5.2-5, by a design factor (DF):

$$SSE = UHRS_{10^{-4}} \times DF \qquad (2.5.2\text{-}1)$$

where

$$DF = \mathbf{Max}(DF_1, DF_2)$$

and

$$DF_1 = 1.0$$

$$DF_2 = 0.6(A_R)^{0.8}$$

The amplitude ratio, A_R, is given by the ratio of 10^{-5} UHRS and 10^{-4} UHRS spectral accelerations for each spectral frequency. As shown in the above equations, the minimum value of DF for each spectral frequency is 1.0, which implies that the SSE will be equivalent to the 10^{-4} UHRS or higher, depending on the amplitude ratio. Table 2.5.2-3 shows the applicant's computation of the horizontal SSE using the two UHRS spectra and the DF for a select number of spectral frequency values.

Table 2.5.2-3 Computation of the Horizontal SSE Spectrum for the ESP Site

Spectral Frequency (Hz)	10^{-4} Mean UHRS (g)	10^{-5} Mean UHRS (g)	DF_2	DF	Horiz. SSE (g)
0.1	0.0129	0.0412	1.519	1.511	0.0196
0.5	0.1400	0.4160	1.434	1.434	0.2007
1.0	0.2970	0.8020	1.328	1.328	0.3945
2.5	0.6382	1.2561	1.031	1.031	0.6582
5.0	0.6570	1.2149	0.981	1.600	0.6570
10.0	0.5864	1.1065	0.997	1.079	0.6002
20.0	0.4599	0.7862	0.921	1.000	0.4599
50.0	0.3200	0.5791	0.914	1.000	0.3200
100.0 (PGA)	0.2660	0.4895	0.977	1.000	0.2660

Figure 2.5.2-6 shows the soil surface 10^{-4} (green line) and 10^{-5} (red line) mean UHRS and the applicant's performance-based SSE spectrum (black line). As shown in Figure 2.5.2-6 and above in Table 2.5.2-3, the final performance-based SSE is approximately equivalent to the 10^{-4} UHRS for spectral frequencies above 2.5 Hz.

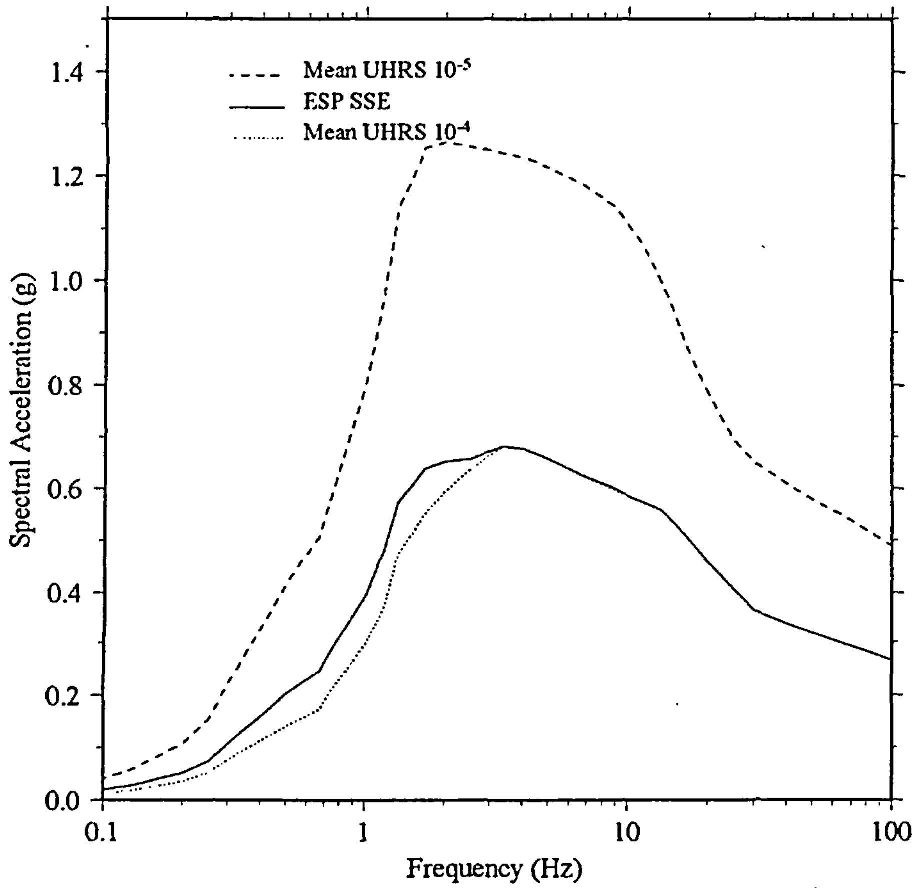


Figure 2.5.2-6 Comparison of performance-based SSE spectrum for the ESP site and the mean 10^{-4} and 10^{-5} UHRS

In RAI 2.5.2-1(a), the staff asked the applicant to justify the selection of the site-specific mean 10^{-4} UHRS as the appropriate starting point for determining the final SSE. In response to RAI 2.5.2-1(a), the applicant stated that the "design amplitude required to achieve the performance goal at each structural period can be calculated starting from the mean 10^{-4} annual probability level of the seismic hazard spectrum in the free field at the ground surface, or from the 10^{-5} annual probability level, or from any intermediate probability level." The applicant explained that it selected a 10^{-4} annual probability level as the starting point based on the precedent set in ASCE/SEI Standard 43-05.

In RAI 2.5.2-1(b), the staff asked the applicant to demonstrate that the SSE envelops the site-specific response spectra from the controlling earthquakes at the reference probability level (median 10^{-5} per year) recommended by RG 1.165 or to justify why this approach was not used to determine the SSE. In response to RAI 2.5.2-1(b), the applicant stated that it did not rely on the site-specific response spectra from the controlling earthquakes at the hazard reference probability level of median 10^{-5} per year to determine the site-specific SSE. Instead, the applicant used the performance-based approach in ASCE/SEI Standard 43-05 to determine the site-specific SSE.

In RAI 2.5.2-1(c), the staff asked the applicant to justify using SSC seismic fragility information, before the selection of a reactor design, to determine the site SSE. In response to RAI 2.5.2-1(c), the applicant stated that the performance-based approach "combines a conservative characterization of equipment/structure performance with ground motion hazard to establish risk-consistent SSEs, rather than only hazard-consistent ground shaking, as occurs using the hazard reference probability approach in Appendix B of RG 1.165."

2.5.2.1.6.1 Derivation of Performance-Based Approach

In RAI 2.5.2-7(b), the staff asked the applicant to provide the derivation of the DF (Equation 2.5.2-1) used to achieve the target performance goal of mean 10^{-5} per year. Using the applicant's response to RAI 2.5.2-7(b), supplemented by a review of ASCE/SEI Standard 43-05, NUREG/CR-6728, and papers by R.P. Kennedy ("Overview of Methods for Seismic PRA and Margins Analysis Including Recent Innovations," dated August 1999, and "Establishing Seismic Design Criteria to Achieve an Acceptable Seismic Margin," dated August 1997), the staff derived the equations and assumptions underlying the performance-based approach. The following SER subsections describe this derivation.

Seismic Hazard Curves. In order to achieve a site SSE that meets the target performance level, the performance-based approach stipulates both the site seismic hazard characteristics as well as the fragility characteristics of nuclear SSCs. The site seismic hazard characteristics are quantified by the PSHA seismic hazard curves and UHRS that cover a broad range of natural frequencies. Figure 2.5.2-7 below shows the mean seismic hazard curves on a log-log scale for the frequencies of 1, 2.5, 5, and 10 Hz for the EGC ESP site. These four seismic hazard curves indicate the mean annual rate of exceedance for different values of spectral acceleration (S_a) for each of the four natural frequencies. Specifically, these curves show the annual probability that the S_a exceeds a particular acceleration value for each of the seismic sources surrounding the ESP site. The hazard curves are developed by identifying and characterizing each seismic source in terms of magnitude recurrence and location as well as determining the ground motion at the site resulting from each source. SER Section 2.5.2.1.4 provides a complete description of the applicant's PSHA results for the ESP site.

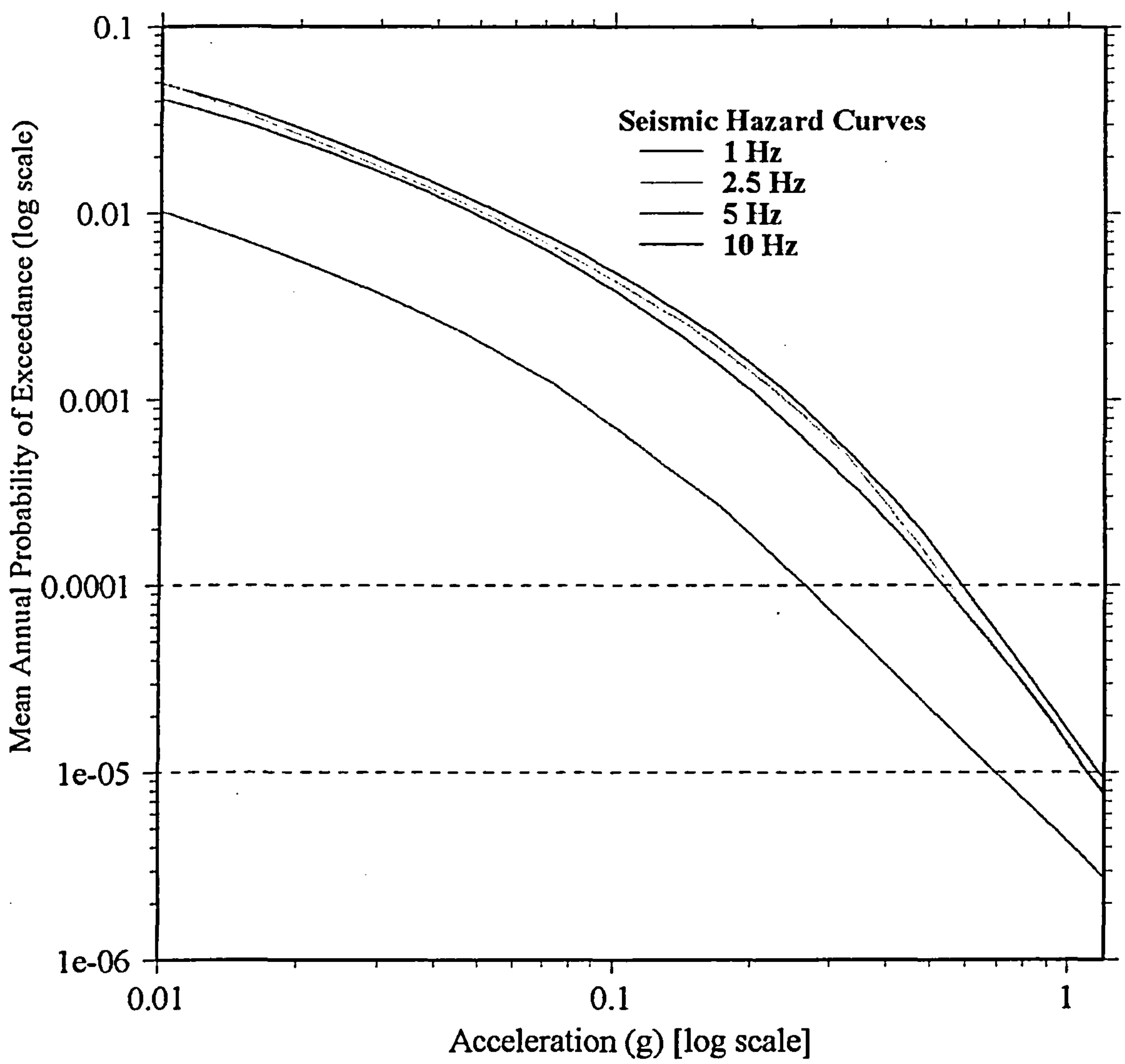


Figure 2.5.2-7 Four mean seismic hazard curves (1 Hz, 2.5 Hz, 5 Hz, and 10 Hz) for EGC ESP site plotted on a log-log scale. Dashed lines indicate annual probability of exceedance intervals of 10^{-4} per year and 10^{-5} per year.

Seismic Fragility. The performance-based approach uses the standard assumption that the seismic fragility of nuclear SSCs can be modeled using a lognormal distribution. The probability density function (PDF) for the lognormal distribution is given by

$$f_C(a;\mu,\sigma) = \frac{1}{\sqrt{2\pi}\sigma a}\exp\left\{-\frac{1}{2}\left[\frac{\ln a - \mu}{\sigma}\right]^2\right\}, a > 0 \quad (2.5.2\text{-}2)$$

where μ and σ are the mean and standard deviation, respectively, of the related normal random variable $X = \ln(C)$. In the area of seismic fragility or capacity, β is used rather than σ to denote the standard deviation. Figure 2.5.2-8 shows lognormal probability density functions for a specified μ and four different β values from 0.3 to 0.6, which is the typical range of standard deviations for nuclear SSCs based on seismic probabilistic risk assessment (PRA) studies. The probability that a lognormally distributed random variable C is less than or equal to some specified value a is given by the cumulative distribution function (CDF)

$$P(C \le a) = F_C(a;\mu,\beta) = \Phi\left(\frac{\ln a - \mu}{\beta}\right) \quad (2.5.2\text{-}3)$$

where Φ denotes the standardized normal distribution with a zero mean and standard deviation of one $F_Z(z; 0, 1)$. Seismic fragility curves are based on the lognormal CDF and express the probability of failure as a function of spectral acceleration or other ground motion parameter. Figure 2.5.2-9 shows seismic fragility curves for a specified μ and four different β values from 0.3 to 0.6. Important quantile values such as the median and lower and upper bounds are shown on the lognormal PDF and CDF curves, respectively, in Figures 2.5.2-10 and 2.5.2-11. The 1-percent quantile value is defined as the high-confidence-low-probability-of-failure (HCLPF) point and represents the seismic capacity corresponding to a 1-percent mean probability of failure. Quantile values (C_q) for the lognormal distribution are given by

$$C_q = \exp(\mu + Z_q\beta) \quad (2.5.2\text{-}4)$$

where Z_q are quantile values from the standard normal distribution with a zero mean and standard deviation of one.

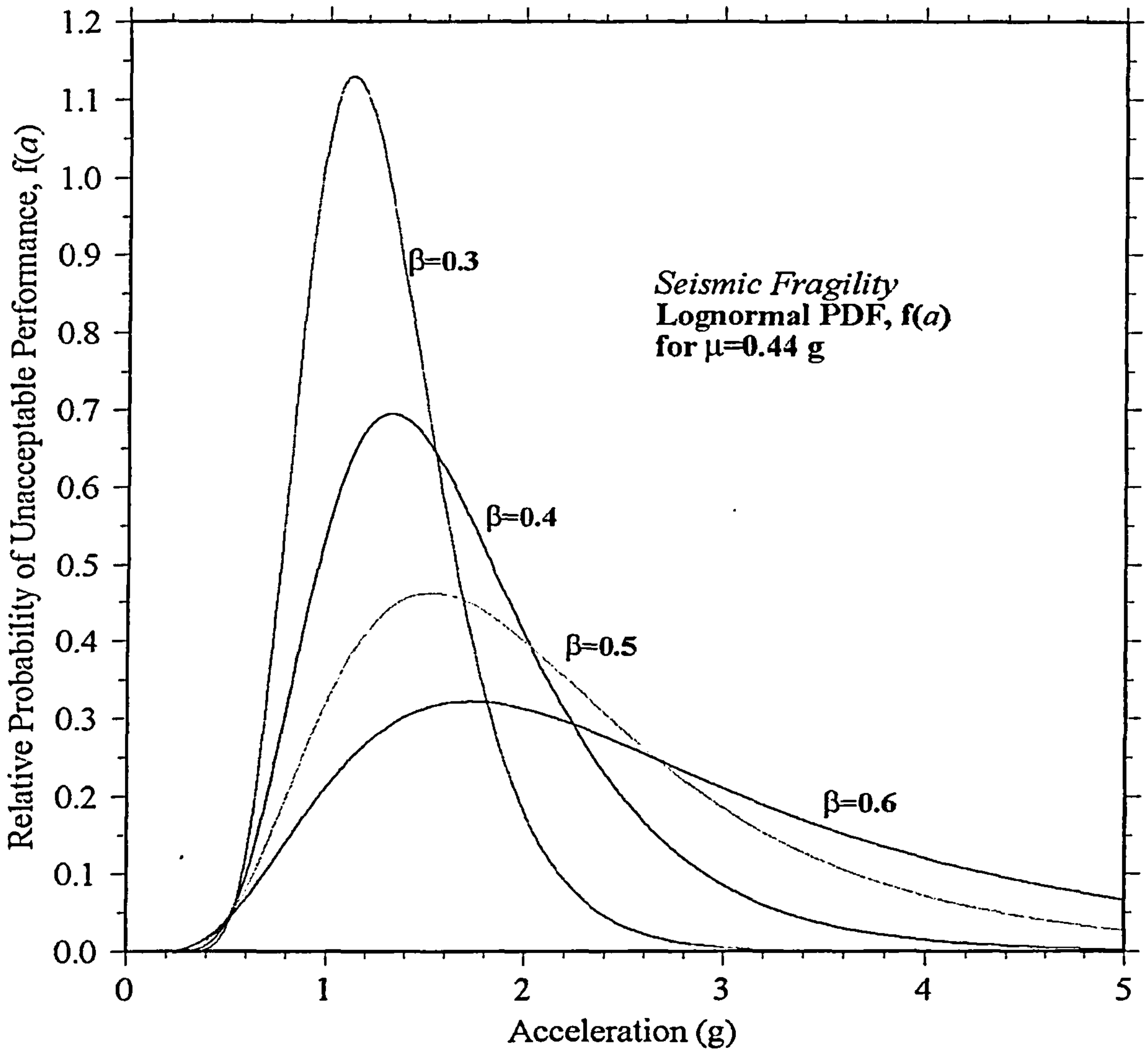


Figure 2.5.2-8 Lognormal PDF for different values of the lognormal standard deviation value, β

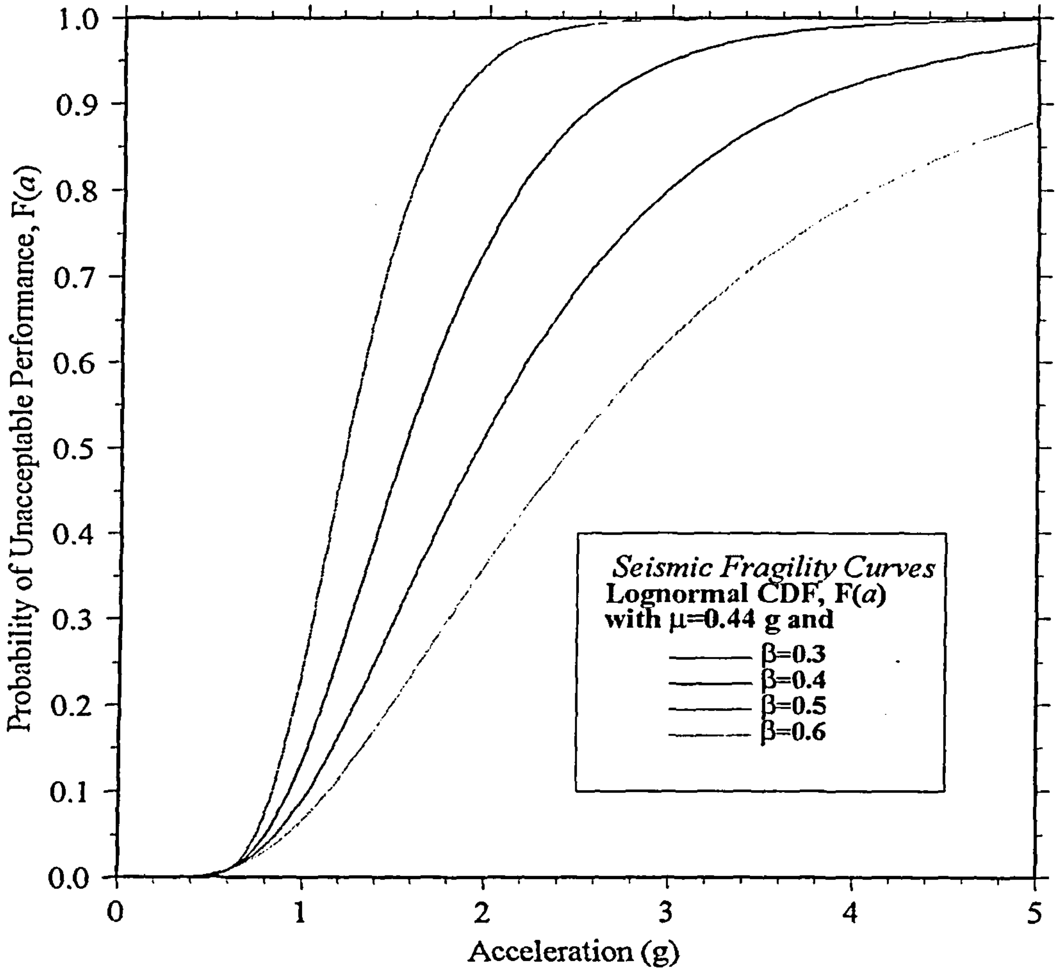


Figure 2.5.2-9 Lognormal CDF for different values of the lognormal standard deviation value, β. Lognormal CDF is used to model the seismic fragility of SSCs.

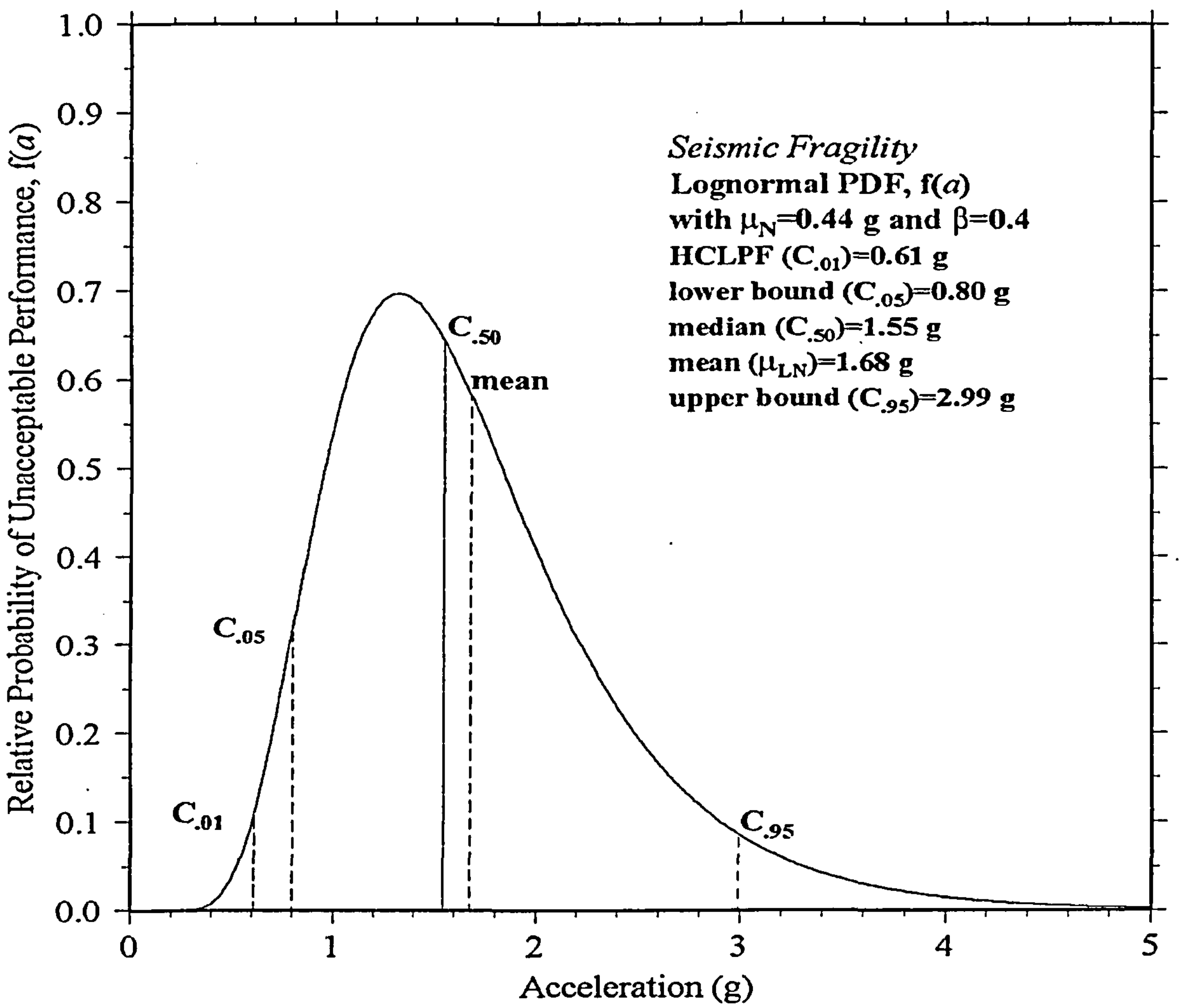


Figure 2.5.2-10 Significant parameter and quantile values for lognormal PDF, including the HCLPF value

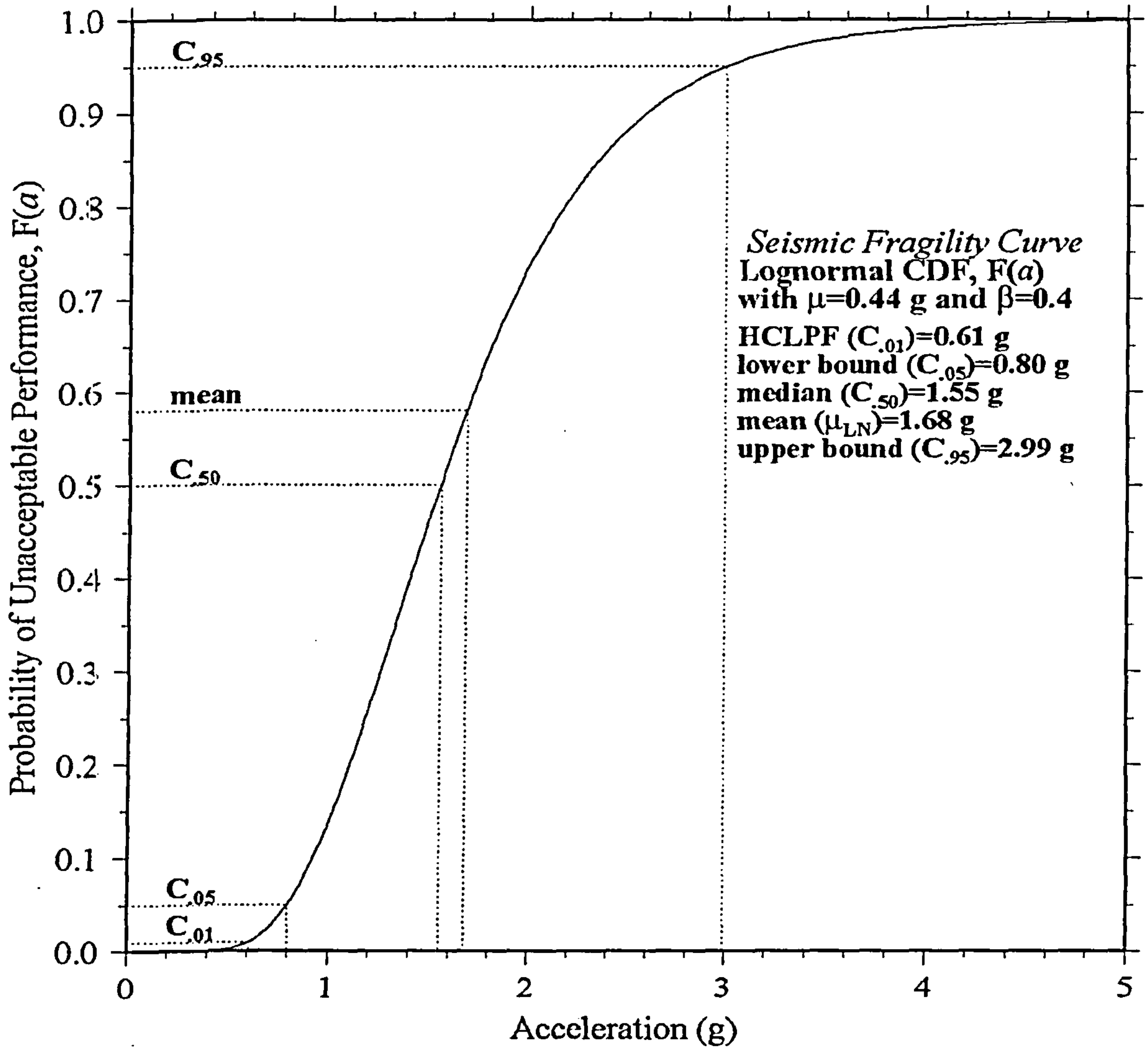


Figure 2.5.2-11 Significant parameter and quantile values for lognormal CDF, including the HCLPF value

Risk Integral. The starting point for the performance-based method is the risk integral, which is an application of the law of total probability:

$$P(B) = \sum_{i=1}^{n} P(B|A_i)P(A_i) \qquad (2.5.2\text{-}5)$$

where $P(B)$ and $P(A_i)$ denote the probabilities of events B and A_i, $P(B|A_i)$ denotes the conditional probability of event B given that event A_i has occurred, and n is the total number of possibilities for event A_i (the probabilities of which sum to unity).

When A is instead a continuous non-negative random variable, the law of total probability is expressed as

$$P(B) = \int_0^{\infty} P(B|A = a)f_A(a)da \qquad (2.5.2\text{-}6)$$

where $f_A(a)$ is the PDF for A.

Letting B denote failure (in a year), A denote the ground motion amplitude (demand), and C denote SSC seismic capacity (in terms of ground motion amplitude), the continuous expression of the law of total probability can also be expressed as

$$P(B) = \int_0^{\infty} P(B|C = a)f_C(a)da \qquad (2.5.2\text{-}7)$$

where $f_C(a)$ is the lognormal seismic capacity PDF given by Equation 2.5.2-2 above.

Recognizing that SSC failure (event B) can be expressed as event A greater than event C (i.e., demand greater than capacity), the conditional probability $P(B|C = a)$ can be rewritten as

$$P(B|C = a) = P(A > C|C = a) = P(A > a) = H(a) \qquad (2.5.2\text{-}8)$$

where $H(a)$ is the site seismic hazard curve. Combining the above two equations gives the risk integral, which forms the basis for the performance-based approach,

$$P_{FT} = \int_0^{\infty} H(a)f_C(a)da \qquad (2.5.2\text{-}9)$$

where *'a'* represents ground motion amplitude, P_{FT} is the target performance goal (10^{-5}), *H(a)* is one of the mean seismic hazard curves for the site (see Figure 2.5.2-7) and $f_C(a)$ is the seismic SSC fragility curve expressed in terms of a lognormal PDF. In words, the risk integral states that the annual probability of failure P_{FT} is equal to the product of (1) the annual probability that the ground motion amplitude, or seismic demand, exceeds *'a'* and (2) the probability (within the differential *da*) that the seismic fragility equals *'a'*, summed (or integrated) over all possible values of *'a'*.

To determine the SSE spectral acceleration value that achieves the target performance goal (P_{FT}) of 10^{-5}, the mean (μ) in the fragility lognormal PDF (Equation 2.5.2-2) can be written in terms of the *HCLPF* capacity using Equation 2.5.2-4 above:

$$\mu = \ln C_q - Z_q\beta = \ln C_{.01} - Z_{.01}\beta = \ln HCLPF + 2.326\beta \qquad (2.5.2\text{-}10)$$

Making this substitution provides an expression for the seismic fragility PDF in terms of the *HCLPF* capacity and the standard deviation, β. The *HCLPF* capacity can then be written in terms of the SSE by assuming that the *HCLPF* seismic capacity of SSCs will exceed the SSE ground motion by a seismic margin, M_s:

$$M_s = \frac{HCLPF}{SSE} \qquad (2.5.2\text{-}11)$$

The seismic fragility lognormal PDF then becomes:

$$f_C(a) = \frac{1}{\sqrt{2\pi}\beta a}\exp\left\{-\frac{1}{2}\left[\frac{\ln a - (\ln SSE \times M_s + 2.326\beta)}{\beta}\right]^2\right\} \qquad (2.5.2\text{-}12)$$

Substituting this expression for the fragility PDF into the risk integral (Equation 2.5.2-9) enables the determination of the SSE value that achieves the target performance goal of 10^{-5}. Figure 2.5.2-12 shows the EGC ESP seismic hazard curve for a natural frequency of 5 Hz along with the seismic fragility PDF, assuming specific values for the SSE, seismic margin (M_s), and standard deviation(β). Figure 2.5.2-13 shows the product of the seismic hazard and fragility curves. The spectral acceleration value that gives an area of 10^{-5} under the curve in Figure 2.5.2-13 is the value of the SSE for the natural frequency of 5 Hz.

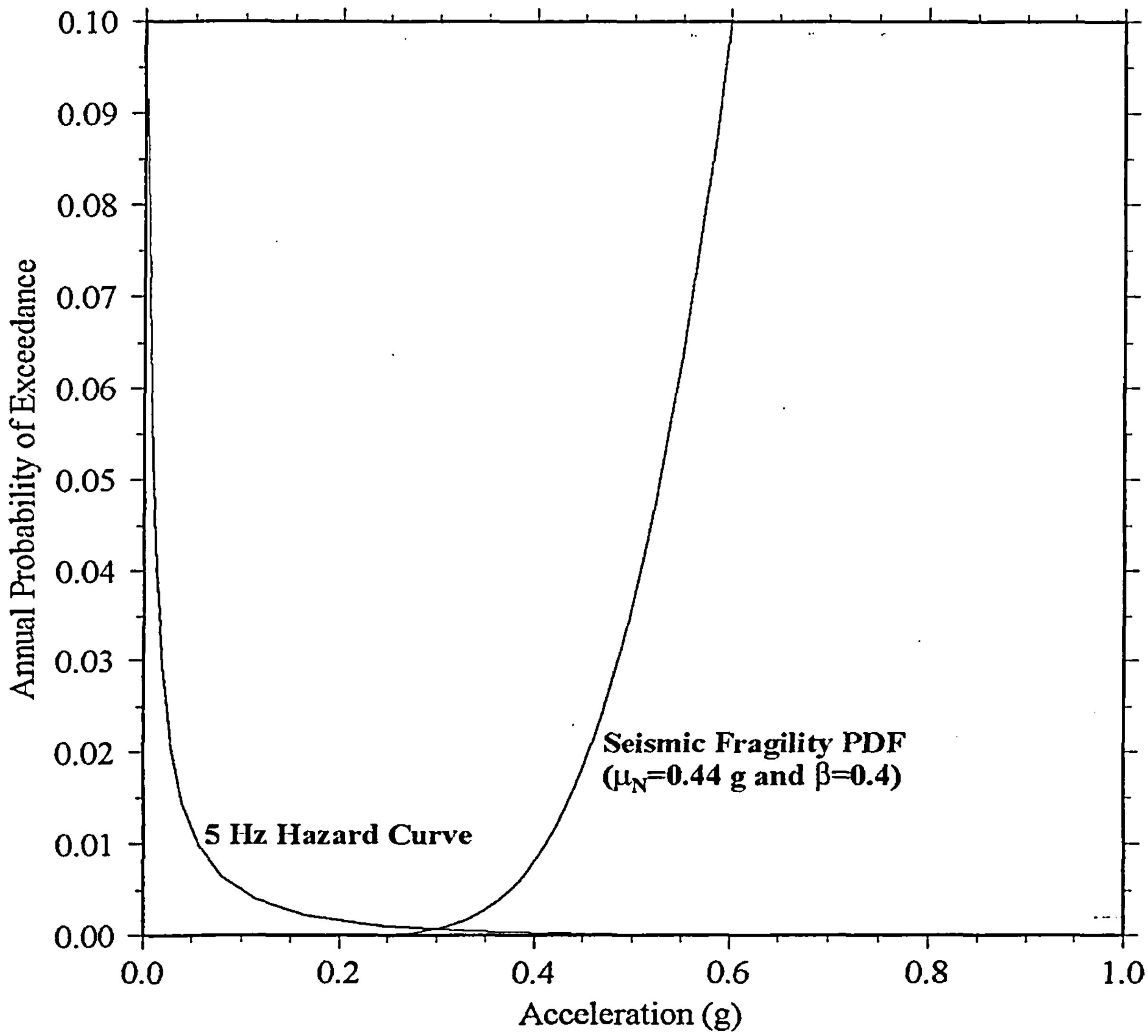


Figure 2.5.2-12 EGC ESP 5-Hz mean seismic hazard curve and seismic fragility curve in terms of the lognormal PDF

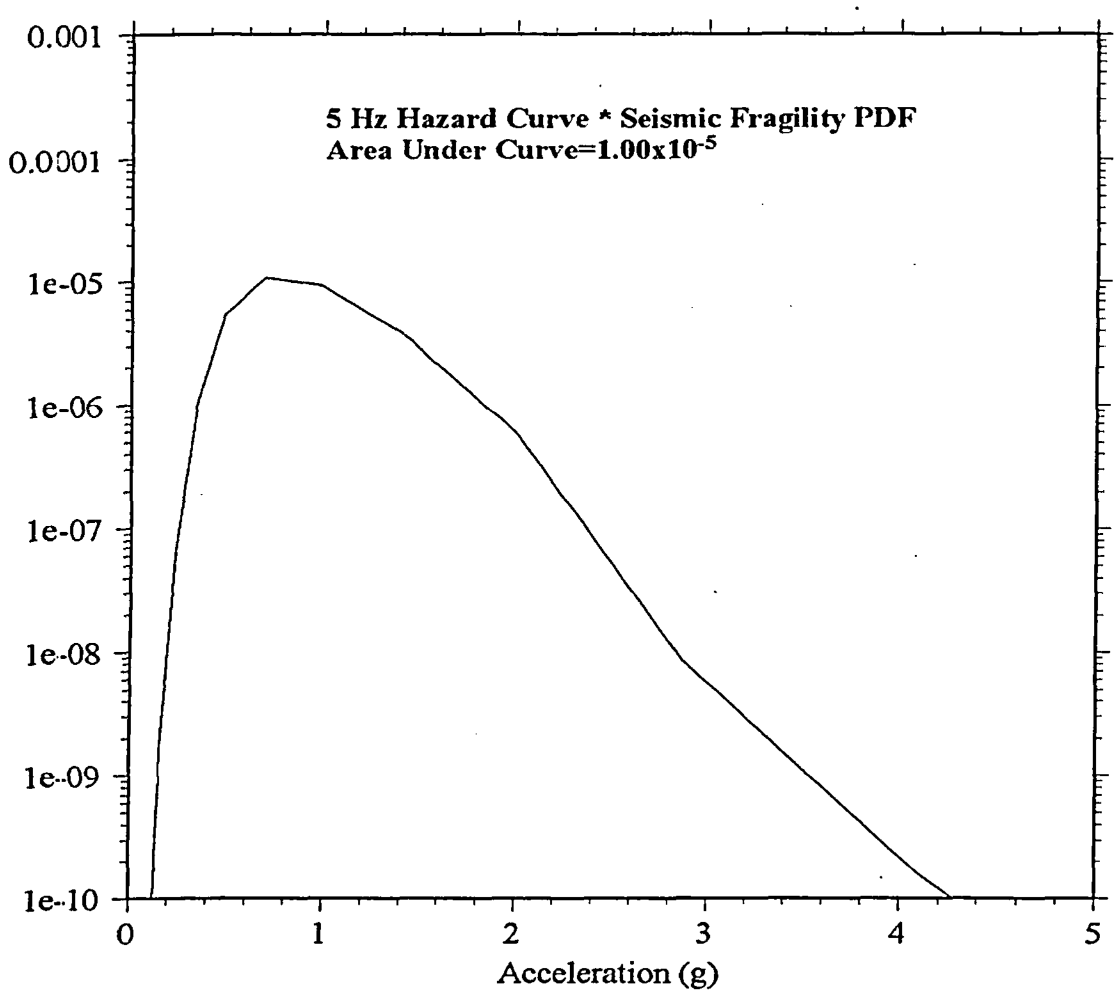


Figure 2.5.2-13 Product of EGC ESP 5-Hz mean seismic hazard curve and seismic fragility curve. Spectral acceleration value that gives an area of 10^{-5} under the curve is the SSE for 5 Hz.

Risk Equation. Rather than using the direct numerical integration approach, illustrated above, to determine the SSE that achieves the target performance goal for each natural frequency, the developers of the performance-based approach assume a functional form for the hazard curve, *H*(*a*). As shown previously in Figure 2.5.2-7, the seismic hazard curves are very close to linear in logarithmic space between the exceedance probabilities of 10^{-4} and 10^{-5}. Assuming a linear hazard curve in logarithmic space implies that the hazard curve can be expressed as

$$\log H(a) = b + m \log a \qquad (2.5.2\text{-}13)$$

where *b* and *m* are the intercept and slope, respectively, between the exceedance probabilities of 10^{-4} and 10^{-5} per year and the slope, *m*, as given by

$$m = \frac{\log 10^{-5} - \log 10^{-4}}{\log a_2 - \log a_1} = \frac{-1}{\log A_R} \qquad (2.5.2\text{-}14)$$

with $A_R = {}^{a_2}\!/_{a_1}$. The equation for the hazard curve, *H(a)*, is then given by

$$H(a) = 10^b a^{-1/\log A_R} = k a^{-1/\log A_R} \qquad (2.5.2\text{-}15)$$

with $k = 10^b$. Assuming this functional form for the hazard curve allows for a closed-form solution of the risk integral:

$$P_{FT} = \int_0^{\infty} \left\{ k a^{-1/\log A_R} \right\} \left(\frac{1}{\sqrt{2\pi} a \beta} \exp\left\{ -\frac{1}{2} \left[\frac{\ln a - (\ln SSE \times M_s + 2.326\beta)}{\beta} \right]^2 \right\} \right) da \qquad (2.5.2\text{-}16)$$

This closed-form solution is obtained by making the substitution $x = \ln a$, which reduces the risk integral to the form

$$\int_0^{\infty} Z(x) \exp(cx) dx \qquad (2.5.2\text{-}17)$$

where $c = {}^{-1}\!/_{\log A_R}$ is a constant and *Z(x)* is the PDF for a normal random variable with mean $\mu = \ln(SSE \times M_s) + 2.326\beta$ and standard deviation β. The solution to the risk integral is then given by

$$\exp\left\{ \mu c + \frac{1}{2} \beta^2 c^2 \right\} \qquad (2.5.2\text{-}18)$$

and solving for the SSE after substituting back in for μ and c gives

$$SSE = \frac{1}{M_s}\left[\frac{k \times g(\beta, A_R)}{P_{FT}}\right]^{\log A_R} \quad (2.5.2\text{-}19)$$

where

$$g(\beta, A_R) = \exp\left\{\frac{-2.326\beta}{\log A_R} + \frac{1}{2}\left(\frac{\beta}{\log A_R}\right)^2\right\}$$

Since k and A_R are given by the intercept and slope of the hazard curve, respectively, only values for the seismic margin (M_s) and standard deviation of the seismic fragility (β) must be assumed. As shown above in Equation 2.5.2-15, the SSE decreases as the seismic margin increases. For this application of the performance-based approach, the seismic margin is assumed to be unity, and as such *HCLPF* = SSE for each SSC. A value for the standard deviation of the seismic fragility, β, must also be assumed in order to determine the SSE. Based on empirical evidence from past seismic PRA studies, the applicant stated that the range of anticipated β values is 0.3 to 0.6. For this application of the performance-based approach, β is assumed to be 0.4.

Rather than using Equation 2.5.2-19 above to determine the SSE value that achieves the target performance goal, the developers of the performance-based approach use the simpler expression given previously in Equation 2.5.2-1, which is repeated here for convenience:

$$SSE = UHRS_{10^{-4}} \times DF$$

where $UHRS_{10\text{-}4}$ is the uniform hazard spectral acceleration value for an exceedance probability of 10^{-4} per year and DF is the design factor. Substituting this expression for the SSE into Equation 2.5.2-19 above shows that DF is given by

$$DF = \frac{1}{M_s}\left[\frac{k \times UHRS_{10^{-4}}{}^{-1/\log A_R}}{P_{FT}} g(\beta, A_R)\right]^{\log A_R} \quad (2.5.2\text{-}20)$$

Since the numerator of the ratio within the brackets is simply equal to P_{REF}, which is 10^{-4}, the DF becomes

$$DF = \frac{1}{M_s}\left[\frac{P_{REF}}{P_{FT}} g(\beta, A_R)\right]^{\log A_R} \quad (2.5.2\text{-}21)$$

Substituting $M_s = 1$, $P_{FT} = 10^{-5}$ and $P_{REF} = 10^{-4}$ results in a function for *DF* that depends only on the amplitude ratio A_R and β. Rather than use this exact equation for *DF*, ASCE/SEI Standard 43-05 uses a close approximation given by Equation 2.5.2-1 above and repeated below for convenience:

$$DF = \max\left[0.6 \times \left(A_R\right)^{0.8}, 1.0\right]$$

Figure 2.5.2-14 shows a comparison between the "exact" *DF* (Equation 2.5.2-21) and the approximate *DF* (Equation 2.5.2-1). The approximate *DF* as a function of A_R is larger than the exact *DF*, which is a function of both A_R and β, except for β=0.3.

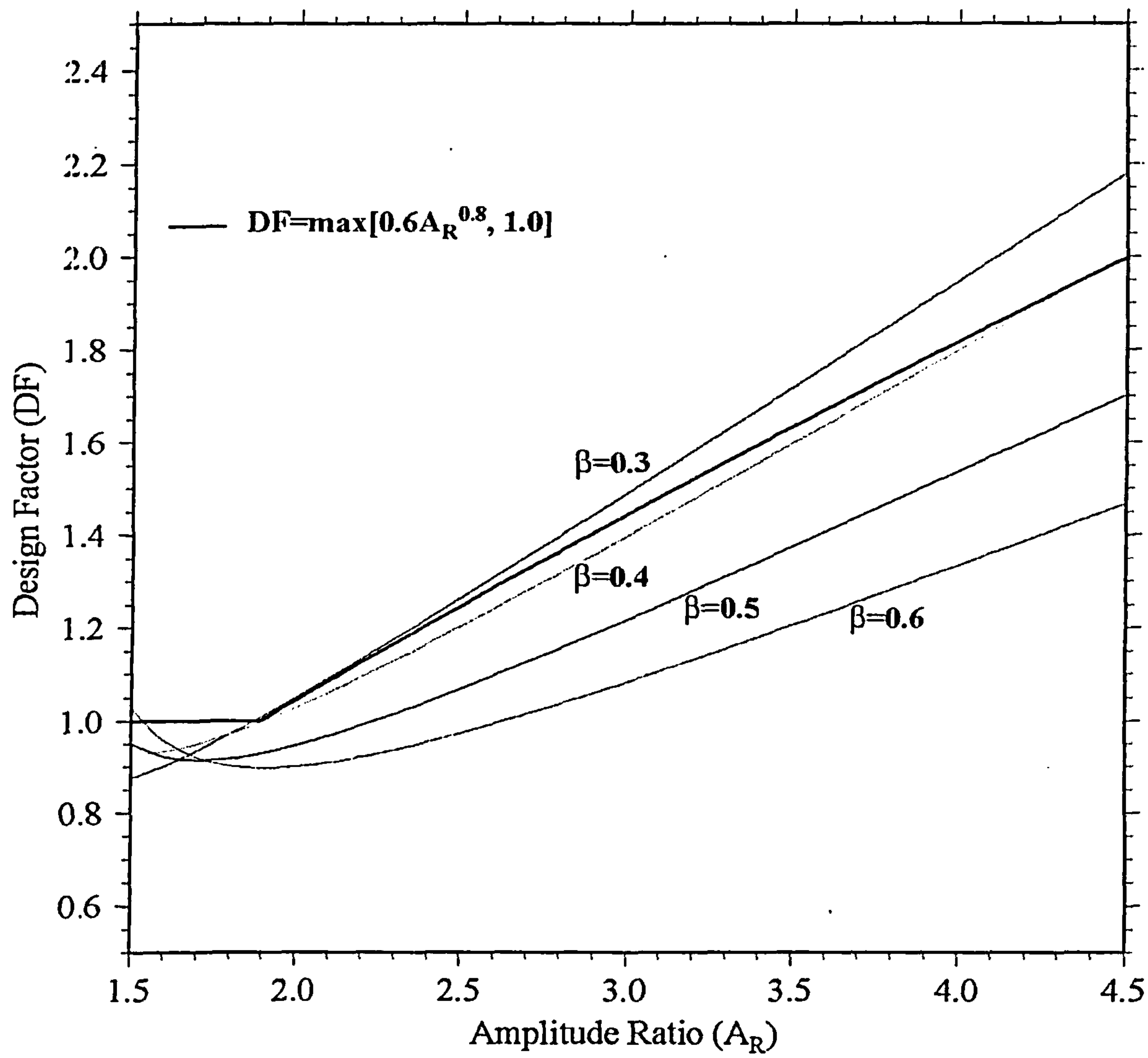


Figure 2.5.2-14 Comparison of exact and approximate *DF*. Exact *DF* varies with both A_R and β, while approximate *DF* depends only on A_R.

2.5.2.1.6.2 Target Annual Performance Goal

In RAI 2.5.2-7(a), the staff asked the applicant to justify the selection of the mean annual frequency of 10^{-5} as the safety performance target for the unacceptable performance of Category I SSCs as a result of seismically initiated events. In response to RAI 2.5.2-7(a), the applicant stated that the primary basis for the target 10^{-5} annual performance goal is from the results of seismic PRAs of 25 nuclear power plants (NUREG-1742, "Perspectives Gained from the IPEEE Program"), which show the median value for the mean seismic core damage frequency (SCDF) to be 1.2×10^{-5}. In addition, the applicant stated the following:

> The approach described in Section 2.5.2 of the EGC ESP SSAR is based on the recently approved ASCE/SEI Standard 43-05, *Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities and Commentary.* This standard uses a mean 10^{-5} probability per year of "unacceptable performance of nuclear structures, systems, and components as a result of seismically initiated events" for nuclear power plants. As noted subsequently in this response, the quantitative goal of this performance-based approach is to achieve an annual frequency of seismically induced core damage frequency ([S]CDF) that is 10^{-5} or lower, when conservatively estimated by calculating the annual frequency of onset of significant inelastic deformation (FOSID) of structures, systems, and components (SSCs).
>
> Justification for the use of mean 10^{-5} per year as an appropriate performance goal is based on work that was published in 2002 as NUREG-1742, as summarized below.
>
> - The selection of mean 10^{-5} annual frequency of exceedance as an appropriate performance goal for generic models of SSCs is based on the results from seismic probabilistic risk assessments (PRA) that were performed for 25 operating nuclear facilities using an SSE ground motion spectrum. These PRAs achieved an annual mean [S]CDF of 10^{-5} or higher for seismic core damage for 50 percent of the operating power plants. The computed results were provided previously in the response to RAI 2.5.2-1. The summary table shows that a mean 10^{-5} annual frequency of core damage from seismic events corresponds to 50 percent of U.S. nuclear power plants where a full seismic PRA has been performed.
>
> - The annual frequency of onset of significant inelastic deformation (FOSID) of structures, systems and components is generally much less than failure of the SSC. Failure results in large inelastic deformations—leading to loss of containment or other unacceptable performance. As long as the SSCs remain essentially elastic in their performance—or have limited inelastic response—performance during the seismic event is considered acceptable. It is generally recognized that [seismic] core damage frequency ([S]CDF) is typically less than the highest SSC failure frequency—indicating that by using [S]CDF as a basis for design, the approach is conservative relative to other SSCs.

- By following the ASCE/SEI Standard 43-05 method, the target performance goal annual frequency is achieved so long as the seismic demand and structural capacity evaluations have sufficient conservatism to achieve both of the following:

  - Less than approximately a 1 percent probability of unacceptable performance for the SSE, and

  - Less than approximately a 10 percent probability of unacceptable performance for a ground motion equal to 150 percent of the SSE.

  Plants reviewed and approved using the USNRC Standard Review Plan guidelines have achieved at least these levels of conservatism.

- The mean 10^{-5} annual frequency of core damage represents a means for achieving safe plant design. Safe plant design is the underlying goal of developing the selected SSE spectrum as reflected in the first paragraph in 10 CFR 100.23:

  > *This section sets forth the principle geologic and seismic considerations that guide the Commission in its evaluations of the suitability of a proposed site and adequacy of the design bases established in consideration of the geologic and seismic characteristics of the proposed site, such that there is a reasonable assurance that a nuclear power plant can be constructed and operated at the proposed site without undue risk to the health and safety of the public ....*

  The requirement for no undue risk is met by determining an SSE spectrum that results in a plant that is as safe as the safest plants currently operating. The results of the seismic PRA analyses summarized above indicate that this objective is satisfied for a mean 10^{-5} frequency.

In summary, the applicant made four main points in response to RAI 2.5.2-7(a) in order to justify the value of mean 10^{-5} per year as an appropriate performance goal:

(1) The results from seismic PRAs, which were performed for 25 nuclear facilities, show an annual mean SCDF of 10^{-5} or higher for 50 percent of the operating power plants.

(2) Setting the performance goal of 10^{-5} to be equivalent to the annual FOSID of SSCs is conservative since the seismic demand resulting in the onset of significant inelastic deformation is less than that for failure of the SSC.

(3) The target 10^{-5} annual performance goal is achieved so long as seismic demand and structural capacity evaluations have sufficient conservatism, which is inherent for plants reviewed and approved using the SRP guidelines.

(4) The target 10^{-5} annual performance goal results in a plant that is as safe as the plants currently operating, as shown by the seismic PRAs.

The primary basis for the target 10^{-5} annual performance goal is from the results of seismic PRAs of 25 nuclear power plants (NUREG-1742), which show the median value for the mean SCDF to be 1.2×10^{-5}. Figure 2.5.2-15 below shows the results of the seismic PRAs from NUREG-1742 in terms of mean ground motion recurrence interval, which is the inverse of mean SCDF. Mean ground motion recurrence intervals for seismic core damage based on the seismic PRA results of 25 nuclear power plants vary from 4,000 to 5,263,158 years. In comparison, the FOSID value in terms of mean ground motion recurrence interval is set at 100,000 years for the performance-based approach.

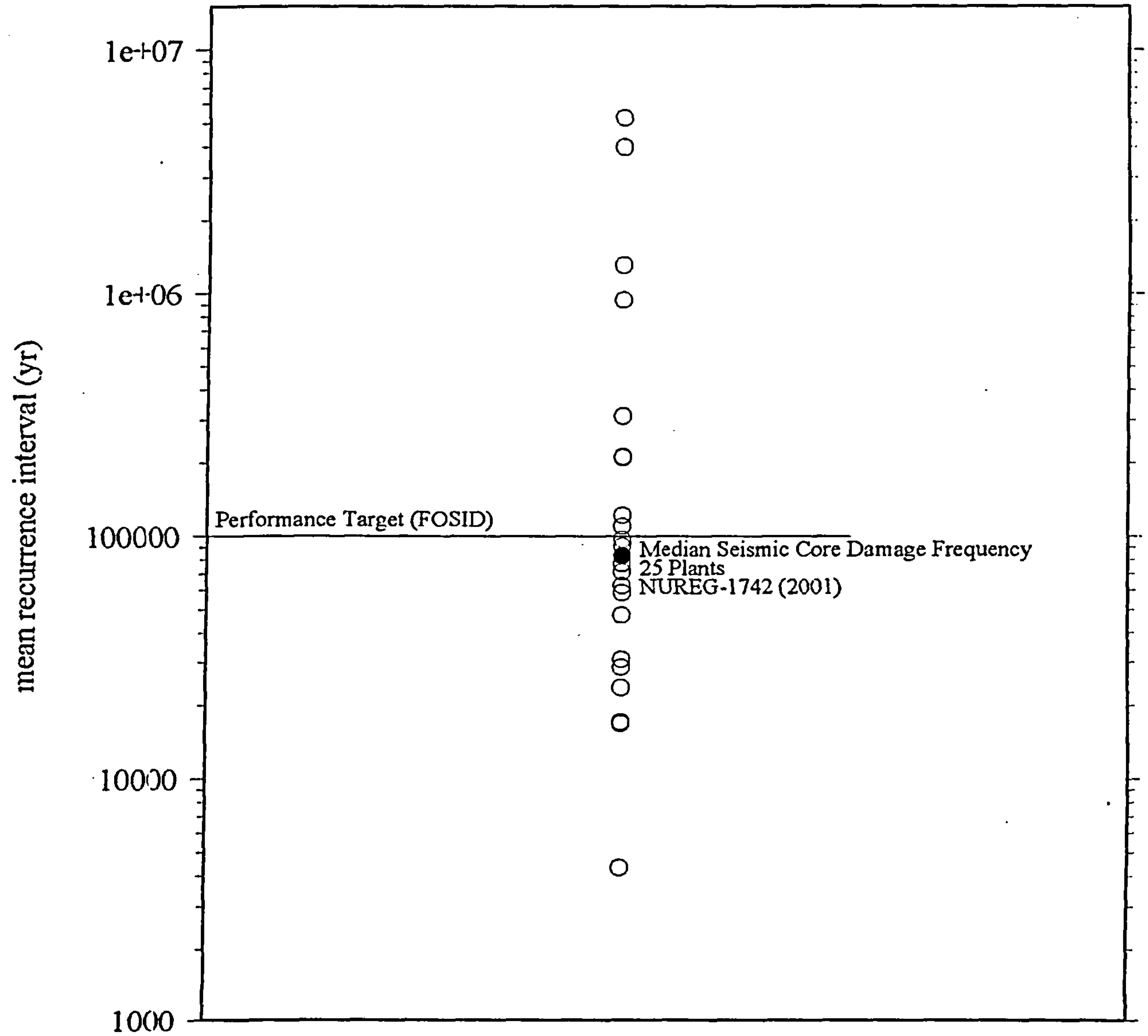


Figure 2.5.2-15 Seismic core damage in terms of mean ground motion recurrence interval for 25 nuclear power plants. For comparison, FOSID is also shown.

2.5.2.1.6.3 Vertical SSE

To compute the vertical SSE, the applicant used the vertical-to-horizontal (V/H) response spectral ratios provided in NUREG/CR-6728. The V/H response spectral ratios given in NUREG/CR-6728 are CEUS hard rock site conditions and depend on the PGA value of the horizontal SSE spectrum. For the ESP site, the V/H ratios used by the applicant are based on having a PGA less than 0.5g. The vertical SSE spectrum is given by multiplying the horizontal SSE spectrum by the V/H ratios. The applicant also considered the effects of the ESP site soil conditions on the vertical ground motions by using ground motion models that provide vertical motions for soil conditions. The applicant used a magnitude 6.4 earthquake at source-to-site distance of 15 km (9 mi) as input to the ground motion models. This magnitude and distance roughly correspond to the high-frequency controlling earthquake.

2.5.2.1.6.4 Design Response Spectrum

In SSAR Section 3.4.1.4.3, "Seismology," the applicant compared the horizontal SSE for the ESP site with the RG 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," design response spectrum (DRS) anchored to a PGA of 0.3g at 33 Hz, which is the DRS used by many of the current reactor designs. The applicant noted that the ESP SSE is lower than the RG 1.60 DRS except at frequencies between 16 and 50 Hz. The applicant stated that these exceedances are considered acceptable based on high-frequency evaluations discussed in a 1993 EPRI study, "Analysis of High-Frequency Seismic Effects." The 1993 EPRI study recommends reduction factors for ground motion at 10 Hz and above because of the higher incoherence of high-frequency ground motion compared to low-frequency ground motion. These reduction factors are 10 percent for ground motion at a frequency of 10 Hz and increase to 20 percent for ground motion frequencies of 25 Hz and larger. The applicant stated that its ESP SSE, after applying the reduction factors, is completely enveloped by the RG 1.60 DRS. The applicant concluded by stating that the high-frequency exceedances of the RG 1.60 DRS by the ESP SSE are not significant, which indicates that the "EGC ESP site is suitable for any design based on the RG 1.60 DRS." This is discussed further in SER Section 2.5.2.3.6.4. Figure 2.5.2-16 shows the horizontal and vertical SSEs as well as the RG 1.60 DRS anchored to a PGA of 0.3g.

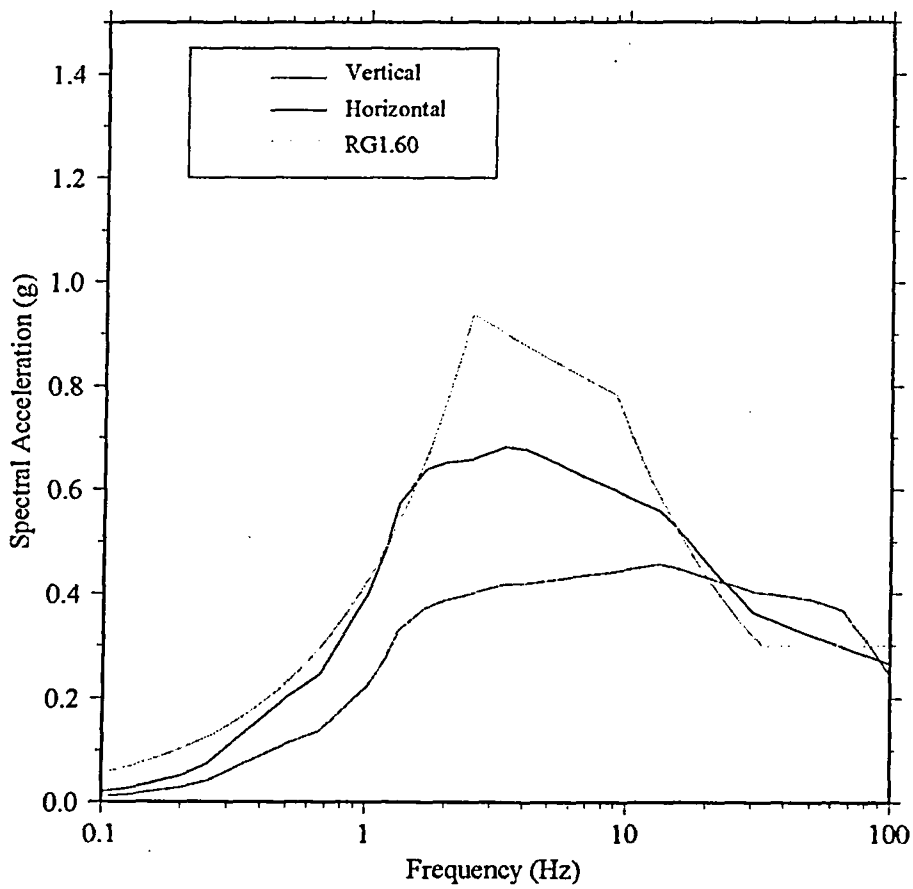


Figure 2.5.2-16 EGC ESP horizontal and vertical ESP SSE as well as the RG 1.60 DRS anchored at 0.3g

2.5.2.1.7 Operating-Basis Earthquake

SSAR Section 2.5.2.7 states that the applicant did not determine the OBE as part of the ESP application.

2.5.2.2 Regulatory Evaluation

SSAR Section 2.5.2 presents the applicant's determination of ground motion at the ESP site from possible earthquakes that might occur in the site region and beyond. In SSAR Section 1.5, the applicant stated that it developed the geological and seismological information used to determine the seismic hazard in accordance with regulations listed in Section 2.5.2 of RS-002, which include 10 CFR 50.34, "Content of Applications; Technical Information," Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50, and 10 CFR 100.23. The applicant further stated in SSAR Section 1.5 that it developed this information in accordance with the guidance presented in RG 1.165. The staff reviewed this portion of the application for conformance with the regulatory requirements and guidance applicable to the determination of the SSE ground motion for the ESP site, as identified below. The staff notes that the application of Appendix S to 10 CFR Part 50 in an ESP review, as referenced in 10 CFR 100.23(d)(1), is limited to defining the minimum SSE for design.

In its application review, the staff considered the regulatory requirements of 10 CFR 52.17(a)(1)(vi) and 10 CFR 100.23(c) and (d), which require that the applicant for an ESP describe the seismic and geologic characteristics of the proposed site. In particular, 10 CFR 100.23(c) requires that an ESP applicant investigate the geological, seismological, and engineering characteristics of the proposed site and its environs with sufficient scope and detail to support estimates of the SSE ground motion, and to permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site. In addition, 10 CFR 100.23(d) states that the SSE ground motion for the site is characterized by both horizontal and vertical free-field ground motion response spectra at the free ground surface. Section 2.5.2 of RS-002 provides guidance concerning the evaluation of the proposed SSE ground motion, and RG 1.165 provides guidance regarding the use of PSHA to address the uncertainties inherent in the estimation of ground motion at the ESP site.

2.5.2.3 Technical Evaluation

This section of the SER provides the staff's evaluation of the seismological, geological, and geotechnical investigations the applicant conducted to determine the SSE ground motion for the ESP site. The technical information presented in SSAR Section 2.5.2 resulted from the applicant's surface and subsurface geological, seismological, and geotechnical investigations performed in progressively greater detail as they moved closer to the ESP site. The SSE is based upon a detailed evaluation of earthquake potential, taking into account regional and local geology, Quaternary tectonics, seismicity, and specific geotechnical characteristics of the site's subsurface materials.

SSAR Section 2.5.2 characterizes the ground motions at the ESP site from possible earthquakes that might occur in the site region and beyond to determine the site SSE spectrum. The SSE represents the design earthquake ground motion at the site and the vibratory ground motion for which certain nuclear power plant SSCs must be designed to remain functional.

According to RG 1.165, applicants may develop the vibratory design ground motion for a new nuclear power plant using either the EPRI or LLNL PSHAs for the CEUS. However, RG 1.165 recommends that applicants perform geological, seismological, and geophysical investigations and evaluate any relevant research to determine whether revisions to the EPRI or LLNL PSHA databases are necessary. As a result, the staff focused its review on geologic and seismic data published since the late 1980s that could indicate a need for changes to the EPRI or LLNL PSHAs.

2.5.2.3.1 Seismicity

The staff focused its review of SSAR Section 2.5.2.1 on the adequacy of the applicant's description of the historical record of earthquakes in the region. The earthquake catalog used in the original EPRI-SOG analysis is complete through 1984. To update the earthquake catalog, the applicant used information from NCEER, USGS, and ANSS. Next, the applicant compared the geographic distribution of earthquakes contained in the EPRI-SOG earthquake catalog (1777–1985) and the earthquakes in the updated catalog (1985–2002). The applicant stated that it found a very similar spatial distribution between the earthquake epicenters for the two time periods.

In addition to updating the EPRI-SOG earthquake catalog with more recent events, the applicant also added prehistoric earthquakes to the catalog, inferred from the evaluation of prehistoric liquefaction information in the ESP site region. These additions include earthquakes from the NMSZ, Wabash Valley-southern Illinois source zone, and the central Illinois basin/background source zone. The most notable addition to the catalog is the Springfield earthquake whose magnitude and location are inferred from paleoliquefaction features discovered approximately 30 miles southwest of the ESP site. These features are from an earthquake centered in the Springfield, Illinois, area that occurred between 5900 and 7400 years ago with an estimated magnitude range of 6.2 to 6.8.

The applicant also conducted paleoliquefaction studies to search for paleoliquefaction features within a 25–30-mile radius of the ESP site. After analyzing the field reconnaissance results, the applicant concluded that evidence for an earthquake comparable to the Springfield earthquake had not been observed in the study area. The applicant did discover some small-scale liquefaction features of probable mid-to-early Holocene age; however, these features were not widespread and likely resulted from a low-magnitude event. In RAI 2.5.2-6, the staff asked the applicant to explain its selected paleoliquefaction study area along the streams near the ESP site. In response, the applicant stated that it selected locations along the Salt Creek, Sangamon River, and Mackinaw River to supplement previous liquefaction studies in this area. SER Section 2.5.1.3.1 provides a complete description of RAI 2.5.2-6 and the staff's evaluation of the applicant's response.

Because the applicant used the EPRI-SOG seismicity catalog, which is part of the 1989 EPRI seismic hazard study that the NRC endorsed, the staff concludes that the seismicity catalog used by the applicant is complete and accurate for the time period 1777–1985. The staff compared the applicant's update of the regional seismicity catalog with its own listing of recent earthquakes and, as a result, concurs with the applicant's assertion that the rate of seismic activity has not increased in the ESP site region since 1985. In addition, the staff reviewed the paleoearthquakes that the applicant added to its earthquake catalog based on evidence from paleoliquefaction features discovered in the NMSZ, WVSZ, and central Illinois seismic zone. The staff concludes that the earthquake catalog used by the applicant is complete and provides a conservative estimate of earthquake magnitudes and locations for the ESP site region.

2.5.2.3.2 Geologic Structure and Tectonic Activity

The staff focused its review of SSAR Section 2.5.2.2 on the applicant's characterization of potential seismic sources in the region surrounding the ESP site. As part of its evaluation of the geologic structure and tectonic activity for the ESP site, the applicant performed a detailed update of the structural features (folds and faults) within the site region. The applicant concluded that the results of the information update on the structure features show that the general structural picture remains the same. Chapter 2 of SSAR Appendix B provides a description of each of the folds and faults surrounding the ESP site. Rather than attempting to characterize the seismic potential of these folds and faults, the applicant defined broad seismic source zones that encompass these structural features. Within a 200-mile radius of the site (or just beyond), the two major sources of potential earthquakes are the NMSZ and WVSZ. In addition to the NMSZ and WVSZ, evidence from recent paleoliquefaction studies indicates that significant earthquakes have occurred in the central Illinois basin, where there are no obvious folds or faults at the surface. Although the size, location, and recurrence of such events are not well constrained, the applicant developed a background source zone for this region, referred to as the central Illinois basin background source zone. The staff's evaluation of the applicant's characterization of these areal seismic sources for its PSHA is provided in SER Section 2.5.2.3.3.

In addition to evaluating regional structural folds and faults, the applicant also evaluated the regional tectonic setting for the ESP site using the most recent results from a GPS network in southern Illinois. The applicant reported that given the current level of error in individual GPS observations, an extended period of time will be required before these observations can fully characterize the regional strain field. The applicant also found that recent geodetic measurements in the NMSZ indicate that the rate of strain accumulation is below the current detection threshold; however, these observations are not inconsistent with a model of seismicity in intraplate regions occurring along weak zones in the crust.

The staff reviewed the applicant's description of the individual structural features (folds and faults) for completeness and accuracy. SER Section 2.5.1.3.1 provides the staff's review of the applicant's description. The staff concurs with the applicant's decision to use large areal seismic source zones rather than attempting to characterize the seismic potential of each of the regional structural features. Both the LLNL and EPRI PSHA seismic source models, endorsed by RG 1.165, use this approach. As described in SER Section 2.5.2.3.3, the applicant updated the EPRI-SOG source model for its PSHA for the ESP site.

2.5.2.3.3 Correlation of Earthquake Activity with Geologic Structure or Tectonic Province

The staff focused its review of SSAR Section 2.5.2.3 on the applicant's updating of the original EPRI-SOG seismic source and ground motion models for its PSHA for the ESP site. The applicant based its update on an evaluation of recent geological and seismological information. The specific areas that the applicant focused on for each of the three major seismic source zones (NMSZ, WVSZ, and central Illinois) are earthquake recurrence rates, maximum magnitudes, and ground motion attenuation.

Earthquake Recurrence Rates. The applicant compared the updated seismicity catalog with an additional 17 years of earthquake data to the original EPRI-SOG catalog and found that the recurrence rates used for the EPRI-SOG study are still valid. In addition to the smaller recorded events over the past 17 years, the applicant also added earthquakes that have occurred in the three source zones as revealed by paleoliquefaction studies. The applicant found that for the central Illinois basin and the WVSZ, the fit of earthquake recurrence relationships to the recorded seismicity envelops the rates of larger earthquakes estimated from paleoliquefaction data. However, for the NMSZ, the applicant found that recent paleoliquefaction data provide evidence that large-magnitude earthquakes have occurred on NMSZ faults more frequently than the seismicity rates specified in the EPRI-SOG source characterizations for NMSZ.

As described in SER Section 2.5.2.1.3, the applicant used the characteristic earthquake model for the occurrence of large earthquakes in the NMSZ. The characteristic earthquake model states that certain fault segments tend to move by approximately the same distance in each earthquake, implying that individual faults repeatedly generate earthquakes of similar size at or near their maximum magnitude. For the NMSZ, the three fault sources that the applicant modeled with the characteristic approach are the NS fault, NN fault, and RF. Based on the characteristic earthquake model, these three faults within the NMSZ have repeatedly generated similar sized earthquakes during each of the previous NMSZ earthquake sequences, including the most recent 1811–1812 sequence. The best constraints on recurrence of characteristic NMSZ events are from paleoliquefaction studies throughout the New Madrid seismic region and paleoseismic investigations of the RF scarp and associated fold. Based on these studies, researchers have found that NMSZ characteristic earthquake sequences have occurred around AD 1450 ± 150, AD 900 ± 100, AD 490 ± 50, AD 300 ± 200, and BC 1370 ± 970, in addition to the recent 1811–1812 sequence. The applicant fit the recurrence intervals between these dates with two recurrence models, a Poissonian model and a lognormal model, weighing each model equally. In addition, for each of these NMSZ earthquake sequences, the applicant determined, based on its review of the literature, that the RF has ruptured in each of the previous sequences but the NN and NS sources may not have produced large earthquakes in all three sequences. The applicant used these observations to set the relative frequency of event sequences in the NMSZ as (1) rupture of all three sources (NN, RF, and NS) one-third of the time, (2) rupture of NN and RF one-third of the time, and (3) rupture of NS and RF one-third of the time.

In RAI 2.5.2-5, the staff asked the applicant to justify its modeling of the relative frequency of event sequences in the NMSZ. Specifically, the staff noted that Tuttle et al. (2002) concluded that all three sources (RF, NN, and NS) ruptured in each of the three sequences, but that one-third of the time the NN rupture may have been smaller than for the 1811–1812 sequence, and one-third of the time NS may have been smaller than in 1811–1812. Tuttle et al. (2002) also concluded that these smaller earthquakes are at least magnitude 7 events. This result differs from the event sequence modeling used by the applicant for NMSZ, which does not include NN or NS for some of the event sequences. The applicant responded to RAI 2.5.2-5 by stating the following:

For the seismic source model developed for the New Madrid characteristic earthquakes in Appendix B of the EGC ESP SSAR, Figure 6 of Tuttle et al. (2002) was used to infer that previous ruptures of the New Madrid North and New Madrid South faults may have been approximately one magnitude unit smaller than the estimated site of the 1811–1812 ruptures. The magnitudes for the 1811–1812 sequence shown on Figure 6 of Tuttle et al. (2002) were those developed by Johnston (1996). The information presented on Figure 6 of Tuttle et al. (2002) was used to infer the relative size of ruptures of the New Madrid North and New Madrid South faults in the 1450 and 900 sequences compared to the 1811–1812 ruptures. Thus, if the size of the 1811–1812 ruptures on these faults were in the low magnitude M 7 range (e.g., values estimated by Bakun and Hooper, 2003), then the size of previous ruptures would have been below magnitude M 7. These smaller ruptures, which would be considered dependent events, were not included in the hazard calculations as characteristic earthquakes. The rupture model developed for the New Madrid characteristic earthquake sources in the EGC ESP Application consisted of three possible sequences, each occurring with a relative frequency of 1/3. One sequence consisted of full ruptures of all three New Madrid faults; one sequence consisted of full rupture of the New Madrid North and Reelfoot thrust faults, with the rupture of the New Madrid South fault being approximately one magnitude unit smaller than the 1811 rupture (this smaller dependent event was not included in calculating the hazard); and one sequence consisted of the full rupture of the New Madrid South and Reelfoot thrust faults, with the rupture of the New Madrid North fault being approximately one magnitude unit smaller than the 1811 rupture (this smaller dependent event was not included in calculating the hazard).

For two of the three NMSZ earthquake sequence models, the applicant considered either the NN or NS a smaller dependent event and, as such, did not include this smaller event for its calculation of the hazard. Dependent events are generally considered to be aftershocks of the main event, and, although dependent events can cause significant damage, a PSHA is intended to evaluate the hazard from discrete, independent releases of seismic energy. Therefore, dependent events are removed from the seismicity database before calculating the final PSHA hazard curves. However, the difference in magnitude between the three earthquakes in the NMSZ sequences is uncertain; therefore, the applicant's decision to identify either the NN or NS as smaller dependent events (for two of the three sequences) and not include them in the hazard calculation is questionable. In its response to RAI 2.5.2-5, the applicant stated that it discussed its NMSZ event sequence modeling with Dr. Tuttle since the model is based on an interpretation of Figure 6 of Tuttle et al. (2002). The applicant stated the following regarding its discussion with Dr. Tuttle:

In addition, recent discussions with Dr. Tuttle indicate that she considers that the difference between the size of the 1811–1812 earthquakes and those of the 900 and 1450 sequences are likely to be smaller than what was portrayed in Figure 6 of Tuttle et al. (2002). Consequently, a revised model for New Madrid sequences was developed consisting of two alternative models for earthquake sequences. In Model A, all ruptures are similar in size to the 1811–1812 earthquakes. Model B is similar to the model used in PSHA for the EGC ESP

Application in that 1/3 of the sequences contain a smaller rupture of the New Madrid North fault and 1/3 of the sequences contain a smaller rupture of the New Madrid South fault. However, the difference in magnitude from the 1811–1812 ruptures was set to be no more than ½ magnitude unit, and no ruptures were allowed to be less than M 7. In addition, all three earthquakes were included in the hazard calculation in all rupture sequences. Model A (always full ruptures) was given a weight of 2/3 and Model B a weight of 1/3 based on Dr. Tuttle's expression of the difficulties in estimating the size of the pre 1811–1812 ruptures and her judgment that the difference between the rupture sizes was likely smaller than that proposed in Tuttle et al. (2002). The hazard resulting from this revised model for rupture sequences combined with the updated magnitude distribution (response to RAI 2.5.1-1) is shown on the curves labeled "Revised magnitudes and sequences" on Figure 2.5.2-5-1. These results produce approximately 9 to 10 percent higher ground motions at the mean 10^{-4} and mean 10^{-5} hazard levels.

The staff reviewed the Tuttle et al. (2002) paper and found that the authors' "preferred interpretation of prehistoric sand blows" is that "at least two earthquakes occurred in A.D. 1450 and A.D. 900 that were similar in size and location to the largest 1811–1812 earthquakes." Based on this statement, the staff concurs with the applicant's revised modeling as described above in response to RAI 2.5.2-5. The staff notes that the applicant found that the hazard resulting from this revised model for rupture sequences combined with the updated magnitude distribution (response to RAI 2.5.1-1) produce approximately 9 to 10 percent higher ground motions at the mean 10^{-4} and mean 10^{-5} hazard levels. In summary, regarding the updated information for the NMSZ (magnitude distribution for rupture sets and ruptures sequence models), the applicant stated the following in its response to RAI 2.5.2-5:

> The assessment of the size of the 1811–1812 earthquakes and the likely scenarios for future ruptures continues to be an area of active research, and thus it is possible that the assessments presented in the ESP Application will undergo future evolution. It is expected, however, that the effects of these changes will be on the order of those presented in the sensitivity analyses presented in this response, and the calculated 1-Hz ground motions corresponding to the mean hazard in the 10^{-4} and 10^{-5} range will vary from those presented in the ESP Application by plus or minus 10 percent or less. A revision to the EGC ESP Application, therefore, is not warranted at this time.

The staff considers the applicant's rationale for not updating its seismic hazard characterization of the NMSZ to be inadequate. In response to the staff's RAIs, the applicant has updated both the magnitudes for the NMSZ characteristic earthquake rupture sets (RAI 2.5.1-1) and rupture sequence modeling (RAI 2.5.2-5). However, for both updates, the applicant only performed limited sensitivity analyses and did not update either its PSHA or SSE. The staff considers both of these updates to the NMSZ characteristic earthquake modeling to be of sufficient importance to justify updating both the PSHA and SSE for the ESP site. In Open Item 2.5.1-1, the staff asked the applicant to incorporate this newer information into its PSHA or SSE and to update the SSAR to reflect the corrected magnitude estimates and rupture sequence modeling. In response, the applicant updated its source characterization of the New Madrid earthquakes, including both the magnitudes for the NMSZ characteristic earthquake rupture sets and rupture sequence modeling. These changes have been incorporated into Revision 1 of the ESP application. Therefore, the staff considers Open Item 2.5.1-1 to be resolved.

In conclusion, as described above, the staff concurs with the applicant's decision to incorporate the characteristic earthquake model for the large NMSZ earthquakes into the original EPRI-SOG model. In addition, the staff concurs with the applicant's use of the most recent models for the NMSZ rupture sequences.

Maximum Magnitudes. The applicant focused on the maximum magnitude values for the NMSZ, WVSZ, and central Illinois background seismic source zone, since these three zones are the main contributors to the total seismic hazard at the ESP site. For the NMSZ, the applicant concluded that the maximum magnitudes used for the EPRI-SOG model (7.2 to 8.8) are consistent with the more recent maximum magnitude evaluations (7.4 to 8.2). For the WVSZ, the maximum magnitudes range from 5.0 to 8.0, while recently published maximum magnitudes range from 7.0 to 7.8. Similarly, for the central Illinois background source zone, the maximum magnitudes used for the EPRI-SOG model range from 4.3 to 7.6, while recently published maximum magnitudes range from 6.0 to 7.0. As a result, the applicant concluded that the maximum magnitude values for both the WVSZ and central Illinois source zone need to be increased to reflect the magnitudes implied by recent paleoliquefaction studies.

The staff reviewed the NMSZ, WVSZ, and central Illinois source zone maximum magnitudes used by the applicant for its PSHA for the ESP site. The staff concurs with the applicant's conclusion that the EPRI-SOG maximum magnitudes for the NMSZ adequately cover the range of magnitudes estimated from recent geologic investigations, as described above. For the WVSZ, the staff reviewed the revised maximum magnitude range used by the applicant to verify its consistency with recent paleoliquefaction studies. The magnitude of the largest paleoearthquake in the lower Wabash Valley (the Vincennes-Bridgeport earthquake), which occurred 6011 ± 200 years ago, was estimated to be between 7.2 to 7.8. The next largest earthquake in the WVSZ has an estimated magnitude of about 7.1 to 7.2 and occurred 12,000 ± 1,000 years ago. The applicant used the following maximum magnitude range for the Wabash Valley region—M 7.0 (0.1), M 7.3 (0.4), M 7.5 (0.4), and M 7.8 (0.1). Based on the magnitudes of these two paleoearthquakes, the staff considers that the applicant's maximum magnitude range and weighting are appropriate for the WVSZ.

For its update of the maximum magnitudes of the central Illinois basin/background source zone, the applicant used a 1994 EPRI study that specifically addresses the problem of defining a maximum magnitude for seismic source regions that are characterized by the rare occurrence of maximum earthquakes without well-defined seismicity patterns associated with seismic sources. The 1994 EPRI study developed worldwide databases that could be used for assessments of maximum magnitudes for seismic sources in the CEUS. Using the database and method found in the 1994 EPRI study, the applicant developed the following maximum magnitude range for earthquakes in the central Illinois source zone—M 6.2 (0.4), M 6.4 (0.3), M 6.6 (0.2), and M 6.8 (0.1). This range of maximum magnitudes is strongly influenced by the estimated M 6.2 to 6.8 Springfield earthquake, which occurred about 6000 years ago about 30 miles to the southwest of the ESP site. In RAI 2.5.2-4, the staff asked the applicant to provide further detail and justification regarding its use of the 1994 EPRI study and accompanying worldwide database of earthquakes. Specifically, the staff requested the applicant to explain why its maximum magnitude for central Illinois should not be set at 6.8

since the two largest SCR earthquakes from nonextended crust are the Accra, Ghana, earthquake of 1862 (M 6.75 ± 0.35) and the Meeberrie, Western Australia, earthquake of 1941 (M 6.78 ± 0.25). In its response to RAI 2.5.2-4, the applicant stated the following regarding its use of the 1994 EPRI study and its maximum magnitude for central Illinois:

> The EPRI-SOG assessments of seismic source characteristics in the CEUS did not start with the assumption that maximum magnitude is the same throughout the region or even throughout regions with similar characteristics. The EPRI-SOG assessments of maximum magnitude for the central Illinois source zone needed to be updated because of new information—the discovery of the Springfield paleo-earthquake. This update could have been performed using the EPRI-SOG approach—expert elicitation, but this would require a major study comparable to the EPRI-SOG program. As an alternative, the Johnston et al. (1994) Bayesian approach [1994 EPRI study] was used. The Johnston et al. (1994) Bayesian approach was developed as part of a study specifically focused on the assessment of maximum magnitudes in Stable Continental Regions (SCR). It provides a quantitative approach based on evaluation of a worldwide database of SCR earthquakes and crustal domains. This approach provides a reasonable method for assessing the uncertainty in maximum magnitude.
>
> The Bayesian approach for estimating maximum magnitude developed by Johnston et al. (1994) does not start from the assumption that all SCR domains have the same maximum magnitude. Instead it assumes that there are characteristics that control the maximum size of an earthquake that can occur in an individual SCR domain and these characteristics vary from domain to domain, just as the maximum size of earthquakes varies for other source types (e.g., plate-boundary faults, subduction zones). The statistical analysis presented in Chapter 5 of Johnston et al. (1994) explored the utility of using the characteristics of the SCR domains as predictors of maximum magnitude. The first step in the process was the development of "super domains" by "pooling" the data for domains that "cannot, with the information available, be considered different." The primary objective of pooling was to increase the earthquake sample size for a given super domain to provide a more constrained estimate of maximum magnitude. The resulting super domains were distinguishable from each other using the tectonic, geologic, and seismologic information gathered as part of the project. The prior distribution from Johnston et al. (1994) used in the EGC ESP probabilistic seismic hazard analysis (PSHA) assessment of maximum magnitude for central Illinois was based on grouping all of the 15 non-extended crust super domains and estimating the statistics of the maximum magnitudes of that group of domains. These 15 super domains all had the common characteristic of non-extended crust, but differ in other characteristics that may or may not be related to differences in maximum magnitude, such as crustal age, state of stress, and orientation of stress relative to structure. The Johnston et al. (1994) analysis did not assume that all of the non-extended crust super domains are identical, and thus would have the same maximum magnitude.

Using the EPRI (1994) approach, the applicant developed the maximum magnitude distribution described above (M 6.2 (0.4), M 6.4 (0.3), M 6.6 (0.2), and M 6.8 (0.1)), with a mean maximum magnitude of 6.65. As requested by the staff in RAI 2.5.2-4, the applicant compared the 10-Hz spectral acceleration hazard curves for the ESP site using its maximum magnitude distribution for central Illinois versus a single fixed value of a maximum magnitude equal to 6.8. The applicant found that the two maximum magnitude distributions yield nearly the same hazard, with the single value of M 6.8 maximum magnitude producing approximately only 2 to 3 percent higher ground motions at the mean 10^{-4} and mean 10^{-5} hazard levels.

To determine the adequacy of the maximum magnitude distribution used by the applicant for the central Illinois seismic source zone, the staff reviewed the 1994 EPRI study and, specifically, the Bayesian analysis recommended by the study. The Bayesian approach to assessing maximum magnitude is derived from the statistical analysis of the SCR global earthquake database (prior distribution) in combination with local or regional earthquakes (e.g., the Springfield earthquake). The prior magnitude distribution, based on the global earthquake database, is combined with information (the sample likelihood function for maximum magnitude) specific to the regional seismic source of interest, and the final product is a probabilistic distribution (posterior distribution) of maximum magnitude that incorporates uncertainties in the assessment. The Bayesian analysis used by the applicant for the central Illinois maximum magnitude produces a posterior distribution of maximum magnitude having a modal value of M 6.5 and a mean of M 6.7. This mean maximum magnitude is close to the value (M 6.8) used by the USGS for its national hazard maps and also to the magnitudes of the two largest earthquakes globally observed (Ghana and Australia) in nonextended SCR domains, similar to the central Illinois source zone. The staff notes, as described above by the applicant, that the difference between these two maximum magnitudes (M 6.7 and 6.8) is insignificant, producing only 2 to 3 percent higher ground motions at the mean 10^{-4} and mean 10^{-5} hazard levels. The staff also notes, based on its review of the global earthquake database used by the 1994 EPRI study, that no nonextended SCR domain has had a historical earthquake of M 7.0 or larger. Although this observation from the historical record of SCR seismicity is based on a small time sample of one to a few centuries, the historical record includes all known SCR earthquakes. In addition, there are no tectonic processes that affect SCRs and operate fast enough to undercut the assumption that the SCR seismicity of a few centuries before the SCR historical record likely looks much like the historical record itself. As such, the 1994 EPRI global database for SCR earthquakes provides a first-order description of how SCR crust behaves seismically in the present millennium or so of the present plate-tectonic cycle. In summary, the staff concludes that the applicant's use of the global SCR earthquake database in combination with paleoliquefaction data for the central Illinois source zone results in an adequate characterization of the maximum magnitude distribution of the central Illinois seismic source zone.

In conclusion, as described above, the staff concurs with the applicant's decision to increase the maximum magnitude distributions of the WVSZ and central Illinois source zone.

Ground Motion Attenuation. As described in SSAR Section 2.5.2.3, the original EPRI-SOG study used three attenuation relationships, developed in the mid 1980s. Since the completion of the EPRI-SOG study, estimating ground motions in the CEUS has been the focus of considerable research. The applicant used the expert-elicitation guidance in NUREG/CR-6372 to characterize the distribution of ground motion prediction for the CEUS. This study and the resulting CEUS ground motion attenuation relationships are described in an EPRI 2003 publication. The EPRI study grouped the selected ground motion attenuation relationships into four clusters, in which each cluster represents a group of models based on a similar approach for ground motion modeling. After comparing the three attenuation models used for the EPRI-SOG study with the new EPRI ground motion study, the applicant concluded that the recent median ground motion models are generally consistent with two of the three older models. However, the estimates of uncertainty or variability about the median ground motion predictions are considerably higher for the recent ground motion attenuation relationships compiled by the recent EPRI study compared to the uncertainty in the ground motion used for the original EPRI-SOG study. Therefore, the applicant decided to use the updated attenuation models.

In RAI 2.5.2-3, the staff asked the applicant to describe how the recent EPRI ground motion study converted the distance measure used for each of the attenuation relationships to a common measure. Specifically, the 13 CEUS attenuation relationships selected by the EPRI ground motion experts each use one of two different distance measures. In response to RAI 2.5.2-3, the applicant provided a description of the method it used to convert the "point-source" distance measure to the more commonly used Joyner-Boore distance measure. In EPRI ground motion clusters 1, 2, and 4, all but two of the individual models (Frankel et al., 1996; and Atkinson and Boore, 1995) use the Joyner-Boore distance, which is the closest distance from the site to the surface projection of the fault rupture in kilometers. The other two ground model attenuation relationships use the hypocentral distance, which is the distance from the site to the earthquake focus in kilometers. To convert the point-source distance to the Joyner-Boore distance, the applicant described the following method:

> These two relationships [Frankel et al. (1996) and Atkinson and Boore (1995)] were converted to Joyner-Boore distance by simulating a data set in terms of moment magnitude and Joyner-Boore distance and fitting this simulated data set. At a given Joyner-Boore distance, earthquake point source depths were simulated for a range of magnitudes using the point-source depth distributions for the CEUS proposed by Silva et al. (2002). These consist of lognormal distributions with the parameters listed in the following table.

Point-Source Depth Distribution Parameters (from Silva et al. 2002)

Magnitude	Minimum Depth	Median Depth	Maximum Depth	$\sigma_{\ln(D)}$
4.5	2 km (1 mi)	6 km (4 mi)	15 km (9 mi)	0.6
5.0	2 km (1 mi)	6 km (4 mi)	15 km (9 mi)	0.6
5.5	2 km (1 mi)	6 km (4 mi)	15 km (9 mi)	0.6
6.0	3 km (2 mi)	7 km (4 mi)	17 km (11 mi)	0.6
6.5	4 km (2.5 mi)	8 km (5 mi)	20 km (12 mi)	0.6
7.0	4.5 km (2.8 mi)	9 km (5.6 mi)	20 km (12 mi)	0.6
7.5	5 km (3 mi)	10 km (6 mi)	20 km (12 mi)	0.6
8.0	5 km (3 mi)	10 km (6 mi)	20 km (12 mi)	0.6
8.5	5 km (3 mi)	10 km (6 mi)	20 km (12 mi)	0.6

For each simulation, the depth and the Joyner-Boore distance were used to compute the corresponding point source distance. The median ground motion for the given magnitude and point source distance were then computed using the Frankel et al. (1996) and Atkinson and Boore (1995) relationships. The resulting simulated data sets were then fit with an appropriate functional form to provide ground motion relationships in terms of moment magnitude and Joyner-Boore distance consistent with the other relationships in Clusters 1 and 2.

In Open Item 2.5.2-1, the staff requested further clarification regarding the EPRI study's distance conversion process. In response, the applicant provided a detailed description of the distance conversion process used in the EPRI CEUS ground motion model. Specifically, the staff asked for clarification on the process used to convert Joyner-Boore distance to hypocentral distance so that the two attenuation relationships based on hypocentral distance can be combined with the relationships based on Joyner-Boore distance. In response, the applicant provided a detailed description of the distance-conversion process for the two attenuation relationships (Atkinson and Boore, 1995; and Frankel et al., 1996). The staff's review of the distance-conversion process determined that the EPRI (2003) implementation process provides a smooth variation with distance and results in somewhat higher median ground motions only at very small values of Joyner-Boore distance. Therefore, the staff considers Open Item 2.5.2-1 to be resolved.

The ESP applicant for the North Anna, Virginia, site also used the EPRI 2003 ground motion study for its PSHA. Many of the staff's RAIs and the open item related to the updated EPRI CEUS ground motion modeling are described in Section 2.5.2 of the staff's final SER for North Anna (ADAMS Accession No. ML051610246). After reviewing the North Anna ESP applicant's responses to the staff's RAIs and open item, the staff concluded that Dominion had adequately resolved each of the staff's concerns with regard to the development by EPRI of new ground motion models for the CEUS.

2.5.2.3.4 Maximum Earthquake Potential

The staff focused its review of SSAR Section 2.5.2.4 on the ESP site controlling earthquakes determined by the applicant after completion of its PSHA. The applicant determined the low- and high-frequency controlling earthquakes by deaggregating the PSHA results at selected probability levels. Before determining the controlling earthquakes, the applicant updated the original EPRI-SOG PSHA using the seismic source zone adjustments and new ground motion modeling described above in the previous SER subsection.

PSHA Results. The applicant performed PSHA calculations for PGA and spectral acceleration at frequencies of 25, 10, 5, 2.5, 1, and 0.5 Hz. Following the guidance provided in RG 1.165, the PSHA calculations were performed assuming generic hard rock site conditions (i.e., an S-wave velocity of 9200 ft/s). The actual local site characteristics are incorporated in the calculation of the SSE spectrum, which uses the hard rock PSHA hazard results as the starting point.

Controlling Earthquakes. To determine the low- and high-frequency controlling earthquakes for the ESP site, the applicant followed the procedure outlined in Appendix C to RG 1.165. This procedure involves the deaggregation of the PSHA results at a target probability level to determine the controlling earthquake in terms of a magnitude and source-to-site distance. The applicant chose to perform the deaggregation of the mean 10^{-4} and 10^{-5} PSHA hazard results. The low- and high-frequency controlling earthquakes are shown above in Table 2.5.2-1 in SER Section 2.5.2.1.4. For the high-frequency mean 10^{-4} hazard, the controlling earthquake is a magnitude 6.5 event occurring at a distance of 83 km (52 mi), corresponding to an earthquake from the WVSZ. In contrast, for the high-frequency 10^{-5} hazard, the controlling earthquake has a magnitude of 6.2 at a distance of only 24 km (15 mi). This controlling earthquake corresponds to the Springfield earthquake from the central Illinois background source zone. For the low-frequency mean 10^{-4} and 10^{-5} hazard, the controlling earthquake has a magnitude of 7.2 at a distance of 320 km (199 mi). This earthquake corresponds to an event in the NMSZ.

Based on its review of the ESP site controlling earthquake magnitudes and distances, the staff concludes that the applicant's PSHA adequately characterized the overall seismic hazard of the ESP site. The staff also concludes that the applicant's controlling earthquakes for the ESP site (magnitude of 6.2 at 24 km (15 mi), magnitude 6.5 at 83 km (52 mi), and magnitude of 7.2 at 320 km (199 mi)) are generally consistent with both the historical earthquake record and paleoliquefaction studies in the NMSZ, WVSZ, and central Illinois seismic source zone. In addition, the staff finds that the ground motions developed by the applicant from the controlling earthquakes (see SER Figure 2.5.2-2) are consistent with the most recent CEUS ground motion evaluations. Accordingly, the staff concludes that the applicant followed the guidance in RG 1.165 for evaluating the regional earthquake potential and determining the ground motion resulting from the controlling earthquakes.

2.5.2.3.5 Seismic Wave Transmission Characteristics of the Site

The staff focused its review of SSAR Section 2.5.2.4 on the method used by the applicant to develop the site free-field ground motion spectrum. The hazard curves from the PSHA are defined for generic hard rock conditions. According to the applicant, these hard rock conditions exist at the ESP site at a depth of several thousand feet or more below the ground surface. To determine the free-field ground motion, the applicant performed a site response analysis.

The staff reviewed the applicant's analysis to ensure that it accurately incorporates the local site properties and conditions as well as their uncertainties. The applicant developed 60 different randomized soil/rock columns in order to model the uncertainties in the soil/rock properties, such as S-wave velocity, density, shear modulus, and damping. The applicant determined these soil/rock properties through its field explorations and laboratory tests, which are described in SER Section 2.5.4.

Based on the large range in S-wave velocities for some of the soil layers (Table 5-2 of SSAR Appendix A) and the differences in SPT blowcount values for ESP borings B1 and B4 compared to those of B2 and B3, the staff in RAI 2.5.4-4 requested that the applicant justify the appropriateness of using a single "average" soil column for the site response analyses rather than including a number of different base-case soil columns. In response to RAI 2.5.4-4, the applicant stated that the variations in S-wave velocity and SPT blowcounts result from "changes in the depositional conditions during formation of the soil profile and the geologic history of the site following deposition." The applicant further stated that for the ESP site, the geologic history includes the advance and retreat of a substantial thickness of ice during the last ice age. This ice loaded the material located below approximately 50 ft, which led to very dense or hard soil conditions (i.e., overconsolidation) by the ice load. Because of the ice loading, the variability of the soil existing below 50 ft after initial formation has been reduced. In contrast, the applicant reported that the soil in the upper 50 ft was formed by fluvial (river) and aeolian (wind) processes, resulting in more variability both vertically and horizontally.

Regarding the modeling of this variability in soil properties, the applicant stated the following:

> In recognition of the natural variability of the soil, the standard approach for site response analyses is to account for the likely variation in soil layering and soil properties within a specific layer by considering different combinations of soil property and soil profile conditions that could exist at a site. One method for evaluating these variations is by manually creating independent soil columns, as suggested in the RAI. The alternative that was taken during the EGC ESP site ground motion response studies was to statistically create a large number of profiles, or realizations, and conduct the site response analyses using these profiles.

The applicant concluded its response to RAI 2.5.4-4 by stating that the randomization process used to develop the transfer functions at the ESP site allows the uncertainty in soil layering and soil properties to be considered during the evaluation of site response effects.

The staff reviewed the applicant's response and found that the large variability in strength and stiffness of the site soils, as demonstrated by the S-wave velocities and SPT blowcounts from the relatively few borings taken at the EGC ESP site, indicates a potentially large epistemic uncertainty in site profiles that cannot easily be captured directly by the randomization process. In Open Item 2.5.2-2, the staff asked the applicant to further justify using only a single site velocity model to account for the variability in strength and stiffness of the site soils. In response, the applicant indicated that the soils in the upper 60 ft of the site will be removed during plant construction and replaced by engineering fill. Since the fill material will be placed under consistent compaction and gradation controls, the variability in shear wave velocity of the engineered fill will be significantly lower than that of the in situ soils. As such, the staff considers Open Item 2.5.2-2 to be resolved.

To account for the variability in soil shear strain modulus and material damping ratio with shearing strain amplitude, the applicant randomized the shear modulus and damping curves used for the site response analysis. In RAI 2.5.4-7, the staff asked the applicant to explain how these curves were used in the randomization process with respect to both the different depth ranges and the soil types occurring within those depth ranges. For example, the soil boring logs indicated that some soils are clays and some soils are silty sands over the same particular depth range. In response to RAI 2.5.4-7, the applicant stated that the modulus and material damping curves are primarily dependent on the depth range and not on the material type. The applicant stated that this is consistent with the development of the EPRI modulus reductions and material damping curves (EPRI, 1993), in which the standardized curves are based only on depth interval, thereby avoiding the need to link the modulus reduction curves and damping curves to the soil boring log. The applicant further stated that the independence of the modulus reductions and material damping curves from the specific soil type is based on laboratory tests that show that the primary variable contributing to the variation in shape and absolute value of the modulus reduction and material damping curves is the depth of the soil below the ground surface, which is an indication of the effective confining pressure on the soil sample. With regard to other variables that may affect the shape and magnitude of the modulus reduction and material damping curves, the applicant stated the following:

> Since there is evidence that the type of soil also has some effect on the shape and magnitude of the modulus reduction and material damping curves—though it can be considered a secondary effect—a range of unique modulus reduction and material damping curves is computed within each depth interval (i.e., 0 to 20, 21 to 50, 51 to 120, etc.) through the randomization process. The computation performed for the EGC ESP project resulted in 60 modulus reduction curves and 60 material damping curves with each of the five depth intervals. The range represented by each of the 60 sets of curves is intended to cover the uncertainties in the shape and absolute value of the modulus reduction and material damping ratio curves resulting from a number of different effects, including the particular soil type, the stress history for the soil, sample disturbance associated with the laboratory testing of soil samples, and random variability that is typically observed in laboratory testing programs.

In summary, the applicant stated that the randomization process for modulus reduction and material damping curves, as well as the low-strain S-wave velocity and thickness profiles, results in combinations of soil stiffness and damping conditions that account for the possible variations in soil type, soil layer thickness, and dynamic soil properties for the EGC ESP site.

In RAI 2.5.4-7, the staff also asked the applicant to explain why it did not incorporate the 15-percent damping cutoff as recommended in SRP Section 3.7.2 and to provide clarification regarding its use of high strain values in the randomization process. In response, the applicant stated that the 15-percent damping in SRP Section 3.7.2 pertains to soil-structure interaction (SSI) problems and not to free-field, site response analyses. The applicant also stated that there is no evidence in laboratory testing programs that material damping should be capped at 15 percent. Regarding the effect of using a 15-percent damping cutoff for the ESP site, the applicant stated the following:

> For a stiff site such as occurs at the EGC ESP Site, the 15 percent cutoff is expected to have little effect except perhaps in the shallowest soil layers, where the shear modulus is lowest. Where soils are relatively stiff and peak ground acceleration only moderate, such as occurs at the EGC ESP Site, the equivalent shearing strains will often be low enough that damping ratios do not exceed 15 percent. Only the upper 50 feet or so of soil profile at the EGC ESP site, where the shear modulus is reduced, could the site response potentially be affected by the damping cutoff.
>
> However, to support the response to this RAI, a series of supplemental computer runs were conducted using the low-strain shear wave velocity profile, the SHAKE program, and modulus reduction curves as discussed in the EGC ESP SSAR. For these supplemental analyses, the material damping curves in the EPRI soil model were capped at 15 percent. The results of a representative set of these analyses were compared to the mean transfer functions shown in Figures 4.2-23 and 4.2-24 from Appendix B of the EGC ESP SSAR. This comparison indicated

that the 15 percent damping cap results in no more that a 2 percent increase in the transfer function for the 10-5 hazard level motions and much less for the 10-4 hazard level motions for the EGC ESP Site. These effects are considered negligible.

In summary, in its response to RAI 2.5.4-7, the applicant indicated that using the EPRI 1993 shear modulus and material damping curves (EPRI TR-102293, "Guidelines for Determining Design Basis Ground Motions") eliminates the need to associate particular laboratory results for individual soil layers in the response calculations. However, the staff notes, as indicated in the plots included in the SSAR, that the difference between nonlinear material models for sandy soils as compared to clayey soils can be significant for high strain levels. As a result, this difference in soil type may result in more than just a secondary effect. The response calculations performed for the EGC ESP site only considered the material models associated with sandy soils. The potential existence of high-plasticity index clay soils at the site is not discussed to a significant extent in the applicant's response.

Regarding the issue related to the 15-percent damping cutoff, the applicant stated that the guideline of the 15-percent damping cutoff in SRP Section 3.7.2 pertains to the SSI problem, but not the site response calculation. This is not acceptable to the staff, because the 15-percent cutoff limit for hysteretic damping mentioned in the SRP is not restricted to SSI analyses only, but is associated with the one-dimensional free-field calculations typically performed before the SSI analyses. The purpose of this restriction acknowledges the fact that at these high strain levels associated with the laboratory tests, the assumption of steady-state behavior is questionable. Therefore, the staff's position has been that excessively high damping values are not appropriate for site response calculations. The applicant stated that the use of the 15-percent damping cutoff in the calculation causes the surface design motions to increase by about 2 percent.

In Open Item 2.5.2-3, the staff asked the applicant to address the impact of plastic clay soils at the site on the assumption of the independence of the modulus reductions and material damping curves from the specific soil type. In response, the applicant presented plots of Atterberg Limit data for the various soils of the site that demonstrate that these soils are silts and sandy silts of low plasticity. Since the applicant has demonstrated that the site soils have low plasticity, the staff concludes that this portion of Open Item 2.5.2-3 is resolved.

In Open Item 2.5.2-3, the staff also asked the applicant to implement the 15-percent damping cutoff in its free-field, site response analyses. In response, the applicant performed new site response calculations using the 15-percent damping cutoff and used these results for computation of the SSE. These changes have been incorporated into Revision 1 of the ESP application. Since the applicant has incorporated the 15 percent damping cutoff in its free-field, site response analyses, the staff considers this issue and Open Item 2.5.2-3 to be resolved.

To determine the ESP dynamic site response, the applicant developed appropriate ground motion or earthquake time histories for several (12) deaggregation earthquakes, which correspond to the low- and high-frequency controlling earthquakes shown above in Table 2.5.2-2. The applicant selected matching earthquake time histories for each of the deaggregation earthquakes from the CEUS time history library provided with NUREG/CR-6728.

As part of its review of the applicant's site response analysis, the staff verified that the deaggregation earthquake magnitudes and distances adequately characterized the local and regional seismic hazard for the ESP site. The three deaggregation earthquakes corresponding to each controlling earthquake represent lower, middle, and higher magnitude earthquakes appropriate for the ESP site. Specifically, the lower magnitude deaggregation earthquake (M = 5.7–6.0 at R = 11–15 km (9 mi)) corresponds to a local earthquake occurring in the central Illinois source zone, the middle magnitude deaggregation earthquake (M = 6.7–6.9 at R = 140–166 km (103 mi)) corresponds to an earthquake in the Wabash Valley-southern Illinois region, and the upper magnitude deaggregation earthquake (M 7.2–7.4 at R = 375–381 km (237 mi)) corresponds to a New Madrid earthquake.

To determine the final site response, the applicant used the program SHAKE to compute the site amplification function for each of the deaggregation earthquakes. The applicant paired the 60 randomized velocity profiles with the 60 sets of randomized shear modulus and damping curves (i.e., one velocity profile with one set of modulus reduction and damping curves). To obtain a site amplification function, the applicant divided the response spectrum from the computed surface motion by the response spectrum from the input hard rock motion. The applicant then computed the arithmetic mean of these 60 individual response spectral ratios to define the mean amplification function for each deaggregation earthquake.

The results of the applicant's site response analysis show that the ESP site subsurface amplifies the input hard rock motion over the fairly wide frequency range of 0.5 to 10 Hz, with the maximum amplification of 3.3 at a frequency of 1.7 Hz. The final site amplification function for each controlling earthquake represents the weighted average of the amplification functions for the associated deaggregation earthquakes. The weights (see SER Table 2.5.2-2) represent the relative contribution of earthquakes represented by the deaggregation earthquakes to the hazard at the appropriate spectral frequency and hazard level. The applicant determined the final soil surface spectra for the ESP site by scaling the rock controlling earthquake spectra by the mean site amplification functions.

In summary, the staff concludes that based on its review of SSAR Section 2.5.2.5, as described above, the applicant's site response analysis adequately incorporates the effects of the local site properties and their uncertainties into the determination of the ESP free-field SSE, as required by 10 CFR 100.23.

2.5.2.3.6 Safe-Shutdown Earthquake

The staff focused its review of SSAR Section 2.5.2.6 on the method used by the applicant to determine the SSE ground motion spectra (horizontal and vertical) for the ESP site. Rather than developing the SSE as recommended by RG 1.165, the applicant used a new method called the performance-based approach. The performance-based approach, which is described in ASCE/SEI Standard 43-05, sets a target of a mean annual frequency of 10^{-5} of unacceptable performance of Category I nuclear SSCs as a result of seismically initiated events. This safety performance target, P_{FT}, is based on assuming (1) a target 10^{-4} mean annual risk of core damage from all accident initiators and (2) that seismic initiators contribute about 10 percent of the risk of core damage posed by all accident initiators. To determine the SSE that achieves the annual performance goal of 10^{-5}, the performance-based approach scales the site-specific mean 10^{-4} UHRS, determined in the previous section, by a DF. The equations for the SSE and

DF are provided in SER Section 2.5.2.1.6. As shown previously in Table 2.5.2-3, a DF is determined for several spectral frequencies in order to create the final SSE.

In RAI 2.5.2-1(a), the staff asked the applicant to justify the selection of the site-specific mean 10^{-4} UHRS as the appropriate starting point for determining the final SSE. In response to RAI 2.5.2-1(a), the applicant stated the following:

> [The] design amplitude required to achieve the performance goal at each structural period can be calculated starting from the mean 10^{-4} annual probability level of the seismic hazard spectrum in the free field at the ground surface, or from the 10^{-5} annual probability level, or from any intermediate probability level. The design factor on the spectrum associated with each of these probability levels would be different, but they all would lead to the same SSE.

The applicant explained that it selected a 10^{-4} annual probability level as the starting point based on the precedent set in ASCE/SEI Standard 43-05. After reviewing the derivation of the equations used by the performance-based approach to achieve an SSE that meets the target performance goal (see SER Section 2.5.2.1.6.1), the staff was able to verify the applicant's assertion that using a 10^{-4} annual probability level as the starting point is an arbitrary choice.

In RAI 2.5.2-1(b), the staff asked the applicant to demonstrate that the SSE envelops the site-specific response spectra from the controlling earthquakes at the reference probability level (median 10^{-5} per year) recommended by RG 1.165 or to justify why this approach was not used to determine the SSE. In response to RAI 2.5.2-1(b), the applicant stated the following:

> The EGC ESP does not rely on the site-specific response spectra from the controlling earthquakes at the hazard reference probability level of median 10^{-5} per year to determine the site-specific SSE. Instead, the ASCE/SEI Standard 43-05 is implemented to determine the site-specific SSE. Application of the ASCE/SEI Standard results in site-specific ground motions that are risk-consistent with the median of the mean seismic-induced core damage frequencies ([S]CDFs) [1.2×10^{-5}] determined from probabilistic risk assessments (PRAs) of existing nuclear power plants, which the Commission has determined to be adequately safe.

Regarding the method recommended in RG 1.165 for determining the SSE, the applicant stated the following:

> Studies carried out in 2003 and 2004 during the ESP Application process have found that the current understanding of seismic sources and ground motion models within the central and eastern United States may result in a significant increase in seismic hazard at some sites. These changes in seismic hazard indicate a need to update the reference probability given in RG 1.165 to account for new ground motion models, new seismic source information, and better site response adjustments.
>
> After reviewing the alternatives, EGC has concluded that a re-evaluation of the hazard reference probability in Appendix B of RG 1.165 would not achieve the

regulatory stability sought by RG 1.165 and necessary for EGC to proceed with their current ESP Application or any future ESP application(s). Relative to overall industry needs, a revision to the current reference probability based on seismic information available in 2004 would remain valid only until new information becomes available on seismic sources near one or more of the 29 sites, or when new information becomes available on ground motion attenuation models. On a site-specific basis, EGC does not support development of an SSE using a reference probability that is not based on the latest seismic hazard information. Moreover, advances in technologies for determining site-specific SSEs since the late 1980s together with advances in NRC's regulation implementation policies, specifically the implementation of the Commission's Risk-Informed Regulation Policy, support the need for updating the guidance contained in RG 1.165 to comply with the current state of the practice (e.g., ASCE SEI methodology). This generic action is outside the scope of the EGC ESP submittal.

The staff acknowledges that the reference probability currently recommended in RG 1.165 (median 10^{-5} per year), which is the average probability of exceeding the SSE ground motion at 5 Hz and 10 Hz using either the 1993 LLNL PSHA or the 1989 EPRI-SOG PSHA, needs to be updated to more adequately represent current seismic hazard information. RG 1.165 endorses both the original LLNL and EPRI-SOG PSHAs; however, it also recommends updating the seismic source characterizations and ground motion models if they differ significantly from the original LLNL or EPRI models. RG 1.165 also states that the staff will review proposals for revised reference probability values on a case-by-case basis. The most important criterion for evaluating the acceptability of either the RG 1.165 approach with a revised reference probability or a new approach, such as the performance-based approach, is the suitability, with respect to the geological and seismological setting of the specific site, of the final SSE ground motion spectra resulting from either approach. Specifically, as required by 10 CFR 100.23, the SSE must provide a design-basis ground motion that adequately reflects the seismic characteristics of the proposed site. As described below in Open Item 2.5.2-4, the staff has concluded that the SSE for the ESP site satisfies this requirement.

In RAI 2.5.2-1(c), the staff asked the applicant to justify using SSC seismic fragility information, before the selection of a reactor design, to determine the site SSE. In response to RAI 2.5.2-1(c), the applicant stated that the performance-based approach "combines a conservative characterization of equipment/structure performance with ground motion hazard to establish risk-consistent SSEs, rather than only hazard-consistent ground shaking, as occurs using the hazard reference probability approach in Appendix B of RG 1.165." As described in SER Section 2.5.2.1.6.1 in the derivation of the equations and assumptions underlying the performance-based approach, the two parameters used by the performance-based approach to model SSC seismic fragility are the *HCLPF* and variability β. Since the actual *HCLPF* seismic capacity varies for different SSCs, the performance-based approach quantifies this value in terms of the SSE ground motion level and a required seismic margin (Equation 2.5.2-11). Following the recommendations of ASCE/SEI 43-05, the applicant selected a value of one for the seismic margin. As shown by Equation 2.5.2-19 in SER Section 2.5.2.1.6.1, a margin (M_s) of unity is a conservative choice since larger margins would result in a smaller SSE value. A margin of one implies that *HCLPF* = SSE for each SSC. This is a conservative assumption since designers will typically be more cautious than to design the HCLPF seismic capacity to barely resist the SSE ground motion. Assuming a smaller seismic margin (i.e., of unity) is equivalent to assuming that the seismic design criteria are less stringent, and hence a larger (more conservative) SSE ground motion will be used. For the β value, which varies from 0.3 to 0.6, the applicant used 0.4. This assumed value for β is discussed below as part of Open Item 2.5.2-5.

2.5.2.3.6.1 Derivation of the Performance-Based Approach

In RAI 2.5.2-7(b), the staff asked the applicant to provide the details of the derivation of the DF that, when multiplied by the mean 10^{-4} UHRS, achieves an SSE that meets the target performance goal of 10^{-5}. In response to RAI 2.5.2-7(b) the applicant provided an explanation of the performance-based method, including the important assumptions and derivations (see SER Section 2.5.2.1.6.1 for the complete derivation). The staff's review of the underlying assumptions and equations used for the performance-based approach resulted in further questions concerning the following assumptions:

- the assumption of a linear hazard equation *H(a)* in logarithmic space and, specifically, the determination of the slope of the hazard equation, $-1/\log(A_R)$, between only the 10^{-4} and 10^{-5} interval
- the assumption that the seismic capacity variability β is 0.40
- the definition of unacceptable performance as the "onset of significant inelastic deformation" (OSID) or "exceedance of essentially elastic behavior"
- the stability of the target performance goal 10^{-5} since this value is from seismic PRAs that used the original EPRI-SOG source models and ground motion estimates
- the applicability of the target performance goal 10^{-5} for advanced reactor designs that may differ considerably from current light-water reactors (LWRs)
- the consistency between the seismic design criteria in NUREG-0800 and ASCE/SEI Standard 43-05

In Open Item 2.5.2-5, the staff requested clarification and further information from the applicant regarding each of the six issues outlined above. The applicant's response and the staff's evaluation are provided below.

<u>Linear Hazard Equation</u>. In Open Item 2.5.2-5(a), the staff asked the applicant to justify the assumption of a linear hazard curve in logarithmic space (see Equation 2.5.2-13 and Figure 2.5.2-7) and the appropriateness of solely using the 10^{-4} to 10^{-5} interval to determine the amplitude ratio A_R and, as such, the DF. In response, the applicant stated the following:

> In developing the design factor, DF, the seismic hazard curve was approximated by a power law which results in a linear hazard curve when plotted on a log-log plot. Seismic hazard curves are close to linear when plotted on a log-log plot. However, they are not perfectly linear. They always curve downward with decreasing hazard exceedance frequency. Thus A_R reduces as the hazard

exceedance frequency is reduced. In other words, an A_R computed over the range of hazard exceedance frequencies from $1x10^{-4}$/yr to $1x10^{-5}$/yr will be larger than that computed over the $1x10^{-5}$/yr to $1x10^{-6}$/yr range.

In addition, the applicant stated that "based upon several hundred rigorous convolutions of hazard and fragility curves, it has been found that P_{FT} is dominated by the portion of the fragility curve between about the 1% failure probability capacity $C_{1\%}$ and the 70% failure probability capacity $C_{70\%}$" (see Figure 2.5.2-11 for an illustration of this portion of the fragility curve). The applicant also compared SSE values obtained by direct integration of the risk integral (Equation 2.5.2-9), which uses the entire hazard and fragility curves, versus the those obtained by using the risk equation (Equation 2.5.2-1), which assumes a linear hazard curve in log-log space between the exceedance frequencies of $1x10^{-4}$/yr to $1x10^{-5}$/yr. Comparing the two results, the applicant stated, "one can see that the use of the approximate power law hazard curve introduces a slight, but generally negligible, conservative bias for the computed P_{FT}."

To verify the acceptability of assuming a linear hazard curve in log-log space between the exceedance frequencies of $1x10^{-4}$/yr to $1x10^{-5}$/yr to determine the SSE via the risk equation as opposed to direct convolution of the risk integral, the staff requested four hazard curves from the applicant. Figure 2.5.2-7 above shows these four hazard curves (1 Hz, 2.5 Hz, 5 Hz, and 10 Hz). The staff then compared the SSE values using these two approaches (i.e., "direct integration" and "risk equation"), which are shown below in Table 2.5.2-4. For both approaches, the staff assumed $\beta = 0.4$ and a performance target of mean $1x10^{-5}$/yr.

Table 2.5.2-4 Comparison of Performance-Based SSE Values

	SSE	
Natural Frequency (Hz)	Risk Integral (g)	Risk Equation (g)
1.0	0.3366	0.3945
2.5	0.5737	0.6582
5.0	0.6043	0.6570
10.0	0.5591	0.5864

Since the seismic hazard curves have a slight downward curvature, as illustrated in Figure 2.5.2-7, assuming a linear fit results in slightly higher exceedance values and, as a result, slightly higher SSE values, as illustrated above in Table 2.5.2-4. Therefore, the staff concludes that the applicant's use of the approximate power law hazard curve is slightly conservative and therefore acceptable.

Seismic Capacity Standard Deviation. In Open Item 2.5.2-5(b), the staff asked the applicant to justify why a β value of 0.4 was used and show how the DF varies with different β values over the range of amplitude ratios (A_R). In response, the applicant stated that the developers of the performance-based approach considered β values between 0.3 and 0.6 and A_R values between 1.5 and 4.5 when developing Equation 2.5.2-1 for DF. Regarding β values, the applicant stated that "the results for β of 0.4 and 0.5 were weighted more heavily than those for β of 0.3 and 0.6

because the fragility β values are most likely in the 0.4 and 0.5 range and β of 0.3 and 0.6 are considered to be extreme low and high values, respectively."

As shown previously in Figure 2.5.2-14 in Section 2.5.2.1.6.1, the DF recommended in ASCE/SEI 43-05 (Equation 2.5.2-1) is slightly unconservative for β=0.3 and conservative for larger β of 0.4 to 0.6. To evaluate the significance of the range of β values on the DF, the staff determined the unacceptable performance frequency values (P_{FT}) for the performance-based SSE values for four natural frequency values 1, 2.5, 5, and 10 Hz. The applicant determined the four performance-based SSE values shown below in Table 2.5.2-5 using the performance-based approach as described in ASCE/SEI 43-05, which assumes a β value of 0.4 and a target performance goal of $1x10^{-5}$/yr. The staff used the four hazard curves provided by the applicant to determine P_{FT} via direct integration of the risk integral (Equation 2.5.2-9) for β ranging from 0.3 to 0.6. As shown below in Table 2.5.2-5, the P_{FT} values for β=0.3 are only slightly larger than the target value of $1x10^{-5}$/yr.

Table 2.5.2-5 Unacceptable Performance Frequency Values for β from 0.3 to 0.6

		P_{FT}*10^{-5}/yr			
Freq (Hz)	SSE (g)	β=0.3	β=0.4	β=0.5	β=0.6
1.0	0.3945	1.08	0.95	0.70	0.55
2.5	0.6582	1.05	0.97	0.73	0.59
5.0	0.6670	1.03	0.96	0.71	0.58
10.0	0.5864	1.02	0.91	0.65	0.52

Since the P_{FT} values for β=0.3 are only slightly larger than the target performance goal of 10^{-5}/yr and fragility β values of 0.3 are not common for SSCs, the staff concludes that the applicant's assumption that β=0.4 for determining the SSE is acceptable.

Onset of Significant Inelastic Deformation. In Open Item 2.5.2-5(c), the staff asked the applicant to clarify the meaning of "onset of significant inelastic deformation" (OSID), specifically the words "onset" and "significant," OSID with regard to the failure of SSCs and core damage, and the relationship of OSID to "essentially elastic" behavior. In response, the applicant stated that OSID means that "localized inelasticity might occur at stress concentrations, [but] the overall seismic response (deformations) will be essentially the same as those computed by [a] linear elastic demand analysis." The applicant also stated that in ASCE/SEI 43-05 essentially elastic behavior (or OSID) is achieved by requiring that the seismic demand computed by sufficiently conservative linear elastic analysis is less than the conservative code-specified allowable seismic capacity (without an "inelastic factor" by which the linear elastic demand can exceed the code capacity). Generally there is less than a 2 percent probability of large inelastic deformation if the actual demand reaches the code capacity (as discussed in the commentary of ASCE/SEI 43-05).

Based on the applicant's response, the staff has determined that OSID is just beyond the occurrence of insignificant (or localized) inelastic deformation, and in this way corresponds to "essentially elastic behavior." As such, OSID of an SSC can be expected to occur well before seismically induced core damage, resulting in much larger frequencies of OSID than SCDF values. In fact, as implied by the applicant's definition, OSID occurs before SSC "failure," where the term failure refers to impaired functionality. To further demonstrate that the frequency of OSID is larger than SCDF, the staff used the four EGC ESP hazard curves (1, 2.5, 5, and 10 Hz) to calculate SCDF values for each of the four performance-based SSE values. In performing this calculation of SCDF, the staff used the risk integral equation (Equation 2.5.2-9) with the complete range of expected β values (0.3 to 0.6) and assumed that the seismic margin (M_s) against core damage is 1.67 for new standard plant designs as specified in staff requirements memorandum (SRM), dated July 21, 1993, on SECY 93-087. As shown in Table 2.5.2-6 below, SCDF values for the four natural frequencies and β values vary from 0.08×10^{-5}/yr to 0.32×10^{-5}/yr.

Table 2.5.2-6 SCDF Values for Clinton Performance-Based SSE

		SCDF $*10^{-5}$/yr			
Freq (Hz)	SSE (g)	β=0.3	β=0.4	β=0.5	β=0.6
1.0	0.3945	0.32	0.28	0.20	0.16
2.5	0.6582	0.20	0.18	0.13	0.11
5.0	0.6570	0.16	0.15	0.11	0.10
10.0	0.5864	0.11	0.12	0.09	0.08

For comparison, NUREG-1742 shows, based on the results of seismic PRAs of 25 nuclear power plants, that the median value for the mean core damage frequency is 1.2×10^{-5}/yr. Therefore, by setting the target performance goal, P_{FT}, to be a FOSID value of 1×10^{-5}/yr, the resulting SSE computed using the ASCE/SEI 43-05 methodology provides SCDF values that are substantially lower than those for most of the 25 nuclear power plants provided in NUREG-1742. Figure 2.5.2-15 in SER Section 2.5.2.1.6.1 shows the results of the seismic PRAs from NUREG-1742 in terms of mean ground motion recurrence interval, which is the inverse of mean SCDF. Figure 2.5.2-17, below, shows these same results and adds the values computed above in Table 2.5.2-5 for the EGC ESP site. For the natural frequencies of 5 and 10 Hz and for β values of 0.4 and 0.5, SCDF is about 1×10^{-6}/yr for the EGC ESP performance-based SSE, which is about 10 times lower than the median of the mean SCDF for the 25 nuclear power plants in NUREG-1742.

In conclusion, the staff has determined that there is a significant difference between OSID, which is set at 10^{-5}/yr as the target performance goal, and seismic core damage. This result follows from assuming that the seismic margin against core damage is 1.67 as specified in SRM, dated July 21, 1993, on SECY 93-087.

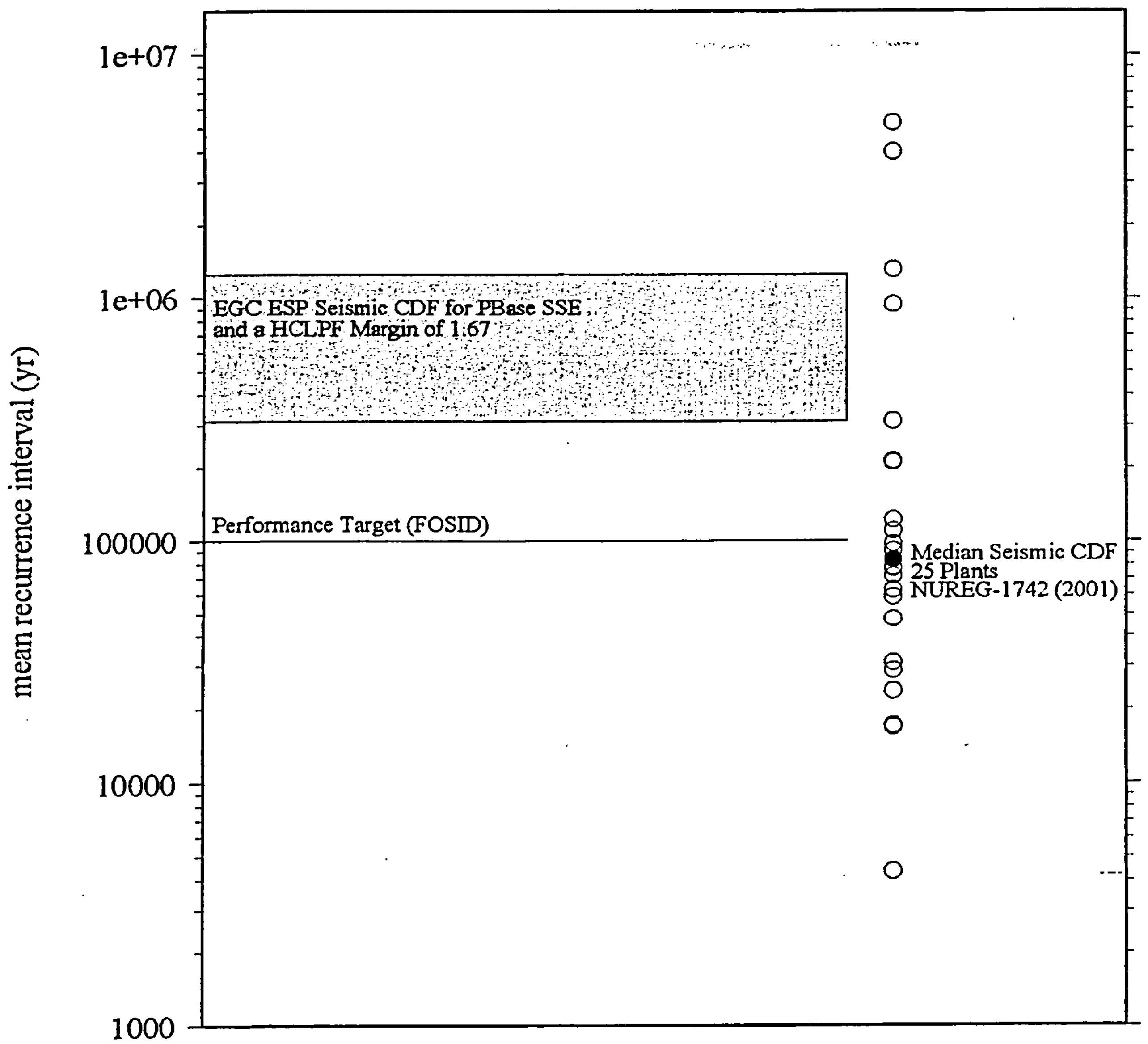


Figure 2.5.2-17 Seismic core damage in terms of mean ground motion recurrence interval for EGC ESP site and 25 nuclear power plants. For comparison, FOSID is also shown.

Stability of Target Performance Goal. In Open Item 2.5.2-5(d), the staff asked the applicant to justify the long-term stability of the target performance goal $1x10^{-5}$ in comparison to the hazard-based approach (reference probability) in RG 1.165, as both values are based on PSHAs for several CEUS nuclear sites. In response, the applicant stated the following:

> Although Regulatory Guide 1.165 was officially issued in early 1997, the guidance is based on late 1980s to early 1990s technologies. EGC recognized that the reference probability approach of Regulatory Guide 1.165 does not provide the regulatory stability that was originally intended and expected, as it is inherently unstable with the updating of the input parameters for PSHAs for CEUS sites. Updating the PSHAs at CEUS sites changes the basis upon which the reference probability was established and a new reference probability must be established. The performance-based criterion on the other hand, remains unchanged by updating the PSHAs, even though the site-specific SSE ground motion will reflect the updated PSHA results. The method provides uniform performance across sites and thus provides performance consistency and regulatory stability.

Although the target FOSID value of $1x10^{-5}$/yr is based on the mean SCDF of $1.2x10^{-5}$/yr from the seismic PRAs of 25 nuclear power plants, as described above and in NUREG-1742, the applicant stated that the performance-based criterion "remains unchanged by updating the PSHAs." Since the target performance criterion (i.e., the FOSID value of $1x10^{-5}$/yr) produces an SSE for the EGC ESP site that adequately reflects the regional and local seismic hazards (see Open Item 2.5.2-4 below) and this performance criterion will remain fixed, the staff finds that the performance-based approach is an adequately stable method.

Applicability of Target Performance Goal. In Open Item 2.5.2-5(e), the staff asked the applicant to justify the use of the target performance goal of $1x10^{-5}$/yr for advanced reactor designs, which may differ considerably from current LWRs. As described above in the applicant's response to RAI 2.5.2-7(a), the target performance goal is based on seismic PRAs for current LWRs. In its response, the applicant stated that the performance-based approach sets the target performance goal of $1x10^{-5}$/yr to be equal to the FOSID for SSCs. Furthermore, the applicant stated that the "onset of significant inelastic deformation of an SSC does not correspond to Seismic-Induced Core Damage particularly for an advanced reactor design with redundant safety features."

Regardless of the advanced reactor design, in SRM, dated July 21, 1993, on SECY 93-087, the Commission approved the use of 1.67 times the design basis SSE for a margin-type assessment of seismic events. Using this criterion, the staff calculated SCDF values for the EGC ESP SSE, as described above in Table 2.5.2-5, that range from 0.18 to $0.09x10^{-5}$/yr for natural frequencies 2.5, 5, and 10 Hz and β equal to 0.4 and 0.5. Based on these results, the staff concludes that the applicant's use of $1x10^{-5}$/yr as the target performance goal results in an SSE for the EGC ESP site that is adequately conservative.

Comparison of NUREG-0800 and ASCE/SEI 43-05. In Open Item 2.5.2-5(f), the staff asked the applicant to clarify how the design criteria in ASCE/SEI Standard 43-05 are similar enough to the seismic criteria in NUREG-0800 such that SSCs designed following NUREG-0800 would also achieve a 1 percent or lower probability of unacceptable performance. In response, the applicant stated that the seismic design criteria in ASCE/SEI Standard 43-05 for Seismic Design Category SDC-5D are nearly identical to the NRC SRP (NUREG-0800), RGs, and professional design codes and standards referenced therein. The staff compared the two design standards and found that the differences between the seismic demand criteria in ASCE/SEI Standard 43-05 and the SRP are sufficiently small that SSCs designed following the SRP will also achieve a 1 percent or lower probability of unacceptable performance for the design-basis earthquake ground motion.

In conclusion, after extensive review, the staff finds that the performance-based approach is an advancement over the solely hazard-based reference probability approach recommended in RG 1.165. The performance-based approach uses not only the seismic hazard characterization of the site from the PSHA, but also basic seismic fragility SSC modeling in order to obtain an SSE that directly targets a structural performance frequency value. The staff concludes that the applicant targeted a sufficiently low value ($1x10^{-5}$/yr), which it set to be equivalent to FOSID, such that the resulting performance-based SSE achieves an SCDF that is about 10 times smaller ($1x10^{-6}$/yr) than the median of the mean SCDF for the 25 nuclear power plants in NUREG-1742. Therefore, the staff considers Open Item 2.5.2-5 to be resolved.

2.5.2.3.6.2 Target Annual Performance Goal

In RAI 2.5.2-7(a), the staff asked the applicant to justify the selection of the mean annual frequency of 10^{-5} as the safety performance target for the unacceptable performance of Category I SSCs as a result of seismically initiated events. In response to RAI 2.5.2-7(a), the applicant made the following four main points:

(1) The results from seismic PRAs, which were performed for 25 nuclear facilities, show an annual mean SCDF of 10^{-5} or higher for seismic core damage for 50 percent of the operating power plants.

(2) Setting the performance goal of 10^{-5} to be equivalent to the annual FOSID of SSCs is conservative since the seismic demand resulting in the onset of significant inelastic deformation is less than that for failure of the SSC.

(3) The target 10^{-5} annual performance goal is achieved so long as seismic demand and structural capacity evaluations have sufficient conservatism, which is inherent for plants reviewed and approved using the SRP guidelines.

(4) The target 10^{-5} annual performance goal results in a plant that is as safe as the plants currently operating, as shown by the seismic PRAs.

The primary basis for the target 10^{-5} annual performance goal is from the results of seismic PRAs of 25 nuclear power plants (NUREG-1742), which show the median value for the mean SCDF to be $1.2x10^{-5}$. The results of the seismic PRAs in terms of mean ground motion recurrence interval, which is the inverse of SCDF, are shown above in Figure 2.5.2-17. Since the target 10^{-5} annual performance goal and the accompanying performance-based approach for determining the SSE constitute a major departure from the hazard-based approach currently recommended by RG 1.165, in addition to focusing on the underlying assumptions of the performance-based approach (see Open Item 2.5.2-5 above) the staff also focused on the results of its application to the EGC ESP site. To determine the appropriateness of the target 10^{-5} annual performance goal and performance-based approach for the EGC ESP site, the staff reviewed the applicant's final SSE to ensure that it adequately reflects the regional and local seismic hazards surrounding the ESP site.

As shown previously in SER Section 2.5.2.1.6, the final SSE using the performance-based approach is calculated by multiplying the DF and 10^{-4} surface UHRS. Since, by definition, the DF is at least 1.0, the final SSE ground motion spectrum will be at least the 10^{-4} UHRS and higher, depending on the value of the amplitude ratio (A_R) for the 10^{-4} and 10^{-5} hazard curves. For the EGC ESP site, the DF values from 2.5 to 100 Hz are very close to 1.0, implying that the final SSE, while meeting the target 10^{-5} annual performance goal, is close to the 10^{-4} surface UHRS. This result is shown by Figure 2.5.2-6 in SER Section 2.5.2.1.6, which shows the 10^{-4} and 10^{-5} surface UHRS along with the final SSE.

The high-frequency and low-frequency controlling earthquakes that provide the largest contribution to these two hazard levels (10^{-4} and 10^{-5}) for the ESP site were shown previously in SER Section 2.5.2.1.4. This table is repeated below for convenience.

Table 2.5.2-7 High- and Low-Frequency Controlling Earthquakes

Hazard	Magnitude (m_b)	Distance
Mean 10^{-4} High Frequency (5 and 10 Hz)	6.5	83 km (52 mi)
Mean 10^{-4} Low Frequency (1 and 2.5 Hz)	7.2	320 km (199 mi)
Mean 10^{-5} High Frequency (5 and 10 Hz)	6.2	24 km (15 mi)
Mean 10^{-5} Low Frequency (1 and 2.5 Hz)	7.2	320 km (199 mi)

Because the performance-based SSE is close to the 10^{-4} surface UHRS, the corresponding controlling earthquakes for the ESP site are M_w 6.5 at 83 km (52 mi) (high frequency) and m_b 7.2 at 320 km (199 mi) (low frequency). These two earthquakes correspond to events in the WVSZ and NMSZ, respectively. Both of these events are somewhat distant from the ESP site. In contrast, the mean 10^{-5} high-frequency controlling earthquake (m_b 6.2 at 24 km (15 mi)) represents a local earthquake from the central Illinois seismic zone.

The seismic hazard for the central Illinois basin/background source zone, which encompasses the ESP site, is dominated by the Springfield earthquake. Paleoliquefaction studies in the area have found evidence that one or, more likely, two prehistoric earthquakes occurred 5900 to 7400 years ago near Springfield, Illinois, approximately 37 mi southwest of the ESP site (McNulty and Obermeier, 1999). These earthquakes were large enough to generate liquefaction features, with magnitude estimates ranging between 6.2 and 6.8 for the larger event and at least 5.5 for the second event. In addition to the Springfield events, geologists have discovered paleoliquefaction features further south near Shoal Creek. The estimated magnitude and date for this event is about 6.5 and 5700 years BP. In addition to the above liquefaction features, the applicant also found smaller liquefaction features along the banks of streams closer to the ESP site. Finally, a magnitude 5.4 earthquake occurred in 1968 in the Illinois basin.

In Open Item 2.5.2-4, the staff asked the applicant to demonstrate that the SSE developed using the performance-based approach adequately reflects the local seismic hazard from the central Illinois basin/background source zone. In response, the applicant stated the following:

> The Springfield earthquake represents an event near the largest size expected to occur in the source zone [Central Illinois basin/background source zone] and at a relatively large distance (approximately 60 km epicentral distance). Because there is no concentration of seismicity at Springfield, there is no peak in the magnitude-distance distribution of earthquake frequencies at that distance, and earthquakes of comparable size can occur closer to the site. Because earthquakes smaller than the Springfield earthquake occur much more frequently, they have a larger contribution to the hazard. As a result, the procedure outlined in Regulatory Guide 1.165 would not identify the Springfield earthquake as a controlling earthquake. In addition, it would not appear as a peak (mode) in the magnitude-distance de-aggregation of the hazard.

In addition, the applicant directly compared the rock $UHRS_{10-4}$, which is slightly smaller than the SSE, and estimated ground motions for the Springfield event. Using the EPRI (2004) ground motion attenuation models, assuming the estimated energy center for the Springfield event to be the earthquake epicenter, and earthquake magnitudes and weights of M 6.2 (0.4), M 6.4 (0.3), M 6.6 (0.2), and M 6.8 (0.1), the applicant determined response spectra (median and 84th percentile) ground motion for comparison with the rock $UHRS_{10-4}$. The results of this comparison show that the rock $UHRS_{10-4}$ envelops both the median and 84th percentile ground motion from the Springfield earthquake at the ESP site. The scale factors to match the $UHRS_{10-4}$ at an average of 5 and 10 Hz spectral frequencies are 1.67 for the median and 1.20 for the 84th percentile.

The applicant also used the latest relationships for estimating the magnitude of prehistoric earthquakes based on the distribution of associated paleoliquefaction features to refine its magnitude estimates for the Springfield earthquake. The applicant used the relationship developed by Olson et al. (2005 in press) to estimate a magnitude of M 6.3 for the Springfield earthquake, which is consistent with the higher weight given to lower magnitudes in the distribution developed for the Springfield earthquake. The applicant then calculated ground motion response spectra from a magnitude 6.3 at 60 km for comparison with the $UHRS_{10-4}$. Figure 2.5.2-18, which is reproduced from Figure 2.5.2-4-12 from the applicant's response to Open Item 2.5.2-4, shows these comparisons of the ground motion estimates for the Springfield earthquake and the $UHRS_{10-4}$.

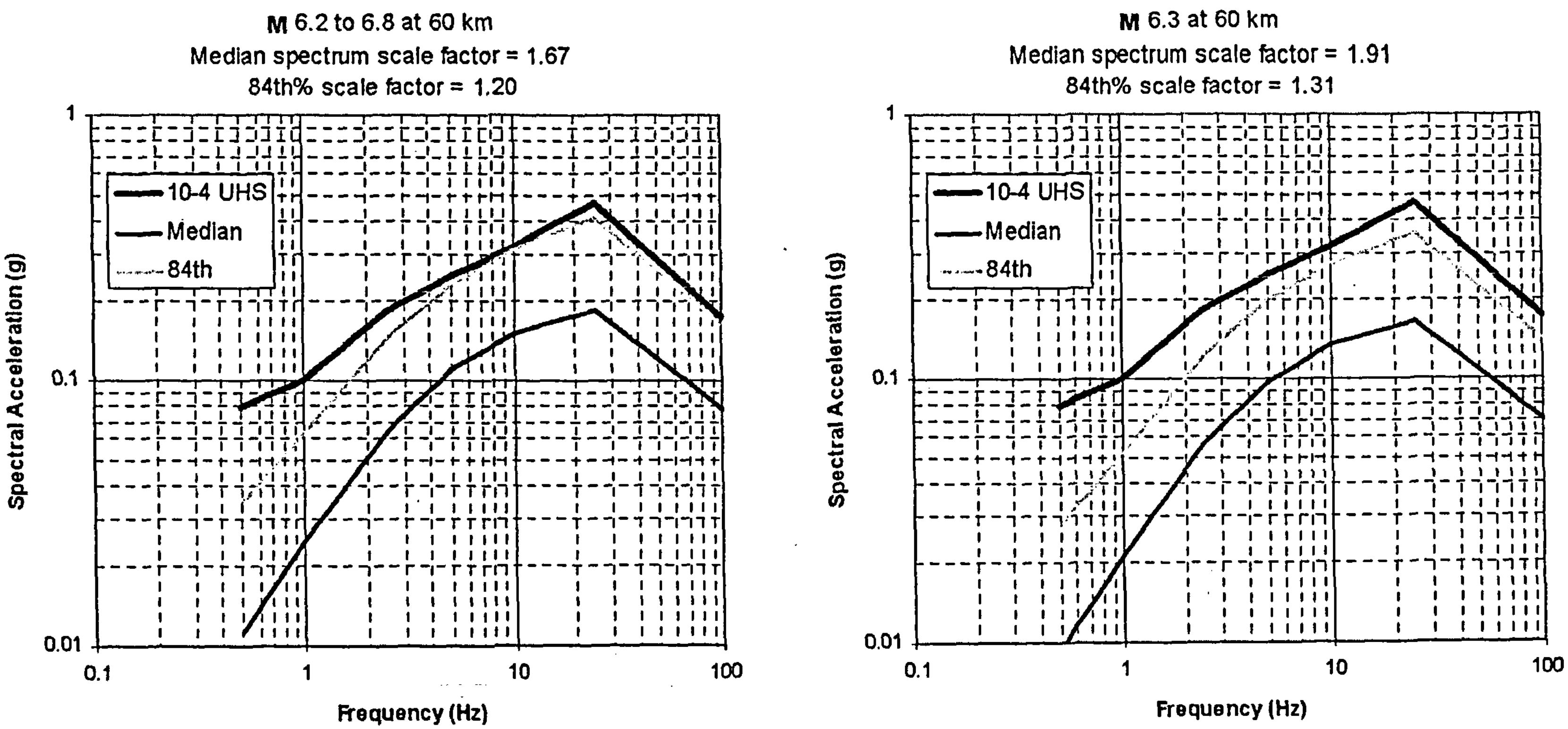


Figure 2.5.2-18 Comparison of $UHRS_{10\text{-}4}$ with estimated ground motion response spectra for the Springfield earthquake

To characterize the seismic hazards for the ESP site, including the controlling earthquake magnitudes and distances, the applicant used the guidance provided in RG 1.165. SER Sections 2.5.2.1 through 2.5.2.5 fully describe the results of this characterization. The applicant departed from RG 1.165 in the use of the performance-based approach for the ESP site to determine the final SSE. The staff has determined, as described above in Section 2.5.2.3.6.1, that the performance-based approach used by the applicant results in an SSE that is adequately conservative based on SCDF values of about $1x10^{-6}$/yr. In addition, based on its review of the applicant's response to Open Item 2.5.2-4, the staff concludes that the SSE adequately represents both the regional and local seismic hazards for the ESP site. This conclusion is based on the applicant's comparison of the estimated ground motion from the largest known prehistoric local event (Springfield earthquake) and the $UHRS_{10-4}$, which is slightly smaller than the SSE. This comparison shows that the SSE envelops the best estimates for the ground motion from the most severe local event. Therefore, the staff considers Open Item 2.5.2-4 to be resolved.

2.5.2.3.6.3 Vertical Safe-Shutdown Earthquake

To compute the vertical SSE, the applicant used the V/H response spectral ratios provided in NUREG/CR-6728. The V/H response spectral ratios given in NUREG/CR-6728 are CEUS hard rock site conditions and depend on the PGA value of the horizontal SSE spectrum. For the ESP site, the V/H ratios used by the applicant are based on having a PGA less than 0.5g. The vertical SSE spectrum is given by multiplying the horizontal SSE spectrum by the V/H ratios. The applicant also considered the effects of the ESP site soil conditions on the vertical ground motions by using ground motion models that provide vertical motions for soil conditions. The applicant used a magnitude 6.4 earthquake at source-to-site distance of 15 km (9 mi) as input to the ground motion models. This magnitude and distance roughly correspond to the high-frequency controlling earthquake.

To verify the adequacy of the V/H SSE ratios used by the applicant, the staff evaluated both the V/H ratios provided in NUREG/CR-6728 and the applicant's consideration of the local site effects on the vertical ground motions. The V/H ratios provided in NUREG/CR-6728 take into account the effects of magnitude, source distance, and local site conditions and are based on earthquake strong motion data. Previous regulatory guidance (RG 1.60 and NUREG/CR-0098) recommended that the V/H ratio be fixed at 2/3 independent of ground motion frequency, earthquake magnitude, distance, and local site conditions. To incorporate the effect of the local site conditions on the vertical ground motions, the applicant used a magnitude 6.4 at a source-to-site distance of 15 km. Based on its review of the V/H ratios provided in NUREG/CR-6728 and the applicant's use of a representative local controlling earthquake, the staff concludes that the V/H ratios used by the applicant are adequate for the EGC ESP site. The staff notes that for higher frequencies (20 Hz and above), the vertical SSE is larger than the horizontal SSE.

2.5.2.3.6.4 Design Response Spectrum

In SSAR Section 3.4.1.4.3, the applicant compared the horizontal performance-based SSE for the ESP site with the RG 1.60 DRS anchored to a PGA of 0.3g at 33 Hz, which is the DRS used by many of the current reactor designs. The applicant noted that the ESP SSE is lower than the RG 1.60 DRS except at frequencies between 15 and 65 Hz. However, after applying the high-frequency reduction factors recommended in a 1993 EPRI study, the ESP SSE is completely enveloped by the RG 1.60 DRS. The applicant concluded by stating that the high-frequency exceedances by the ESP SSE in relation to the RG 1.60 DRS are not significant, which indicates that the "EGC ESP site is suitable for any design based on the RG 1.60 DRS." Regarding the applicant's above conclusion, the staff has determined that its evaluation of ESP applications will not include a comparison of the site-specific SSE with generic DRS, which may or may not be used by the COL applicant. The staff's review of the acceptance of the final SSE is based on whether the SSE ground motion adequately reflects the local and regional seismic hazard and not on a comparison of the SSE with DRS. In addition, the staff is currently discussing the suitability of high-frequency ground motion reduction factors, similar to those in EPRI 1993, with industry representatives. Therefore, the staff rejects the applicant's conclusion that the ESP site, after the application of the high-frequency reduction factors, is suitable for any design based on the RG 1.60 DRS.

2.5.2.4 Conclusions

As set forth above, the staff reviewed the seismological information submitted by the applicant in SSAR Section 2.5.2. On the basis of its review of SSAR Section 2.5.2 and the applicant's responses to the RAIs, the staff finds that the applicant has provided a thorough characterization of the seismic sources surrounding the site, as required by 10 CFR 100.23. In addition, the staff finds that the applicant has adequately addressed the uncertainties inherent in the characterization of these seismic sources through a PSHA, and that this PSHA follows the guidance provided in RG 1.165. The staff concludes that the controlling earthquakes and associated ground motion derived from the applicant's PSHA are consistent with the seismogenic region surrounding the ESP site. In addition, the staff finds that the applicant's SSE, which was developed using the performance-based approach, adequately represents the regional and local seismic hazards and accurately includes the effects of the local ESP subsurface properties. After extensive review, the staff concludes that the performance-based approach is an advancement over the solely hazard-based reference probability approach recommended in RG 1.165. The performance-based approach uses not only the seismic hazard characterization of the site from the PSHA but also basic seismic fragility SSC modeling in order to obtain an SSE that directly targets a structural performance frequency value. The staff concludes that the proposed ESP site is acceptable from a geologic and seismologic standpoint and meets the requirements of 10 CFR 100.23.

2.5.3 Surface Faulting

SSAR Section 2.5.3 describes the potential for surface faulting at the ESP site. The information presented by the applicant in SSAR Section 2.5.3 is supplemented in Chapter 5 of SSAR Appendix B.

2.5.3.1 Technical Information in the Application

2.5.3.1.1 Surface Faulting Investigations

<u>Geologic Evidence for Surface Deformation</u>. To investigate the potential for surface faulting or fold deformation at the ESP site, the applicant constructed a site-specific geologic cross section based on the site borehole data. The applicant found that irregularities in the upper units of glacial till are not reflected in the older, underlying bedrock units. In particular, the contact

between the top of bedrock (300 ft below ground surface) and the overlying glacial till is flat-lying across the entire site. As a result, the applicant concluded that there is no potential for surface faulting or fold deformation at the ESP site.

Earthquakes Associated with Capable Tectonic Sources. As a result of its geologic investigations, the applicant concluded that there have been no historically reported earthquakes within 25 miles of the site that can reasonably be associated with a local geologic structure. At greater distances from the ESP site, historical earthquakes have been postulated to be associated with geologic faults. At approximately 50 miles from the ESP site, a group of small earthquakes has been postulated for the northern part of the Peru monocline. Other seismic activity within the WVSZ, over 100 miles from the ESP site, has been correlated with the CGL. In addition, the applicant noted that a spatial association of seismicity has been attributed to the Du Quoin monocline and Centralia fault zone in south-central Illinois. Each of these geologic structures is described in SER Section 2.5.1.1.1. Rather than characterizing the seismic potential of each of the above regional geologic structures, the applicant used the EPRI-SOG seismic hazard study, which groups these potential sources into large areal seismic sources zones.

Ages of Most Recent Deformation. To search for evidence of nearby prehistoric earthquakes, the applicant conducted extensive paleoliquefaction investigations along the banks of several streams near the ESP site. The applicant stated that the results of these investigations suggest that no repeated moderate to large events (comparable to the postulated M 6.2 to 6.8 Springfield earthquake) occurred in the site vicinity since the late Pleistocene (2 mya) that would indicate a capable tectonic structure within 25 miles of the ESP site. The applicant found only a small number of paleoliquefaction features and concluded that there was not sufficient information to estimate an earthquake location or magnitude. Although the applicant was unable to attribute these local paleoliquefaction features to a specific earthquake or geologic structure, the seismic activity of the area was characterized as a background areal seismic source zone, referred to as the central Illinois basin/background source. The central Illinois basin/background source encompasses the ESP site area and is modeled as part of the applicant's PSHA. The applicant's paleoliquefaction investigations and the central Illinois basin/background source are further described in SER Section 2.5.1.1.1.

Relationship of Tectonic Structures in the Site Area to Regional Tectonic Structures. Within a 25-mi radius of the ESP site, the applicant found no evidence of geologic faults. Based on its search of the geologic literature, the applicant noted that folds within the La Salle anticlinorium (series of anticlines) do lie within the 25-mile radius. However, the applicant stated that there is no evidence for tectonic surface deformation that is associated with this series of anticlines within 25 miles of the site.

Characterization of Capable Tectonic Sources. The applicant stated that it found no capable tectonic sources within 25 miles of the site.

Designation of Zones of Quaternary Deformation in Site Region. The applicant stated that the licensee's previous geologic investigations for the CPS site found no evidence of capable faulting. For the ESP application, the applicant conducted paleoliquefaction investigations along the banks of local streams, as described above and in SER Section 2.5.1.1.1. The applicant stated that the results of these paleoliquefaction investigations revealed evidence for possible seismic ground shaking associated with prehistoric earthquakes. However, the applicant found no evidence for tectonic Quaternary faulting or surface deformation during its field reconnaissance along the selected rivers. In addition, the applicant found no evidence for Quaternary deformation in the site region in the recent geologic literature.

Potential for Surface Tectonic Deformation. The applicant stated that the original investigations for the CPS site as well as its own investigations for the ESP site found no evidence for surface faulting or deformation that would pose a hazard to the ESP site.

2.5.3.2 Regulatory Evaluation

SSAR Section 2.5.3 describes the applicant's evaluation of the potential for surface deformation that could affect the site. The applicant did not state which regulations SSAR Section 2.5.3 addressed; however, in response to RAI 1.5-1, the applicant stated that it complied with all of the regulations listed in RS-002. This statement by the applicant implies that SSAR Section 2.5.3 conforms to the requirements of GDC 2 of Appendix A to 10 CFR Part 50, Appendix S to 10 CFR Part 50, and 10 CFR 100.23. In SSAR Table 1.5-1, the applicant stated that it developed the geological, seismological, and geophysical information used to evaluate the potential for surface deformation in accordance with the guidance presented in RG 1.165. The staff reviewed this portion of the application for conformance with the regulatory requirements and guidance applicable to determining the potential for near-surface tectonic and nontectonic deformation, as identified below. The staff notes that application of Appendix S in this portion of an ESP review, as referenced in 10 CFR 100.23(d), is limited to characterizing the potential for surface deformation as a basis for design.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 100.23(d)(2), which state that an applicant for an ESP must determine the potential for surface tectonic and nontectonic deformations. SRP Section 2.5.3 and RG 1.165 provide specific guidance concerning the evaluation of information characterizing the potential for surface deformation, including the geological, seismological, and geophysical data that the applicant needs to provide to establish the potential for surface deformation.

2.5.3.3 Technical Evaluation

This section of the SER provides the staff's evaluation of the seismological, geological, and geophysical investigations carried out by the applicant to address the potential for surface deformation that could affect the site. The technical information presented in SSAR Section 2.5.3 resulted from the applicant's surface and subsurface investigations performed in progressively greater detail as they moved closer to the ESP site. Through its review, the staff determined whether the applicant complied with the applicable regulations and whether the applicant conducted its investigations with an appropriate level of thoroughness.

In order to thoroughly evaluate the surface faulting investigations performed by the applicant, the staff sought the assistance of USGS. The staff and its USGS advisors visited the ESP site and met with the applicant to assist in confirming the interpretations, assumptions, and conclusions presented by the applicant concerning potential surface deformation. Specific areas of review during the staff's site visit included the applicant's geological investigations, with an emphasis on the applicant's paleoliquefaction reconnaissance of local streams. In addition, the staff reviewed the applicant's conclusions concerning the association of earthquakes with capable tectonic sources, the ages of most deformation, the relationship of local area tectonic structures to regional tectonic structures, the characterization of capable tectonic sources, the designation of zones of Quaternary deformation, and the potential for surface tectonic deformation.

As a result of its geologic investigations, the applicant found no potential for surface faulting or fold deformation at the ESP site. In addition, the applicant was unable to associate any of the historically reported earthquakes within 25 miles of the site with local geologic structures. Rather than characterizing the seismic potential of the known geologic folds and faults in the region, the applicant used the EPRI-SOG seismic hazard study, which groups these potential sources into large areal seismic source zones. The EPRI-SOG seismic hazard study is endorsed by RG 1.165 as an acceptable method for evaluating the seismic hazard for CEUS sites. The staff concurs with the applicant's characterization of the regional and local seismic sources as broad areal source zones. Within these source zones, earthquakes are modeled as occurring over a large area as part of the applicant's PSHA. The ESP site is located within the Illinois basin/background seismic source zone.

To search for evidence of nearby prehistoric earthquakes, the applicant conducted extensive paleoliquefaction investigations along the banks of several streams near the ESP site. The applicant found only a small number of paleoliquefaction features and concluded that there is insufficient information to estimate a location or magnitude for the prehistoric earthquake which caused these features. The staff concurs with the applicant's conclusion that the results of these paleoliquefaction investigations imply that no repeated moderate to large earthquakes comparable to the Springfield earthquake (M 6.2 to 6.8) occurred in the site vicinity during the past 6,700 to 7,000 years.

Based on its review of SSAR Section 2.5.3, as well as the supporting information in Chapter 5 of SSAR Appendix B, the staff concludes that the applicant adequately investigated the potential for surface faulting in the site area as required by 10 CFR 100.23. The staff concludes that the applicant performed extensive field investigations and concurs with the applicant's conclusion that there are no capable faults within the site area. The applicant noted that folds within the La Salle anticlinorium do lie within 25 miles of the site; however, the staff concurs with the applicant's statement that there is no evidence for tectonic surface deformation that is associated with this series of anticlines. Based on its site visit and its review of SSAR Section 2.5.3, as set forth above, the staff concurs with the applicant's conclusion that there are no capable tectonic sources within 25 miles of the site that would cause surface deformation in the site area.

2.5.3.4 Conclusions

In its review of the geological and seismological aspects of the ESP site, the staff considered the pertinent information gathered by the applicant during the regional and site-specific geological, seismological, and geophysical investigations. As a result of this review, described above, the staff concludes that the applicant performed its investigations in accordance with 10 CFR 100.23 and RG 1.165 and provided an adequate basis to establish that no capable tectonic sources exist in the site vicinity that would cause surface deformation in the site area.

The staff concludes that the site is suitable from the perspective of tectonic surface deformation and meets the requirements of 10 CFR 100.23.

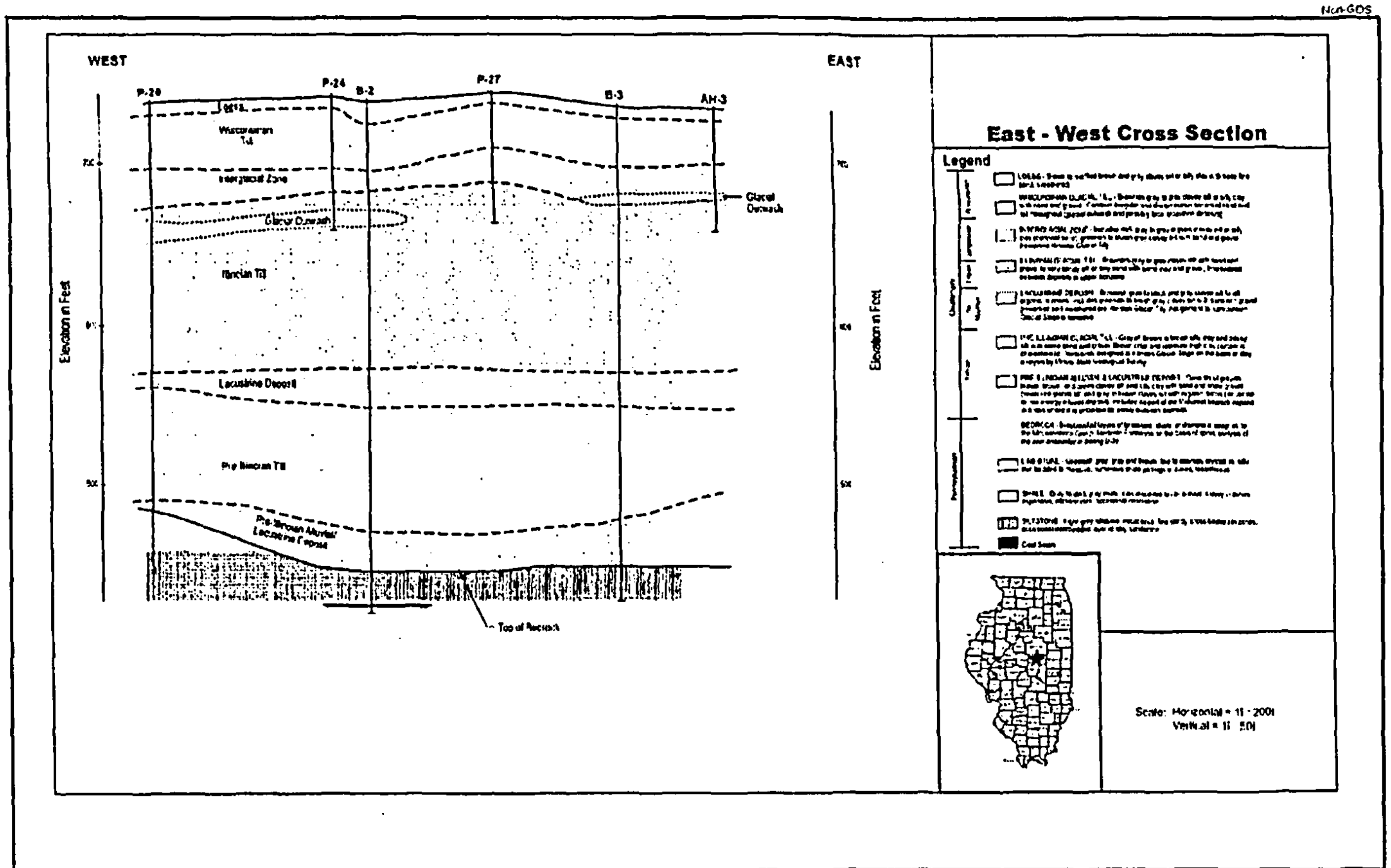
2.5.4 Stability of Subsurface Materials and Foundations

SSAR Section 2.5.4 presents the applicant's evaluation of the stability of subsurface materials that underlie the ESP site. Section 2.5.4.1, "Geologic Features," presents a brief description of the subsurface geology; Section 2.5.4.2, "Properties of Subsurface Materials," describes the engineering properties of the subsurface materials; Section 2.5.4.3, "Explorations," describes the subsurface explorations performed by the applicant; and Section 2.5.4.4, "Geophysical Surveys," describes the geophysical surveys performed by the applicant to determine the S-wave velocity of the soil and rock beneath the ESP site. Section 2.5.4.5, "Excavation and Backfill," describes the excavation and backfill work for the CPS site; Section 2.5.4.6, "Groundwater Conditions," describes the local ground water conditions; Section 2.5.4.7, "Response of Soil and Rock to Dynamic Loading," defers the evaluation of SSI to the COL stage; Section 2.5.4.8, "Liquefaction Potential," describes the applicant's evaluation of liquefaction potential; and Section 2.5.4.9 describes the applicant's use of the new performance-based approach for determining the SSE. Sections 2.5.4.10, "Static Stability," through 2.5.4.14, "Construction Notes," describe analyses and evaluations that the applicant has deferred to the COL stage.

2.5.4.1 Technical Information in the Application

2.5.4.1.1 Geologic Features

SSAR Section 2.5.4.1 states that the geologic features at the ESP site and CPS site are very similar. The subsurface geology at the ESP site consists of nearly 300 ft of hard or dense soil overlying rock. Other than the uppermost 50 feet, the soils have been overridden during past glaciations. As shown in Figure 2.5.4-1, reproduced from Figure 5.1-1 in SSAR Appendix B, there are seven primary soil layers at the ESP site.



Seismic Hazards Report for the EGC ESP Site **Site-Specific Geologic Cross Section (from SSAR, Appendix A, 2003)**	Figure **5.1-1**

Figure 2.5.4-1 Site-specific geologic cross section

Each of these soil layers is mainly composed of silts and clays with some sand and gravel. The applicant stated that the boundaries between each of the soil layers is relatively horizontal and each layer is consistent in its thickness and contents. The ground water table beneath the ESP site is located approximately 30 ft below the surface, and the applicant stated that there are no geologic hazards such as karst terrain or underground mine openings underlying the site. SSAR Sections 2.5.1.1 and 2.5.1.2 provide a complete description of the regional and site geologic features for the ESP site. These two SSAR sections are supplemented by additional background information in SSAR Appendices A and B. Section 2.5.1.3 of this SER contains the staff's technical evaluation of the applicant's description and characterization of the regional and site geology.

2.5.4.1.2 Properties of Subsurface Materials

SSAR Section 2.5.4.2 states that the applicant established the engineering properties of the subsurface materials at the ESP site through field and laboratory measurements and by drawing upon the extensive database of information that was developed for the CPS site. The properties measured by the applicant include strength, consolidation, dynamic/cyclic, and other physical test results from soil samples recovered from the ESP site. The applicant stated that it determined these properties from the ground surface to the top of rock, located nearly 300 ft below the ground surface. Based on its field and laboratory measurements, the applicant reached the following conclusions regarding the properties of subsurface materials existing at the ESP site:

- The physical property tests indicate that the soil profile consists primarily of low-plasticity silts and clays. Sands and occasionally gravels are found in the predominantly fine-grained soil profile.

- Results of the compressibility and strength tests indicate that the soil has low compressibility and very high strength. Unconfined compressive strengths vary from 1 to 15 tons per square ft (tsf), unconsolidated undrained strengths vary from 2 to 9 tsf, and the effective strength friction angle from a consolidated undrained triaxial test is 32.6 degrees.

- The modulus and damping properties of soil from resonant column/cyclic torsion shear tests indicate that the low-strain S-wave velocity of samples ranges from approximately 800 ft per second (fps) to over 2000 fps, depending on the specific layer from which the soil sample was obtained. Low-strain material damping ratios for the same samples vary from approximately 5 percent to less than 1 percent. The changes in shear modulus and material damping ratios with the level of shearing strain are consistent with published modulus and damping characteristics of low-plasticity soils.

The applicant stated that the purpose of the ESP site laboratory testing program was to show that the properties of the ESP site are similar to those reported in the CPS USAR. By showing the similarity between the two sites, the applicant was able to utilize the extensive soil properties database in the CPS USAR to augment the information it collected for the ESP site. The scope of the soil testing reported in the CPS USAR includes (1) strength tests on soil and rock, (2) dynamic tests on soil samples such as cyclic triaxial and resonant column tests, (3) tests to determine soil type, settlement potential, and dewatering requirements, (4) chemical tests on ground water samples, (5) strength tests on excavated soils, and (6) liquefaction tests. The applicant compared the soil classification, strength, and consolidation test results from the ESP and CPS sites and concluded that soil conditions at the two sites are consistent. Specifically, the applicant obtained similar average values of water content, density, strength, and compressibility from soil sampled at similar depths from each site. In RAI 2.5.4-1, the staff asked the applicant to describe its criteria for assessing whether the differences in the soil properties for the ESP and CPS sites were significant enough to warrant additional soil exploration. In response to RAI 2.5.4-1, the applicant stated that it used both visual and quantitative criteria to assess the similarity between the soils underlying the two sites. The applicant stated that it would have conducted additional explorations if it had encountered significant differences in the soil properties between the two sites. SER Section 2.5.4.3.2 provides a complete description of the applicant's response to RAI 2.5.4-1 as well as the staff's evaluation of this response.

The applicant conducted cyclic testing of the ESP site soils to determine the variation in shear modulus and material damping ratio with shearing strain amplitude. These dynamic properties are necessary to construct shear modulus and damping curves in order to determine the response of the site to the SSE ground motion. The applicant was unable to make a comparison between its cyclic test results for the ESP and CPS sites because significant advances in resonant column/cyclic torsional shear tests have occurred since the licensee conducted cyclic tests on soils from the CPS site. Since it had conducted only six sets of resonant column/cyclic torsional shear tests, the applicant decided to use the EPRI shear modulus and damping curves (EPRI 1993) for its site response analyses. As justification for this approach, the applicant stated the following:

> The rationale for using the EPRI curves rather than the EGC ESP Site data was that a much larger database was used to develop the EPRI curves and, therefore, average EPRI results are expected to be representative of conditions at the EGC ESP Site if an extensive dynamic testing program had been conducted. It is important to note that the dynamic test results for the EGC ESP Site are very consistent with the EPRI curves, indicating that use of the EPRI curves is acceptable.

Figures 2.5.4-2 and 2.5.4-3, reproduced from Figures 5-20 and 5-21 in SSAR Appendix A, show a comparison of the EPRI and ESP site cyclic test results.

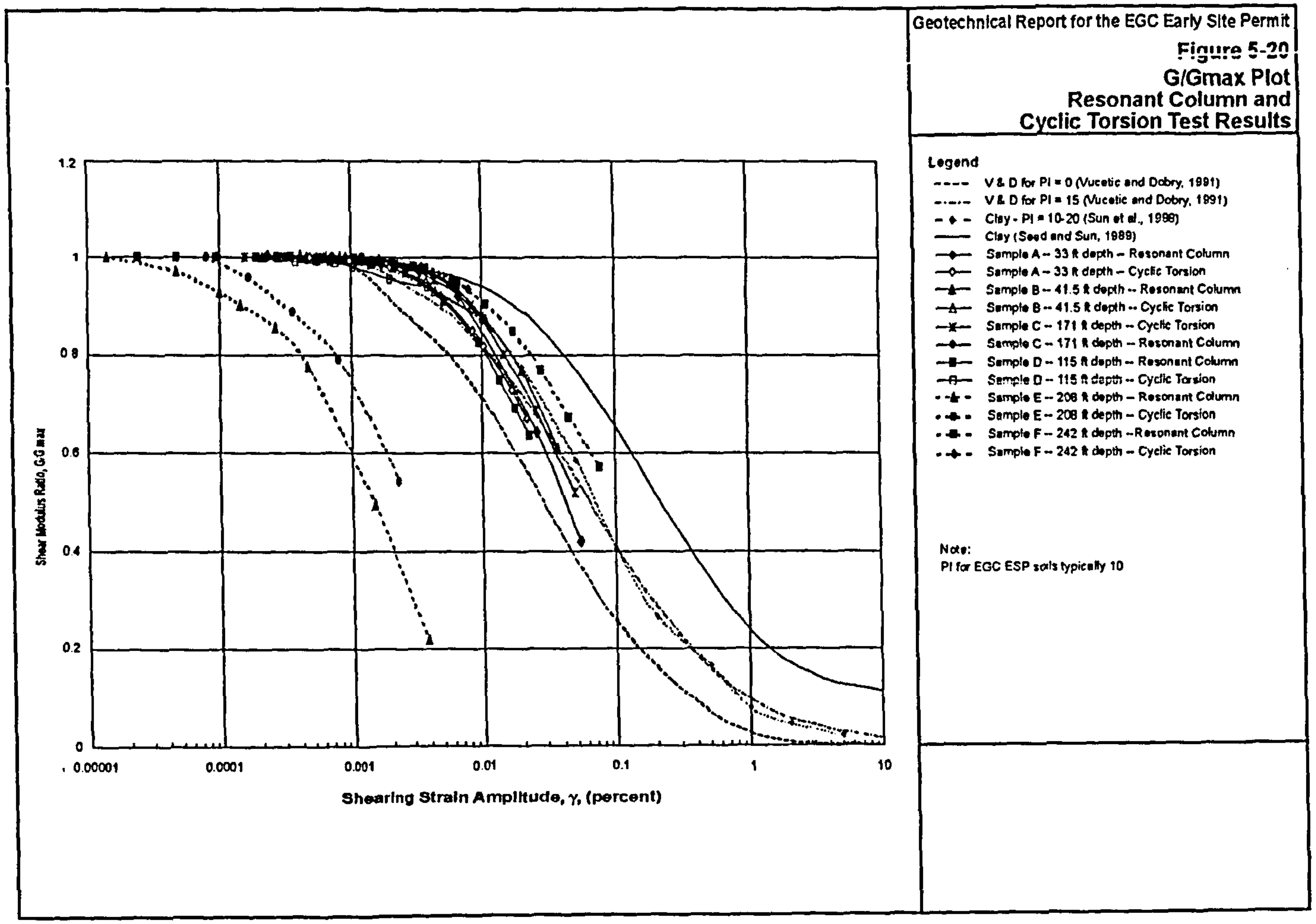


Figure 2.5.4-2 G/G_{max} plot resonant column and cyclic torsion test results

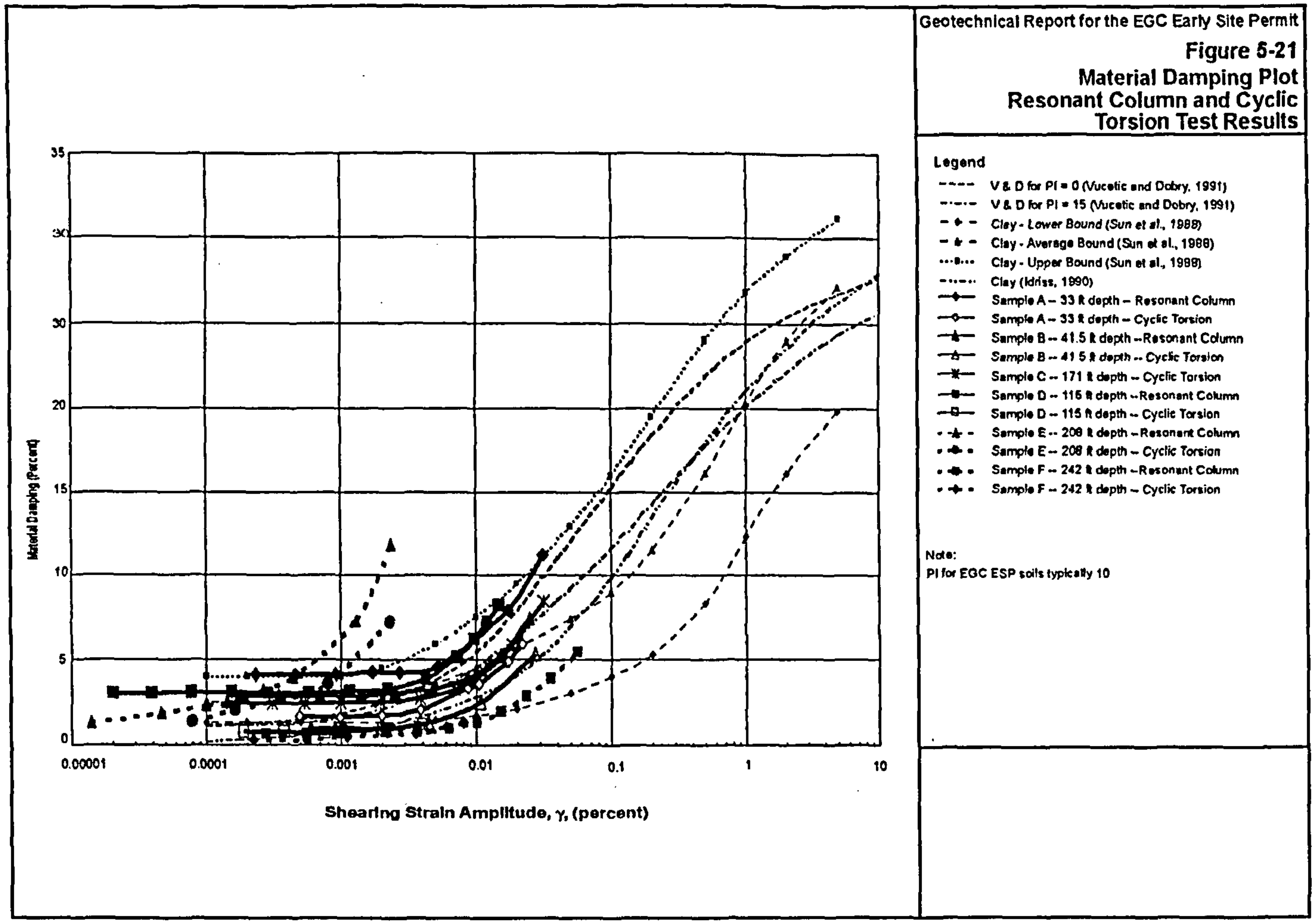


Figure 2.5.4-3 Material damping plot resonant column and cyclic torsion test results

In RAI 2.5.4-2, the staff asked the applicant to justify its use of the EPRI curves and to further explain its basis for concluding that the ESP site soils are consistent with those used to develop the EPRI curves. In response to RAI 2.5.4-2, the applicant stated that the EPRI curves it used represent soils in the general range of gravelly sands to low-plasticity silty or sandy clays and that soils at the ESP site fall within this category of soils. SER Section 2.5.4.3.2 provides a complete description of the applicant's response to RAI 2.5.4-2 and the staff's evaluation of this response.

In RAI 2.5.4-5, the staff asked the applicant to explain the difference between soil S-wave velocities measured directly in the field and in the laboratory using soil samples. For two of the soil samples, taken at depths of 208 and 242 ft, the laboratory measurement of S-wave velocity is 68 and 76 percent, respectively, of the field-measured test results for similar depths. In response to RAI 2.5.4-5, the applicant stated that the low values are an indication of the accumulated disturbance that occurs to soil samples when they are removed from the ground, transported to the laboratory, and tested in equipment that may not replicate the in situ stress state and loading conditions. SER Section 2.5.4.3.2 provides a complete description of the applicant's response to RAI 2.5.4-2 and the staff's evaluation of this response.

2.5.4.1.3 Explorations

To characterize the ESP site, the applicant conducted a subsurface exploration program that consisted of drilling and sampling four boreholes and conducting four cone penetrometer tests (CPT) with pore pressure measurements. The applicant stated that the purpose of the exploration work was to establish the location and consistency of the soil layers, to collect soil samples for laboratory testing (see SER Section 2.5.4.1.2), and to install piezometers for ground water monitoring. For guidance, the applicant stated that it used RG 1.132, "Site Investigations for Foundations of Nuclear Power Plants," with the exception of the number and depth of explorations. The applicant stated that fewer explorations were justified because of the similarity of soil conditions at the ESP and CPS sites. Specifically, the applicant stated in Section 3.1.1 of SSAR Appendix A that its rationale for the reduced number of explorations was as follows:

- Over 10 explorations had been previously drilled, sampled, and tested within the general EGC ESP Site footprint area during the investigation for the CPS Site. A careful review of this existing information determined that the methods used for drilling and sampling, soil classification, and laboratory testing of soils from these explorations was of sufficient quality to allow re-use of the data for the EGC ESP Site work.

- The work being carried out for the EGC ESP was being done before the reactor plant design had been selected. Therefore, some of the spacing and depth requirements given in Appendix C of RG 1.132 could not be established. Once a reactor plant design is selected, then the requirements in Appendix C of RG 1.132 will be reviewed again during the COL stage, along with the design requirements of the reactor plant design, to determine whether additional drilling and sampling is needed.

In addition, the applicant stated that if it had encountered any significant soil property variations during its drilling and sampling program, it would have added more explorations to resolve the observed differences.

The applicant used mud rotary drilling methods for the four explorations that it drilled at the ESP site. Figure 2.5.4-4, reproduced from Figure 3-1 in SSAR Appendix A, shows the locations of each of the four boreholes.

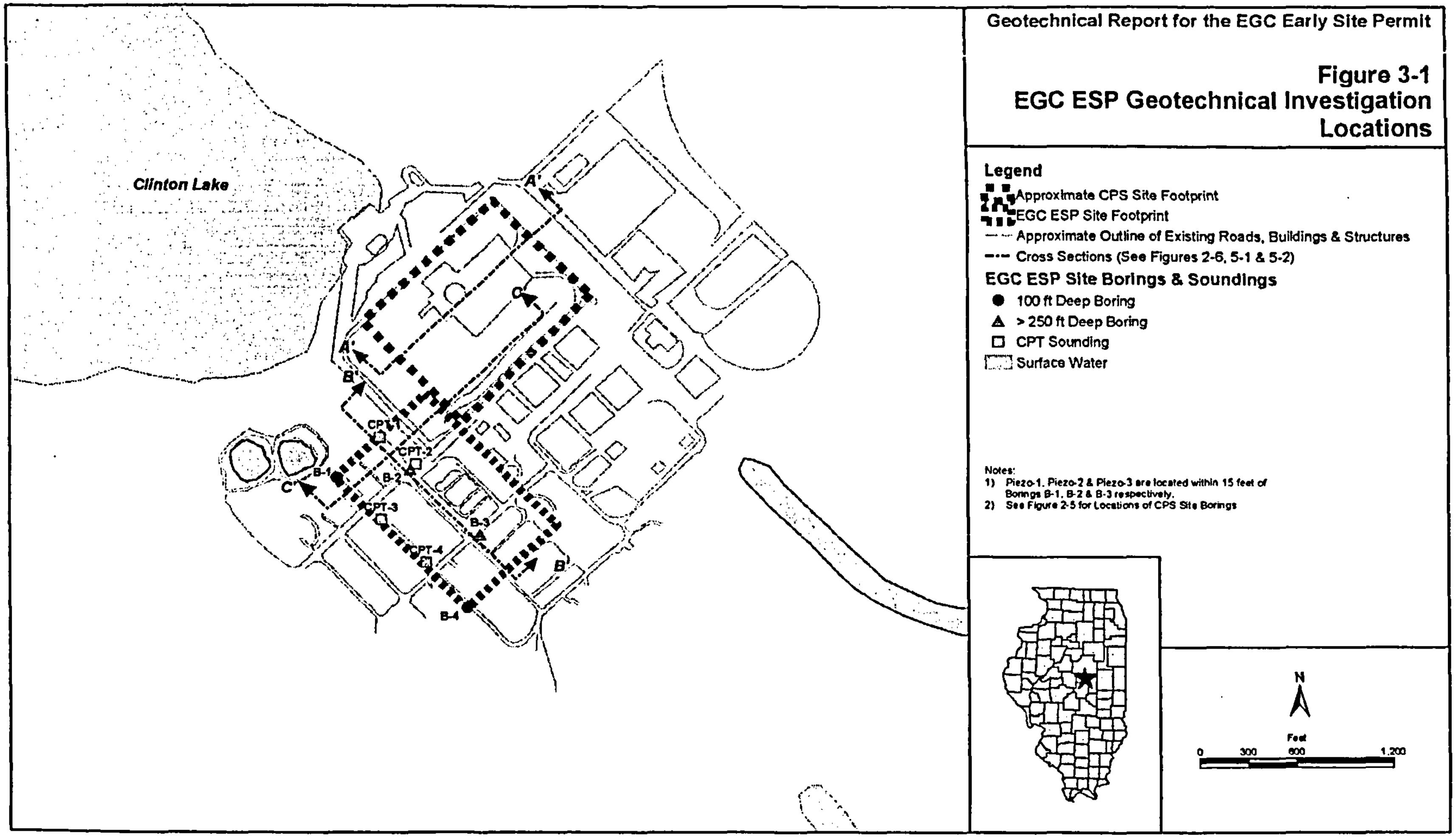


Figure 2.5.4-4 EGC ESP geotechnical investigation locations

Two of the explorations extended to 100 ft below the ground surface, and the other two extended 20 to 30 ft into rock at nearly 300 ft below the ground surface. The applicant used SPT, Shelby, and Pitcher tube sampling methods to collect representative soil samples. For each borehole, the applicant obtained SPT blowcounts and also calibrated the SPT hammer system in one of the boreholes. At depths shallower than 100 ft, the applicant collected soil samples at 5 ft intervals using ASTM D 1586-99, "Standard Test Method for Penetration Resistance and Split Barrel Sampling of Soils," for guidance. At each major change in stratigraphy, the applicant also collected undisturbed soil samples following the methods given in ASTM D 1587-00, "Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes." At depths between 100 and 150 ft (at boreholes B-2 and B-3), the applicant increased its soil sampling interval to 10 ft, and at depths greater than 150 ft, the applicant used a sampling interval of 15 ft. For the two boreholes that extended down into rock, the applicant collected continuous rock-core samples for classification using ASTM D 2113-99, "Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigations."

The applicant also conducted a CPT program at the ESP site. The locations of the CPT soundings are shown above in Figure 2.5.4-4. The applicant used the results of the CPT soundings to evaluate the consistency of the soils in the upper 50 to 80 ft of soil in the ESP site area. The CPT soundings included pore water pressure measurements, and during two of the soundings, the applicant obtained S-wave velocity data. The total depths of the soundings at CPT-1, CPT-2, CPT-3, and CPT-4 were 78.1, 55.7, 54.0, and 76.9 ft, respectively. For the seismic tests, the applicant generated an S-wave at the ground surface by horizontally striking a board at the surface using a sledge hammer. The applicant measured the travel time of the resulting S-waves with a velocity-sensitive geophone located at the tip of the CPT assembly. The applicant made measurements of S-wave travel times at 3-ft depth intervals from the ground surface until it could no longer advance the CPT assembly into the ground.

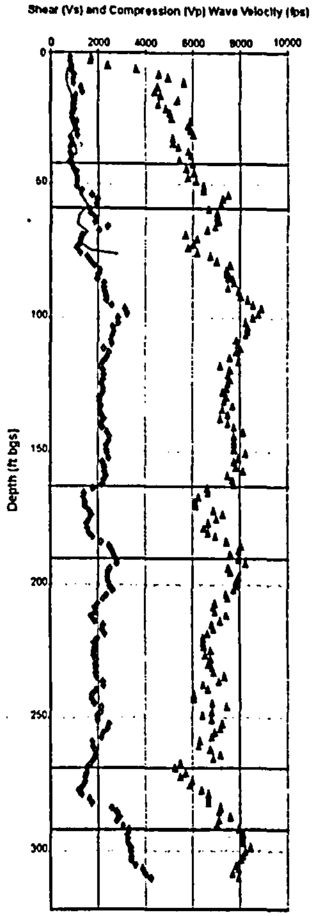
The applicant used its four ESP boreholes and CPT soundings to augment the results of similar programs conducted at the CPS site. The licensee conducted an extensive drilling and sampling program during work on the CPS site, which consisted of 76 boreholes. The applicant stated that some of these boreholes were drilled within or adjacent to the footprint of the ESP site and a number of the boreholes extended into rock. Concerning its comparison of the results between the ESP and CPS site boreholes, the applicant stated the following:

> Results of these comparisons show that both sites consist of over 250 feet of predominantly silts and clays overlying rock. The silts and clays are very stiff to hard in consistency—as a result of past glaciations. Rock is slightly deeper at the EGC ESP Site (specifically, nearly 250 ft below ground surface at the CPS Site versus over 280 ft at the EGC ESP Site); however, rock descriptions and quality are consistent between the sites. It was concluded from this comparison that the engineering characteristics of the two sites are consistent; therefore, the database from the CPS Site can be used in evaluating site response to gravity and seismic loading at the EGC ESP Site.

2.5.4.1.4 Geophysical Surveys

The applicant conducted geophysical surveys at the ESP site in order to determine the S-wave velocity of the soil and upper layer of rock. The applicant stated that it would use this information to determine the response of the site to seismic ground motion propagating up from the rock to the ground surface. In addition, the applicant stated that it may use the results of the geophysical surveys during the COL stage of design to evaluate SSI.

The applicant used two types of geophysical seismic tests. The first test was a P- and S-wave suspension logging test in one of the boreholes, and the second test used the CPT assembly, which was described above in SER Section 2.5.4.1.3. The applicant conducted the P-S suspension logging test at approximately 1.5-ft depth intervals to within approximately 20 ft into the top of rock. The applicant performed the test by lowering the logging probe into the open borehole filled with drilling fluid. Each measurement recorded the average P- and S-wave velocity of the subsurface material between the two receivers located near the top of the probe. The applicant stated that the quality of the test results was influenced by the integrity of the borehole sidewalls and by the consistency of the drilling mud. Therefore, in order to optimize the quality of the measurements, the applicant performed the test on the same day as the completion of the rock coring at borehole B-2 and mixed the bentonite drilling fluid immediately before the start of the test. Figure 2.5.4-5, reproduced from Figure 5-19 in SSAR Appendix A, shows the P- and S-wave velocities for each of the different soil units to a depth of about 300 ft below the ground surface.



		Soil Properties - EGC ESP Site *(and CPS Site)*[1]					
Unit	Depth (ft. bgs)	Moist Unit Wt (pcf)	Moist. Cont. (%)	LL	PL	PI	Comments
Loess & Wisconsinan Till	0 - 42	131 *(131)*	16 *(16)*	35 *(25)*	14 *(14)*	14 *(11)*	Perched water table at ~5 ft bgs
Interglacial	42 - 59	116 *(132)*	39 *(17)*	40 *(26)*	26 *(13)*	14 *(13)*	
Illinoian Till	59 - 163	148 *(147)*	8 *(9)*	18 *(18)*	9 *(11)*	9 *(7)*	
Lacustrine	163-190	133 *(140)*	13 *(11)*	28 *(19)*	11 *(12)*	17 *(7)*	
Pre-Illinoian Till	190 - 269	138 *(137)*	14 *(14)*	29 *(27)*	14 *(14)*	15 *(13)*	
Pre-Illinoian Alluvial/ Lacustrine	269 - 292	N.A. *(N.A.)*	23 *(N.A.)*	48 *(N.A.)*	17 *(N.A.)*	29 *(N.A.)*	
Bedrock	292-322	N.A. *(N.A.)*	N.A. *(N.A.)*	N.A. *(N.A.)*	N.A. *(N.A.)*	N.A. *(N.A.)*	Weathered rock contact at 292 ft bgs

Geotechnical Report for the EGC Early Site Permit

Figure 5-19

Shear and Compressional Wave Velocities and Other Soil Properties

Legend

- ● Vs at B-2
- ▲ Vp at B-2
- --- Vs at CPT-02
- — Vs at CPT-04

Notes:

1 Soil properties shown are the arithmetic mean values for all available soil sample results for each stratigraphic unit. Top number is the mean value of applicable EGC ESP Site investigation data.

(Italic) = Mean value of applicable data from CPS Site P-Series Soil Samples, as reported in Section 2.5 of CPS, 2002

N.A. = Results not available

Figure 2.5.4-5 S- and P-wave velocities and other soil properties

Based on its geophysical surveys, the applicant established the following minimum site characteristic S-wave velocities in its plant parameter envelope (PPE) table (SSAR Table 1.5-1):

- 820 ft/s in the upper 50 ft of soil
- 1090 ft/s to nearly 3000 ft/s at depths of 50 ft to the top of rock
- 2580 ft/s in the upper 20 ft of rock

The applicant found that its comparison of the velocities between the CPS and ESP sites showed very similar average conditions. The applicant used a much smaller depth interval for its velocity measurements during the ESP site tests, and, therefore, the ESP site velocity results provided a much better indication of the variation in velocity within each of the prominent stratigraphic units.

2.5.4.1.5 Excavation and Backfill

SSAR Section 2.5.4.5 states that construction of the facilities at the ESP site would likely require excavations to a depth of approximately 55 to 60 ft below the ground surface to avoid potential settlement and liquefaction concerns. The applicant stated that during original excavations at the CPS site, the following conditions were observed:

- The excavation work at the CPS site shows that the drilling and sampling program provided a good description of the soil conditions in the upper 56 ft at the site, confirming that the boreholes completed within the EGC ESP site footprint for both the CPS and EGC ESP sites will be representative of conditions in the upper 56 ft of soil profile.

- Seepage into the construction excavation was very limited at the CPS site. This observation indicates that dewatering requirements within the upper 56 ft at the EGC ESP site will be minimal because of the similarity in ground water location and soil types.

- Some localized pockets of sand were encountered at the base of the excavation at a depth of 56 ft. These pockets were either compacted or removed and replaced with a flyash-backfill mixture. Similar conditions could be encountered at the EGC ESP site.

The applicant found that nothing discussed within Section 2.5.4.5 of the CPS USAR indicates a condition that would significantly affect the construction or operation of a new generating facility at the ESP site.

2.5.4.1.6 Ground Water Conditions

The applicant installed three piezometers during its ESP site exploration to obtain more specific information about ground water conditions at the ESP site. The applicant's ground water measurements indicate that the static ground water table within the Illinoian till is approximately 30 ft below the ground surface, but that there are shallower perched ground water layers closer to the surface. The applicant found similar ground water conditions at both the ESP and CPS sites. SSAR Section 2.5.4.6 provides a complete description of the ESP site ground water conditions.

2.5.4.1.7 Response of Soil and Rock to Dynamic Loading

SSAR Section 2.5.4.7 defers the analyses of soil-rock-structure interaction for the ESP site to the COL stage. Specifically, the applicant stated that these analyses will depend on the geometry and weight of the selected power generating system, and on the method that it will use during the COL stage to evaluate SSI. Since some of the soil and rock dynamic tests used by the licensee for the CPS site in the mid-to-late 1970s are no longer used, the applicant stated that before adopting any of the dynamic soil and rock properties given in the CPS USAR, it will re-derive these dynamic properties based on the results of field and laboratory information collected during the ESP site program (see SER Section 2.5.4.1.2) and future programs. Section 2.5.2.3.5 of this SER presents the staff's evaluation of the applicant's free-field site response analysis, including an evaluation of the applicant's responses to RAIs 2.5.4-4 and 2.5.4-7. The applicant's decision to defer the SSI analyses to the COL stage is **COL Action Item 2.5.4-1.**

2.5.4.1.8 Liquefaction Potential

To evaluate the liquefaction potential of the soils at the ESP site, the applicant used an empirical blowcount procedure, which is described in RG 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plants," issued November 2003. This approach uses correlations between blowcounts recorded during SPT tests and observed liquefaction at sites that did or did not liquefy. The empirical method calculates a factor of safety (FOS) based on the expected soil shearing resistance and the expected maximum seismically induced shearing stresses in a soil layer. The soil shearing resistance is quantified by the cyclic resistance ratio (CRR), which is determined from the SPT blowcount values, with modifications for depth and SPT driving conditions. The shearing stresses induced by seismic loading are quantified by the cyclic stress ratio (CSR), which is proportional to the PGA for the specified seismic loading. In addition, the method uses a magnitude scaling factor (MSF), which is based on the specified earthquake M_w that is expected to generate the specified PGA. The FOS against liquefaction is calculated as:

$$FOS = \frac{CRR}{CSR}(MSF)$$

The MSF is smaller for larger magnitude earthquakes (reducing the FOS) to account for the longer duration of shaking and lower frequency vibrations typical of larger events. The applicant calculated the FOS against liquefaction for soil conditions at regular depth intervals to obtain a profile of FOS with depth.

To implement the above liquefaction procedure for the ESP site, the applicant used a PGA of 0.3g, which represents the peak acceptable value for the plant that forms the basis for the PPE. The applicant also used a range of earthquake magnitudes (M = 5.5, 6.5, and 8.0) that are consistent with the range of source mechanisms that have the potential to cause ground shaking at the ESP site. To estimate the shearing resistance of the ESP site soils, the applicant used the SPT blowcount values from its four boreholes (B-1, B-2, B-3, and B-4). The applicant found that the FOS is greater than 1.1 for the soil layers below a depth of 60 ft below the ground surface. Above 60 ft, the applicant found several layers where the FOS is less than 1.1, indicating that these layers are susceptible to liquefaction. RG 1.198 states that soil elements with an FOS less than or equal to 1.1 "would achieve conditions wherein soil liquefaction should be considered to have been triggered." However, the applicant stated that these soils (susceptible to liquefaction) will "need to be excavated and replaced or improved for settlement considerations, thereby mitigating any liquefaction potential." Therefore, the applicant concluded that liquefaction is not a design consideration for the ESP site.

In RAI 2.5.4-6, the staff asked the applicant to provide a sample liquefaction analysis from one of its four borehole locations and to clearly show how it determined the FOS for the different soil layers. In addition, the staff asked the applicant to describe the methods that it might use to mitigate the potential for liquefaction and to describe the extent of the liquefiable soils over the ESP site area. In response to RAI 2.5.4-6, the applicant provided a sample calculation for borehole B-1 at the 38.5-ft depth interval. In addition, the applicant described the methods (other than removal and replacement) that it may use to mitigate the potential for liquefaction. The applicant stated that it encountered noncohesive soils in its soil borings, but that not all of these noncohesive soils are considered liquefiable. SER Section 2.5.4.3.8 provides a complete description of the applicant's response to RAI 2.5.4-6 and the staff's evaluation of this response.

For the CPS site, the licensee used a different method to assess the potential for liquefaction. Instead of using the empirical blowcount procedure, the licensee used cyclic triaxial testing to determine the soil shearing resistance. To determine the shearing stresses induced by seismic loading, the licensee used the SSE ground motion. Using this method, the licensee found an FOS greater than 2.0, and, therefore, liquefaction was not an issue for the CPS site.

2.5.4.1.9 Earthquake Design Basis

SSAR Section 2.5.4 describes the development of the SSE ground motion for which the applicant used the performance-based approach, described in ASCE/SEI Standard 43-05. Section 2.5.2.1.6 of this SER describes the applicant's use of the performance-based approach to develop the SSE response spectrum for the ESP site.

2.5.4.1.10 Static Stability

The applicant did not estimate the bearing capacity, settlement, or lateral earth pressures for the ESP site, since it has not selected a nuclear power plant design. The applicant stated that each generating system has different footprint sizes, depths of embedment, and effective weights, and these variables will affect the determination of bearing pressures, settlement, and lateral earth pressures. For this reason, the applicant deferred the determination of static stability to the COL stage.

Using the licensee's evaluation of static stability for the CPS site, the applicant stated that it expected high allowable bearing values and low compressibility for the ESP site because of the similarity in soil conditions between the two sites. Based on the bearing capacity values given in the CPS USAR, which range from 39.9 to 60.6 tsf, the applicant established the minimum site characteristic value for bearing pressures at the ESP site at 25 tsf. Net foundation pressures for the Category I structures at the CPS site are less than 2.5 tsf.

In RAI 2.5.4-3, the staff asked the applicant to provide further detail regarding the criteria that it used to establish the minimum static bearing capacity of 25 tsf for the ESP site. In response to RAI 2.5.4-3, the applicant stated that the methods used by the licensee for the calculation of the bearing capacities were conventional methods that assume a local shear failure condition. The applicant stated that the combination of foundation depth below the ground surface and the heavily overconsolidated state of the Illinoian till result in the high bearing capacities given in the CPS USAR. Comparing the minimum bearing capacity value chosen by the applicant (25 tsf) with the lower value in the range of bearing capacities for the CPS site (39.9) provides an FOS greater than 1.5. SER Section 2.5.4.3.10 provides a complete description of the applicant's response to RAI 2.5.4-3 and the staff's evaluation of this response.

2.5.4.1.11 Design Criteria

SSAR Section 2.5.4.11, "Design Criteria," states that the design criteria for the ESP site Category I structures will be established during the COL stage when the physical characteristics of the operating system are known. The applicant stated that it would use the CPS USAR as a starting point for developing design criteria for the ESP site.

2.5.4.1.12 Techniques to Improve Subsurface Conditions

SSAR Section 2.5.4.12, "Techniques to Improve Subsurface Conditions," states that until the power generating system is selected, the need for ground improvement for the ESP site is unknown. The applicant stated that systems that are founded at depths of 55 ft or above could require ground improvement and that decisions regarding the need for and type of ground improvement will be made during the COL stage. For the CPS site, the licensee encountered localized areas and pockets of loose granular material at the base of excavations for the CPS Category I structures (about 55 ft below the ground surface) during construction at the CPS site. These materials were either compacted or removed and replaced with a flyash-backfill material.

2.5.4.1.13 Subsurface Instrumentation

SSAR Section 2.5.4.13, "Subsurface Instrumentation," states that the settlement measurements made by the licensee for the CPS plant structures will be used for future settlement predictions at the ESP site. Because of the similar soil conditions between the two sites, and assuming the new facilities are similar in size, load, and foundation level to those constructed at the CPS site, the applicant stated that it will be able to use conventional settlement prediction methods and rely on the previous settlement measurements.

2.5.4.1.14 Construction Notes

SSAR Section 2.5.4.14 states that the CPS USAR provides valuable information from the construction of the CPS facilities and that this information will be used during the COL stage of the project. The applicant stated the following:

Any future excavation associated with the construction of a new generating system will be mapped to confirm that soil types and consistency are in general accord with the conditions identified during previous construction at the site and that have been interpreted from the field explorations carried out at the EGC ESP Site. This field mapping will involve inspecting excavated slopes for the presence of previously unknown fault offsets.

The applicant also committed to (1) "notify the NRC staff immediately if previously unknown geologic features that could represent a hazard to the plant are encountered during excavation," and (2) "notify the NRC staff when the excavations are open for examination and evaluation."

2.5.4.2 Regulatory Evaluation

SSAR Section 2.5.4 describes the applicant's evaluation of the stability of the subsurface materials and foundations at the ESP site. In SSAR Section 1.5, the applicant stated that it developed the geological, geophysical, and geotechnical information used to evaluate the stability of the subsurface materials in accordance with the requirements of 10 CFR 100.23. The applicant applied the guidance of RS-002, RG 1.70, DG-1105 (which has been superseded by RG 1.198 since the applicant submitted the SSAR), RG 1.132, and RG 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants." The staff reviewed SSAR Section 2.5.4 for conformance with the regulatory requirements and guidance applicable to the characterization of the stability of subsurface materials, as identified below.

In its review of SSAR Section 2.5.4, the staff considered the regulatory requirements in 10 CFR 100.23(c) and 10 CFR 100.23(d)(4). According to 10 CFR 100.23(c), applicants must investigate the engineering characteristics of a site and its environs in sufficient scope and detail to permit an adequate evaluation of the proposed site. Pursuant to 10 CFR 100.23(d)(4), applicants must evaluate siting factors such as soil and rock stability, liquefaction potential, and natural and artificial slope stability. Section 2.5.4 of RS-002 provides specific guidance concerning the evaluation of information characterizing the stability of subsurface materials, including the need for geotechnical field and laboratory tests as well as geophysical investigations.

2.5.4.3 Technical Evaluation

This section provides the staff's evaluation of the geophysical and geotechnical investigations carried out by the applicant to determine the static and dynamic engineering properties of the materials that underlie the ESP site. The technical information presented in SSAR Section 2.5.4 resulted from the applicant's field and laboratory investigations performed for the ESP. The applicant intended its ESP field and laboratory field investigations to confirm the large volume of geotechnical data developed by the licensee for the existing CPS units, located adjacent to the ESP site. The applicant used the subsurface material properties from its field and laboratory investigations to evaluate the response of the site to dynamic loading (SSE ground motion), including liquefaction potential. The applicant deferred the determination of static stability to the COL stage.

Through its review of SSAR Section 2.5.4, the staff determined whether the applicant adequately sampled the subsurface materials underlying the ESP site in order to characterize the engineering properties as well as the response of the site to dynamic and static loading. The staff also reviewed the applicant's field and laboratory investigations used to determine the geotechnical engineering properties of the soil and rock underlying the ESP site. In addition, the staff observed some of the applicant's onsite borings and field explorations, performed August 7–8, 2002, to determine whether the applicant followed the guidance in RG 1.132.

2.5.4.3.1 Geologic Features

SSAR Section 2.5.4.1 references SSAR Section 2.5.1 for a description of the regional and site geology. Section 2.5.1.3 of this SER presents the staff's evaluation of the regional and site geology.

2.5.4.3.2 Properties of Subsurface Materials

The staff focused its review of SSAR Sections 2.5.4.2 (properties of subsurface materials) and 2.5.4.3 (explorations) on the applicant's description of (1) subsurface materials, (2) field investigations, (3) laboratory testing, and (4) static and dynamic engineering properties of the ESP site subsurface materials.

Normally, an applicant performs a complete field investigation and sampling program to evaluate the engineering properties and stability of the soil and rock underlying the site. However, since the applicant relied on the licensee's previous field and laboratory investigations for the existing CPS units, the applicant's ESP investigations were used to confirm previously established soil and rock properties. As such, the applicant conducted a subsurface exploration program that consisted of drilling and sampling four boreholes and conducting four CPTs. In RAI 2.5.4-1, the staff asked the applicant to describe its criteria for assessing whether the differences in the soil properties for the ESP and CPS sites were significant enough to warrant additional soil exploration. In addition, the staff asked the applicant to provide tables showing a comparison between the static and dynamic soil properties for the two sites. In response to RAI 2.5.4.1, the applicant stated that it would have conducted additional explorations if it had encountered significant differences in the soil properties between the two sites. The applicant stated that the geologic information it reviewed indicated that the regional processes that formed the site profile at the two sites were the same. In addition, the applicant stated that the sampling program for the CPS site included a number of explorations within and beyond the ESP site. Since the geologic formation and stratigraphy for the two sites were essentially the same, the applicant expected to encounter only small local variations in soil properties during its ESP site exploration. During its ESP site exploration, the applicant visually monitored the soil it retrieved during drilling and sampling to see if the soil color and texture were consistent with the soil profile described in the CPS site USAR. In addition, the applicant also compared the SPT blowcount values that it obtained from the ESP boreholes to those from the CPS site boreholes. The applicant used the combination of consistency, color, and texture to decide whether the material was essentially the same. As an example of its evaluation process, the applicant stated the following:

> For example, if the blowcount reported in the USAR was significantly different (e.g., an order of magnitude greater) than what was recorded during the EGC

ESP Site exploration program and the texture of the material was fine-grained rather than a sand, the field task leader for the EGC ESP Site explorations was prepared to take additional soil samples to investigate this difference.

Once the applicant completed its fieldwork, it made the following comparisons during its laboratory testing program:

- It compared visual-manual field descriptions of the soil samples collected during the EGC ESP site investigation with each other and with CPS site data. These comparisons were performed to evaluate whether each stratigraphic unit encountered at the CPS site was present or absent at the EGC ESP site, and to identify similarities and/or differences in thickness of and contact elevations between these units. Soil descriptions compared include apparent soil gradation, plasticity, presence of inclusions and bedding, color, consistency (soft to hard, loose to dense), and moisture condition. This comparison differed from that done in the field from the standpoint that all the information was available for review, rather than the individual comparisons done in the field as the boring was drilled and sampled. Details of these comparisons are presented in Sections 5.2.1 and 5.2.2 of SSAR Appendix A. As described, the same stratigraphic units were identified between each EGC ESP site investigation location and the CPS site, with moderate variations in contact elevations and unit thicknesses.

- It compared data from laboratory tests performed on samples from the EGC ESP site with each other and with CPS site test data. These comparisons were performed to identify similarities and/or differences in engineering properties of the stratigraphic units between the two sites, and within the EGC ESP site. Test results compared include Atterberg Limits, in situ dry density, moisture content, undrained shear strength, and consolidation properties. Results of these comparisons are presented in Sections 5.2.2 and 5.2.3 of SSAR Appendix A. SPT blowcounts at the two sites were also compared, as summarized in Section 5.2.1 of SSAR Appendix A. S- and P-wave velocity data from the seismic CPT and suspension logging tests were also compared with applicable data from the CPS site (from downhole and uphole logging tests), as described in Section 5.2.4 of SSAR Appendix A.

After making the comparisons as described above, the applicant developed qualitative and quantitative criteria to determine the similarity between soil stratigraphic units and the engineering properties within each stratigraphic unit. The applicant's qualitative criteria consisted of observing the similarities of the soil descriptions between the sites. These descriptions included soil color, texture, and consistency in terms of denseness or hardness as indicated by SPT blowcounts. The applicant's quantitative criteria consisted of comparing plots and tables of the engineering property data for similarity. The applicant's comparison focused on the typical range of properties within a stratigraphic unit recorded at the CPS site versus the range in the same properties recorded at the ESP site. The applicant stated that it did not use "hard numerical acceptance criteria" for this comparison of engineering properties; however, the applicant observed that the ESP site data generally fell within the range of CPS site results for each stratigraphic unit. In conclusion, the applicant stated that there were some variations, but that these variations were not considered significant enough to alter the conclusion that subsurface conditions are similar between the sites and within the ESP site.

The staff reviewed the applicant's comparison of the soil properties between the two sites in Section 5.2 of SSAR Appendix A. The staff's review included a comparison between SPT blowcount values, in situ dry density, moisture content, Atterberg limits, compressibility and strength characteristics, P- and S-wave velocities, and modulus and damping properties. In addition, the staff also reviewed the tabulated statistical summaries of the geotechnical test results that the applicant provided in response to RAI 2.5.4-1. Figures 5-7 through 5-18 in SSAR Appendix A provide an excellent visual comparison of the engineering properties between the CPS and ESP sites. While there are some outliers, for the most part the staff concurs with the applicant's conclusion that the subsurface conditions are similar between the two sites. As such, the staff concludes that the applicant has sufficiently sampled the ESP site subsurface in order to establish the similarity between the CPS and ESP sites. The staff notes that 76 locations were drilled and sampled by the licensee for the CPS site investigation and that some of these locations (10) overlapped with the ESP site area. Regarding future subsurface investigations for the ESP site, the applicant stated the following:

> The work being carried out for the EGC ESP was being done before reactor plant design had been selected. Therefore, some of the spacing and depth requirements given in Appendix C of Regulatory Guide 1.132 could not be established. Once a reactor plant design is selected, then the requirements in Appendix C of Regulatory Guide 1.132 will be reviewed again during the COL stage, along with the design requirements of the reactor plant design, to determine whether additional drilling and sampling is needed.

Concerning the appropriate spacing of borings or soundings, RG 1.132 states that for favorable uniform geologic conditions, at least one boring should be made at the location of every safety-related structure. Where variable conditions occur, RG 1.132 states that the spacing between borings should be smaller. For larger, heavier structures, such as the containment and auxiliary buildings, RG 1.132 recommends a boring spacing of at least 100 ft with a number of additional borings along the periphery, at corners, and other selected locations. Regarding the appropriate depth for borings, RG 1.132 states that all borings should extend at least 33 ft below the lowest part of the foundation. With regard to these recommendations in RG 1.132, the staff cannot accept the applicant's concluding statement to review RG 1.132 at the COL stage to "determine whether additional drilling and sampling is needed" as sufficient. While the staff's review of the applicant's geotechnical field and laboratory test results confirmed the similarity between the CPS and ESP subsurface soil layers and properties, this similarity does not eliminate the need for further soil borings during the COL stage. There are enough variations in the soil properties within the ESP site itself to necessitate further exploration at the COL stage. Examples include variations in SPT blowcount values, S-wave velocities, and other static and dynamic properties, which may indicate localized areas of variable subsurface material.

In Open Item 2.5.4-1, the staff asked the applicant to clarify its intentions with respect to the need for additional field drilling and sampling of soil at the ESP site during the COL stage. In response, the applicant stated that the original wording in the ESP application indicates that the *need for additional explorations will be determined during the COL stage*. The applicant stated that this wording will be revised to indicate that additional exploration work is expected consistent with the following information:

If this site is selected in the future for a COL application, additional explorations will be conducted by the COL contractor for the final design of the selected reactor system. This additional exploration work will include a sufficient amount of drilling and sampling to characterize soil conditions and collect soil samples for laboratory testing necessary for the final design of the foundations for the structures. The numbers and locations of the additional explorations will depend on the depth and plan view area of the foundation for the selected reactor system, the net weight of the various components of the reactor system, and the sensitivity of the selected system to settlement. These explorations would be required to meet the standard of practice for foundation design of a large structure. Additional explorations will also be required for the new intake alignment, and could be required to assess construction methods. Examples of exploration carried out for construction evaluations could include groundwater pump tests for dewatering evaluations or collections of samples from selected areas for material re-use studies.

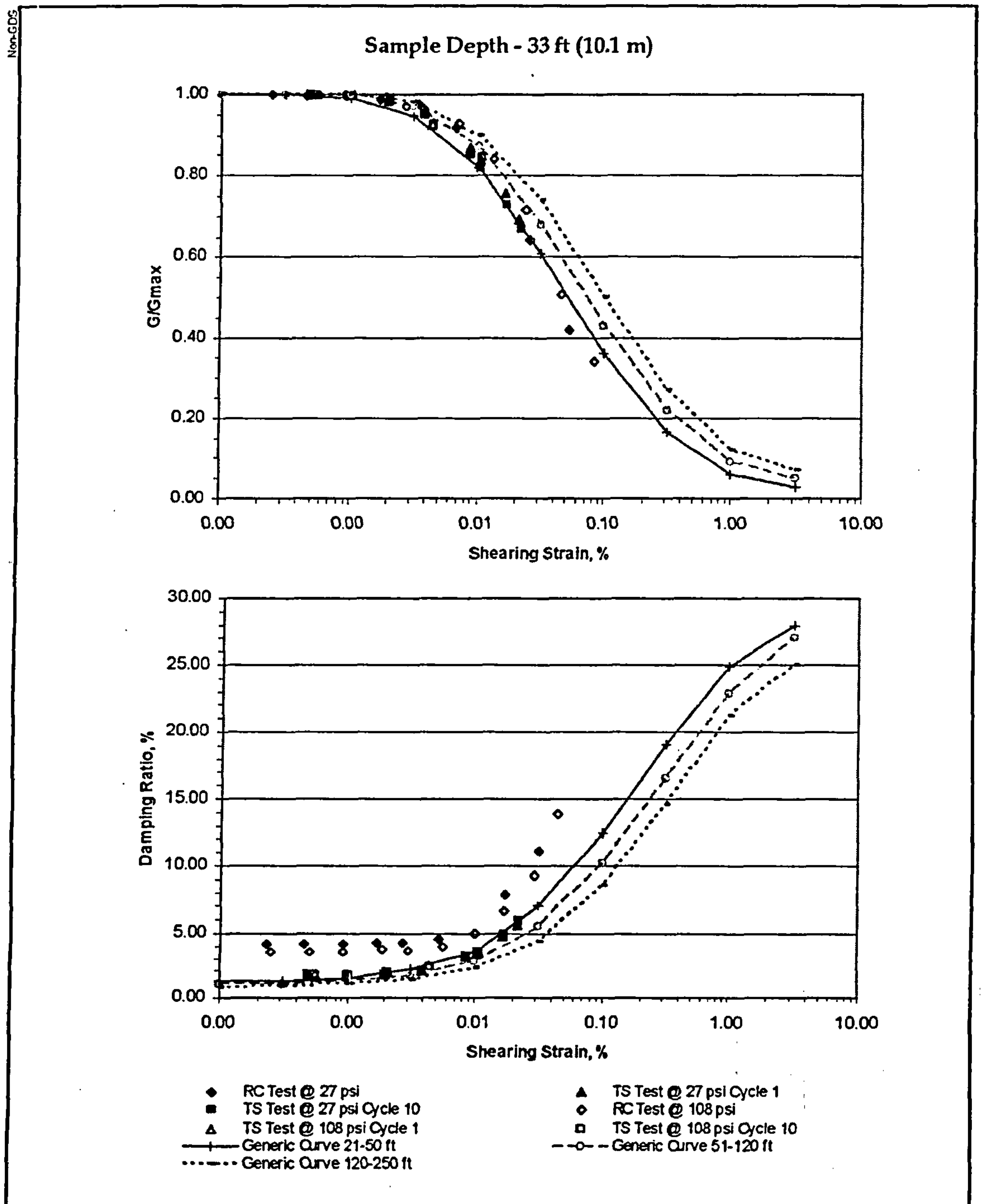
The COL application will consider and address Regulatory Guide 1.132 when determining the number, location, depth, and type of explorations. The specific scope of final explorations will also consider the design requirements of the structure and the uniformity of conditions encountered during the COL explorations relative to previous information and relative to design requirements such that appropriate and sufficient information is available for final design of the selected reactor system.

Since the applicant has clarified its intentions to perform further drilling and sampling during the COL stage and to address the guidance recommended by RG 1.132, the staff considers Open Item 2.5.4-1 to be resolved. The applicant's commitment to address the guidance in RG 1.132 regarding drilling and sampling during the COL stage is **COL Action Item 2.5.4-2.**

To determine the variation in shear modulus and material damping ratio with shearing strain amplitude, the applicant conducted cyclic testing of the ESP site soils. These dynamic properties are necessary to construct shear modulus and damping curves in order to determine the response of the site to the SSE ground motion. The applicant was unable to make a comparison between its cyclic test results for the ESP and CPS sites, since significant advances in resonant column/cyclic torsional shear tests have occurred since the licensee conducted cyclic tests on soils from the CPS site. Since the applicant conducted only six sets of resonant column/cyclic torsional shear tests, the applicant decided to use the EPRI shear modulus and damping curves (EPRI, 1993) for its site response analyses. The EPRI curves are based on a much larger cyclic testing data set than that gathered by the applicant for the ESP site. In RAI 2.5.4-2, the staff asked the applicant to justify its use of the EPRI curves and to further explain its basis for concluding that the ESP site soils are consistent with those used to develop the EPRI curves. In addition, the staff asked the applicant to explain why the material damping values from the ESP laboratory tests, shown in Figures 5-21 and 5-24 of SSAR Appendix A, are higher than the EPRI damping curves. In response to RAI 2.5.4-2, the applicant stated that the EPRI curves represent soils in the "general range of gravelly sands to low plasticity silty and sandy clays." The EPRI curves are based on a hyperbolic model of the nonlinear change in soil shear modulus and material damping with shearing strain. This model was developed in the late 1960s and early 1970s through laboratory testing programs and developed for use in generic site response studies in eastern North America. Subsequent to the development of the EPRI curves, the applicant stated that regression analyses of recorded ground motions "were conducted to confirm that use of the curves in site response analyses produces reasonable ground response predictions." The applicant stated that information in Section 5.2 of SSAR Appendix A indicates that soils at the ESP site fall within the range of gravelly sands to low-plasticity silty or sandy clays. In response to the staff's observation that the ESP laboratory testing data for hysteric damping appear to be relatively high at low strain compared to the generic data from the EPRI report, the applicant stated the following:

> The information in Figure 5-21 (SSAR Appendix A) does indeed suggest that the hysteric damping from the laboratory tests was higher than the EPRI curves. The same conclusion can be made from the information in Figure 5-24. However, the curves that are above the EPRI damping curves are related to the resonant column tests. The fact that the resonant column data shown in Figures 5-21 and 5-24 are solid, bold lines masks the response from the torsional shear tests—suggesting that all the damping values are too high at low shearing strain amplitudes. However, material damping values from the torsional shear tests are consistent with the EPRI damping curves, as shown in Figures 4.2-2 through 4.2-6 of Appendix B to the EGC ESP SSAR.
>
> The higher damping from the resonant column tests has been recognized for a number of years, and was noted in the EPRI (1993) set of reports. It is attributed to rate of loading effects. Typical frequencies of loading for the resonant column test range from 100 to 200 Hz for these soils. As the frequency increases from the torsional shear testing (frequencies of 0.1 to 10 Hz) to resonant column (frequencies of 100 to 200 Hz), the absolute value of damping increases by several percent. This trend is shown in Figures B.15, C.15, D.15, E.15, and G.15 of Attachment A-7 to the Appendix A report. The observed frequency effect on damping is the reason combined resonant column/torsional shear (RC/TS) tests are conducted. The frequency of loading for the torsional shear tests ranges from 0.1 to 10 Hz and therefore is much more consistent with predominant frequencies of earthquake loading.

In order to verify the applicant's classification of the ESP soils as "gravelly sands to low plasticity silty and sandy clays," the staff reviewed Section 5.2.2 of SSAR Appendix A. Section 5.2.2 provides a general description of each of the soil layers underlying the ESP site and includes information on plasticity, water content, and dry density. The staff concludes from its review that the applicant's characterization of the ESP site soils is appropriate. In addition, the staff concludes that the applicant's use of the EPRI curves is justified since these curves are based on a much larger database of properties from similar soils (gravelly sands) than those obtained by the applicant for the ESP site from its four soil borings. Although the fit between the EPRI curves and the resonant column tests on the ESP site soils is weak, the staff notes that the torsional shear test data do fit the EPRI curves. The frequency of loading for the torsional shear tests ranges from 0.1 to 10 Hz, which is consistent with the predominant frequencies of earthquake ground motion. Figure 2.5.4-6, which reproduces Figure 4.2-2 from



Seismic Hazards Report for the EGC ESP Site **Modulus Reduction and Damping Test Results Compared to EPRI (1993) Soil Property Curves for Test UTA-34-A**	Figure **4.2-2**

Figure 2.5.4-6 Modulus reduction and damping test results compared to EPRI (1993) soil property curves for test UTA-34-A

SSAR Appendix B, shows the fit between the ESP site data from the resonant column and torsional shear tests compared to the EPRI (1993) generic curves for gravelly sands to low-plasticity silty or sand clays.

Based on its review of the applicant's soil classifications and the fit between the ESP site soil torsional shear test data and the EPRI (1993) generic curves, described above, the staff concludes that the applicant's use of the EPRI shear modulus and damping curves is appropriate.

In addition to its field measurements (CPT and suspension logging) of the soil S-wave velocities, the applicant also made laboratory measurements of S-wave velocity using the six resonant column tests on ESP site samples taken over a range of depths. For the first four laboratory samples (from depths of 33, 41.5, 115, and 171 ft below the surface), the applicant's S-wave velocity results closely match the field suspension logging test results. As shown in Table 5-3 of SSAR Appendix A, the ratio of laboratory- to field-measured S-wave velocity is between 86 to 95 percent for each of these samples. For the deepest two soil samples at depths of 208 and 242 ft, the ratio decreased to 68 and 76 percent, respectively. Since the difference between S-wave velocities (field and laboratory) is caused primarily by sample disturbance associated with the laboratory testing process, the staff asked the applicant in RAI 2.5.4-5 to justify these low ratios. In response to RAI 2.5.4-5, the applicant stated that the low ratios are an indication of the accumulated disturbance that occurs to soil samples when they are removed from the ground, transported to the laboratory, set up in the laboratory, and tested in equipment that may not replicate the stress state and loading conditions in situ during a seismic event. For the soil sample with the lowest ratio (0.68), the applicant stated that this was an obviously disturbed sample as shown by its modulus and damping ratio curves, which are shown in Figures 5-20 and 5-21 in SSAR Appendix A (Sample E). For the deepest sample at 242 ft below the surface, the applicant attributed its low ratio (0.76) to the large, unavoidable stress relief as the applicant brought the sample to the surface. Since these two deeper soil samples showed evidence of disturbance, the applicant used only the shallower soil samples to determine the shear modulus and damping ratio to justify its use of the EPRI (1993) generic curves.

Since the applicant was able to use its shallower laboratory test results to show a fit to the EPRI (1993) generic shear modulus and damping ratio curves (see RAI 2.5.4-2 above), the staff concludes that the low laboratory- to field-measured S-wave velocity ratios are not significant. The applicant used the EPRI (1993) generic curves to determine the site response to the SSE ground motion.

The staff concludes, based on its review of SSAR Sections 2.5.4.2 and 2.5.4.3 and the applicant's responses to its RAIs and open item, that the applicant adequately determined the engineering properties of the soil and rock underlying the ESP site through its field and laboratory investigations. In addition, the applicant used the latest field and laboratory methods, in accordance with RGs 1.132 and 1.138, to determine these properties. The staff concludes that the applicant performed sufficient field investigation and laboratory testing to establish the similarity between the CPS and ESP sites and, as such, the overall subsurface profile as well as the material properties underlying the ESP site. The staff notes that in response to Open Item 2.5.4-1 the applicant committed to perform additional investigations (soil borings) once it has selected the building locations, as recommended in RG 1.132 (see Open

Item 2.5.4-1 above). The COL (or construction permit (CP)) applicant will need to describe these additional investigations in its COL (or CP) application. See COL Action Item 2.5.4-2.

2.5.4.3.3 Relationship of Foundations and Underlying Materials

Section 2.5.4.3 of RS-002 directs the staff to compare the applicant's plot plans and the profiles of all seismic Category I facilities with the subsurface profile and material properties. Based on this comparison, the staff can determine if (1) the applicant performed sufficient exploration of the subsurface and (2) the applicant's foundation design assumptions contain adequate margins of safety. The applicant decided to provide this information as part of its COL submittal. Submission of the applicant's plot plans and the profiles of all seismic Category I facilities for comparison with the subsurface profile and material properties is **COL Action Item 2.5.4-3.**

2.5.4.3.4 Geophysical Surveys

The staff focused its review of SSAR Section 2.5.4.3 on the adequacy of the applicant's geophysical investigations to determine the soil and rock dynamic properties. The applicant conducted four CPT soundings and, during two of the soundings, obtained S-wave velocity data. To measure the S-wave velocity of the soil, the applicant generated an S-wave at the ground surface by horizontally striking a board at the surface using a sledge hammer. The applicant measured the travel time of the resulting S-waves with a velocity-sensitive geophone located at the tip of the CPT assembly. In addition to the CPT soundings, the applicant also conducted P- and S-wave suspension logging tests in one of its four soil borings. The applicant performed the suspension logging test at approximately 1.5-ft depth intervals to within approximately 20 ft into the top of rock. In addition to these two seismic tests, the applicant also measured the S-wave velocity of the soil samples in the laboratory as part of its cyclic testing.

The staff reviewed the applicant's description of the suspension logging test and the CPT. In addition, the staff reviewed the applicant's test reports, prepared by its two contractors, in Attachments A-4 and A-5 to SSAR Appendix A. Attachment A-4 provides the details of the applicant's CPT soundings and includes a number of seismograms, which show the S-wave arrivals at the tip of the CPT assembly. In addition, the staff reviewed the applicant's computation of the S-wave velocities, which were based on S-wave travel times and the seismic receiver (geophone) depth. Attachment A-5 provides the details of the applicant's suspension logging tests and includes a few sample seismograms, a P- and S-wave velocity depth profile, and the measured P- and S-wave velocity values. For the 280 ft of soil, the S-wave velocity gradually increased from about 800 ft/s to nearly 3000 ft/s. The staff noted that there are fairly significant oscillations in the S-wave velocity profile with depth, which the applicant captured in its dynamic site response analyses (see Section 2.5.2.1.5 of this SER). The S-wave velocity results from the CPT soundings, which covered the upper soil layers to a depth of about 55 and 76 ft, are consistent with those from the suspension logging tests. In addition, the older CPS site S-wave velocity results are consistent with the ESP site results.

The staff has determined that the applicant used the latest geophysical and geotechnical measurement methods and equipment in accordance with the recommendations of RGs 1.132 and 1.138 to determine the dynamic properties of the soil and rock underlying the site. Based on its review of SSAR Section 2.5.4.4, the staff concludes that the applicant adequately determined the soil and rock dynamic properties through its geophysical survey of the ESP site.

2.5.4.3.5 Excavation and Backfill

In SSAR Section 2.5.4.5, the applicant stated that the construction of the facilities at the ESP site would likely require excavations to a depth of approximately 55 to 60 ft below the ground surface to avoid potential settlement and liquefaction concerns. The applicant also described some of the licensee's findings during its excavations for the CPS site. The most important finding is that the licensee encountered some localized pockets of sand at the base of the excavation at a depth of 56 ft. The licensee either compacted these sand pockets or removed and replaced them with a flyash-backfill mixture.

Since the applicant has not selected a reactor design or location within the ESP site, it did not provide detailed excavation and backfill plans or plot plans and profiles as outlined in Section 2.5.4 of RS-002. Therefore, the staff could not adequately evaluate the applicant's excavation and backfill plans and will await future submittal of these plans as part of the COL or CP application. This is **COL Action Item 2.5.4-4.**

The applicant also included SSAR Sections 2.5.4.13 and 2.5.4.14 in its application. The ESP review standard RS-002 covers these two subsections under Section 2.5.4.5.

SSAR Section 2.5.4.13 states that the applicant will perform settlement analyses at the COL stage and will be able to use previous settlement measurements made by the licensee for the CPS plant structures. The applicant's assertion is based on the assumption of similar soil conditions between the two sites and that the new facilities will be similar in size, load, and foundation level to those constructed at the CPS site. The need for the COL or CP applicant to perform settlement analyses is covered below in SER Section 2.5.4.3.10.

SSAR Section 2.5.4.14 states that the applicant will map any future excavation associated with the construction of a new nuclear power plant to confirm that the soil types and consistency are in agreement with the conditions identified and interpreted from the ESP field explorations. The applicant stated that this field mapping will involve inspecting excavated slopes for the presence of previously unknown fault offsets. The applicant also committed to inform the NRC staff (1) if it encounters previously unknown geologic features that could represent a hazard to the plant and (2) when site excavations are open for examination and evaluation. These commitments comprise **COL Action Item 2.5.4-5.**

2.5.4.3.6 Ground Water Conditions

In SSAR Section 2.5.4.6, the applicant briefly described its installation of three piezometers during its ESP site exploration to obtain more specific information about ground water conditions at the ESP site. The applicant found that the static ground water table is approximately 30 ft below the ground surface and that the ground water conditions are similar at the ESP and CPS sites.

Since the applicant has not selected a reactor design or location within the ESP site, it did not provide an evaluation of ground water conditions as they affect foundation stability or detailed dewatering plans as outlined in Section 2.5.4 of RS-002. Therefore, the staff could not evaluate the ground water conditions as they affect the loading and stability of foundation materials or the applicant's dewatering plans during construction as well as ground water control throughout the life of the plant. As such, the staff will await the future submittal of these evaluations and plans as part of the COL or CP application. The need to evaluate ground water conditions as they affect foundation stability or detailed dewatering plans is **COL Action Item 2.5.4-6.**

2.5.4.3.7 Response of Soil and Rock to Dynamic Loading

In SSAR Section 2.5.4.7, the applicant stated that it deferred the analyses of the SSI for the ESP site to the COL stage. Since the SSI analyses will depend on the geometry and weight of the selected power generating system and the ESP applicant has not selected a reactor design or location within the ESP site, it did not perform SSI analyses. The staff concurs with the applicant's decision to defer the SSI analyses to the COL stage; however, the staff expected to review the applicant's determination of the free-field site amplification response in SSAR Section 2.5.4.7. Instead of providing the ESP site free-field site amplification in SSAR Section 2.5.4.7, the applicant provided the site amplification in SSAR Section 2.5.2.5 and a description of the soil dynamic properties in SSAR Section 2.5.4.2. Section 2.5.2.3.5 of this SER contains the staff's evaluation of the applicant's site response analyses, and SER Section 2.5.4.3.2 provides the staff's evaluation of the ESP site dynamic soil properties.

2.5.4.3.8 Liquefaction Potential

In its review of SSAR Section 2.5.4.8, the staff evaluated the applicant's liquefaction analyses. The staff's review focused on the applicant's conclusion that, based on its liquefaction evaluations, liquefaction is not a design consideration for the ESP site. The applicant found that, above 60 ft below the ground surface, there are several soil layers for which the FOS against liquefaction is less than 1.1, indicating that these layers are susceptible to liquefaction. However, the applicant stated that "potentially liquefiable soils in the upper 60 ft at the EGC ESP Site will likely have to be removed to meet settlement requirements." The applicant stated that it would select fill material (heavily compacted granular fill) that is stronger than the removed soil, which would increase the FOS against liquefaction to be greater than 1.1.

Concerning the applicant's liquefaction analyses, the staff reviewed the empirical blowcount procedure used by the applicant, which is described in RG 1.198. The empirical method calculates an FOS based on the expected soil shearing resistance and the expected maximum seismically induced shearing stresses in a soil layer. In RAI 2.5.4-6, the staff asked the applicant to provide a sample liquefaction analysis from one of the four borehole locations and to clearly show how it determined the FOS for the different soil layers. In addition, the staff asked the applicant to describe the methods that it may use to mitigate the potential for liquefaction and to describe the extent of the liquefiable (noncohesive) soils over the ESP site area.

In response to RAI 2.5.4-6, the applicant provided a sample calculation for borehole B-1 at the 38.5-ft depth interval. In addition, the applicant described the methods (other than removal and replacement) that it may use to mitigate the potential for liquefaction. The four ground improvement methods described by the applicant are (1) use of vibro-densification methods, (2) use of stone columns, (3) use of in-place soil cement mixing, and (4) use of earthquake drains. For each of these improvement methods, the applicant provided a brief description and an assurance that most of these methods have been tested in severe earthquakes and have successfully controlled the potential for and consequences of liquefaction. With regard to the third part of RAI 2.5.4-6, the applicant provided the following description of the extent of the noncohesive (silts and sands) soils over the ESP site area:

> The extent of the non-cohesive soils at the EGC ESP site is generally limited to outwash intervals in the Wisconsinan till, interglacial zone, and upper 15 feet of the Illinoian till. Interbedded silt and sand layers were encountered from 62 to 72 feet bgs [below ground surface] at Borehole B-2, sand was encountered from 43 to 60 feet bgs at Borehole B-3, and clayey sand was encountered from 49 to 59 feet bgs at Borehole B-4. Additional thinner layers of non-cohesive sands and silts were observed in shallower intervals in B-1 and B-2.

The applicant added that not all of these noncohesive soils are considered liquefiable for the design considerations.

The staff reviewed the sample liquefaction analysis provided by the applicant for borehole B-1 to verify that the applicant used the method recommended by RG 1.198 for determining the FOS against liquefaction. The applicant used the Youd (2001) procedure, which evaluates soil strength against liquefaction based on SPT blowcount values and the induced cyclic stresses based on earthquake PGA and magnitude values. The applicant evaluated three earthquakes with magnitudes of 5.5, 6.5, and 8.0 and a constant PGA of 0.3g for each earthquake. The applicant selected these three earthquake magnitudes based on its deaggregation of the PSHA results for the controlling earthquakes for the ESP site. The M 5.5 earthquake represents a local source mechanism, the M 6.5 earthquake represents an earthquake from the Wabash Valley source zone, and the M 8.0 earthquake represents an earthquake from the New Madrid seismic source zone. The applicant used a constant PGA value of 0.3g since this is the PPE value it selected for the ESP site. The peak acceleration value of 0.3g exceeds the peak acceleration value (at 100 Hz) of the ESP site SSE, which is 0.26g. For each of the three magnitudes, some of the soil layers had FOSs less than 1.1. The applicant also varied the peak acceleration values to determine the sensitivity of the calculated FOS to changes in magnitude and peak acceleration. The applicant found that a reduction in PGA from 0.35 to 0.25 increases the FOS by approximately 50 percent for each depth interval. Based on its review of the sample liquefaction analysis, the staff concludes that the applicant used the latest empirical method and adequately varied the significant soil and seismic input parameters in accordance with the guidance provided in RG 1.198. Therefore, the applicant's liquefaction analyses are acceptable.

In addition to the applicant's sample liquefaction analysis, the staff also reviewed the applicant's descriptions of potential soil improvement methods and its description of the extent of the potentially liquefiable soils over the ESP site. From the applicant's above description, the staff concludes that noncohesive soils are fairly extensive over the area of the ESP site.

Based on its review of SSAR Section 2.5.4.8 and the applicant's response to RAI 2.5.4-6, described above, the staff concludes that the applicant has employed an acceptable methodology to determine the liquefaction potential of the soil underlying the ESP site. Because portions of the upper 60 ft of soil are susceptible to liquefaction, the applicant stated that these soils would be either removed or replaced or improved to reduce any liquefaction potential. This is **Permit Condition 6.**

2.5.4.3.9 Earthquake Design Basis

SSAR Section 2.5.4.9 describes the performance-based approach used by the applicant to determine the SSE. This approach is also described in SSAR Section 2.5.2.6 and in more detail in Section 4.3 of SSAR Appendix B. Section 2.5.2.3.6 of this SER provides the staff's evaluation of the SSE, including the performance-based approach.

2.5.4.3.10 Static Stability

SSAR Section 2.5.4.10 states that the applicant deferred the determination of static stability to the COL stage. The applicant stated that since it has not selected a nuclear power plant design, it did not estimate the bearing capacity, settlement, or lateral earth pressures for the ESP site. These analyses depend on factors such as building footprint size, depth of embedment, and effective weight. The applicant did establish an ESP site characteristic value for minimum static stability at 25 tsf. This value is based on the licensee's evaluation of static stability for the CPS site and the assumption that similar-sized structures will be built on the ESP site. Bearing capacities in the CPS USAR range from about 40 to 60 tsf.

In RAI 2.5.4-3, the staff asked the applicant to provide further detail regarding the criteria that it used to establish the minimum static bearing capacity of 25 tsf for the ESP site. In response to RAI 2.5.4-3, the applicant stated that the methods used by the licensee for the calculation of the bearing capacities were conventional methods that assume a local shear failure condition. The range in bearing capacity values for the Category I structures at the CPS site range from 39.9 to 60.6 tsf and correspond to CPS building foundation elevations ranging from 35 to 40 ft below the ground surface. The applicant stated that during the construction of the CPS facility, the soil was excavated to a depth of approximately 55 ft below the ground surface to remove soils that could be compressible. The licensee then placed approximately 20 ft of highly compacted granular backfill between the base of the excavation and the foundation level for the CPS facility foundations. The values given by the licensee for the bearing capacity represent, therefore, a condition in which the foundations were placed on approximately 20 ft of highly compacted granular fill over the highly overconsolidated Illinoian till soil unit. The applicant stated that the combination of depth below the ground surface and the heavily overconsolidated state of the Illinoian till results in the high bearing capacities given in the CPS USAR. Comparing the minimum bearing capacity value chosen by the applicant (25 tsf) with the lower value in the range of bearing capacities for the CPS site (39.9) provides an FOS greater than 1.5.

Since, as the applicant points out, the minimum bearing capacity value established by the applicant provides an FOS greater than 1.5 compared to the minimum calculated bearing capacity for the CPS Category I structures, the staff finds that this value is appropriate as a PPE for the ESP site. This finding is based on the applicant's commitment to excavate approximately 55 ft below the ground surface and to backfill with highly compacted granular fill. In addition, the average undrained shear strength of the Illinoian till must be similar to that underlying the CPS site. The applicant stated that the actual foundation depth, size, and shape, structure locations, and settlement limits "will be considered to confirm the final ultimate bearing capacity at COL." The need for the COL or CP applicant to perform a complete static stability assessment (including bearing capacities, settlement analyses, and lateral load assessment) and to ensure that the bearing capacities meet the minimum value of 25 tsf comprises **COL Action Item 2.5.4-7.**

2.5.4.3.11 Design Criteria

SSAR Section 2.5.4.11 states that the design criteria for the ESP site Category I structures will be established during the COL stage. Since the applicant has not selected a reactor design or location within the ESP site, its deferral of a description of the design criteria to the COL stage is acceptable to the staff. The need for the COL or CP applicant to describe the design criteria and methods, including the FOSs from the design analyses, is **COL Action Item 2.5.4-8.**

2.5.4.3.12 Techniques to Improve Subsurface Conditions

SSAR Section 2.5.4.12 states that until the power generating system is selected, the need for ground improvement for the ESP site is unknown. The applicant stated that structures that are founded at depths of 55 ft or above could require ground improvement, and that "decisions regarding the need for and type of ground improvement will be made during the COL stage." Based on the applicant's liquefaction analyses, which showed that portions of the upper 60 ft of soil are susceptible to liquefaction (FOS $\leq$ 1.1), the staff considers the improvement (i.e., removal and replacement or compaction) of the upper 55 ft of soil beneath the ESP site to be necessary. The improvement of the upper soil layers beneath the site will also be necessary to ensure that the minimum bearing capacity value of 25 tsf is met. In addition, the licensee encountered localized pockets of loose granular material at the base of the excavations for the CPS Category I structures during construction at the CPS site. The licensee either compacted these loose granular pockets of soil or removed and replaced them with backfill material. The need to employ ground improvement for the ESP site is also discussed above in conjunction with Permit Condition 6.

2.5.4.4 Conclusions

Based on its review of SSAR Section 2.5.4 and the applicant's responses to the associated RAIs and open item, the staff concludes that the applicant has adequately determined the engineering properties of the soil and rock underlying the ESP site through its field and laboratory investigations. In addition, the applicant used the latest field and laboratory methods, in accordance with RGs 1.132, 1.138, and 1.198, to determine these properties. Accordingly, the staff concludes that the applicant performed sufficient field investigations and laboratory testing to determine the overall subsurface profile, the properties of the soil and rock underlying the site, and the similarity between the CPS and ESP subsurface profiles and properties. Specifically, the staff concludes that the applicant adequately determined (1) the soil and rock dynamic properties through its field investigations and laboratory tests and (2) the liquefaction potential of the soils. The applicant covered the response of the soil and rock to dynamic loading in SSAR Section 2.5.2.

In SSAR Sections 2.5.4.5, 2.5.4.6, 2.5.4.10, 2.5.4.11, and 2.5.4.12, the applicant did not provide sufficient information for the staff to perform a complete evaluation. In addition, the applicant did not provide any information on the relationship of the foundation and underlying materials (Section 2.5.4.3 in RS-002). The staff reviewed SSAR Sections 2.5.4.13 and 2.5.4.14 as part of its review of SSAR Section 2.5.4.5. Each of these topics depends on specific information related to building location and design and will be needed as part of any COL or CP application.

In SSAR Table 1.4-1, the applicant identified three subsurface material properties as ESP site characteristic values. The first site characteristic specifies that there is no liquefaction below 60 ft below the ground surface. The applicant demonstrated, in SSAR Section 2.5.4.8, that any liquefaction at the ESP site would be limited to the upper 60 ft of soil. SSAR Table 1.4-1 states that "soils above 60 ft bgs to be replaced or improved"; however, in SSAR Section 2.5.4.12 the applicant stated, "decisions regarding the need for and type of ground improvement will be made during the COL stage." An unequivocal commitment by the applicant to improve or replace and remove the soils above 60 ft below the ground surface is Permit Condition 6. The second site characteristic value specifies a minimum bearing capacity of 25 tsf. This value is based on the CPS site soil properties and not the ESP site properties, since the applicant deferred the determination of bearing capacity values to the COL stage. Finally, the third design parameter specifies minimum S-wave velocities for the three depth intervals 0–50 ft, 50–285 ft, and 285–310 ft as 820 ft/s, 1090 ft/s, and 2580 ft/s, respectively. These S-wave velocity values are based on the applicant's field geophysical surveys. The staff has reviewed the applicant's suggested site characteristics related to SSAR Section 2.5.4 for inclusion in an ESP, should the NRC issue one to the applicant. For the reasons set forth above, the staff agrees with the applicant's site characteristics and the values for those characteristics.

2.5.5 Stability of Slopes

SSAR Section 2.5.5 describes the applicant's plans for future slope stability analyses. The applicant did not carry out slope stability analyses for the ESP application.

2.5.5.1 Technical Information in the Application

The applicant stated that it did not perform a slope stability analysis for the ESP site application. If a new intake structure into Clinton Lake is required for a future design, the applicant stated that it would perform an additional assessment of the slope stability at the point of entry into the lake. The applicant further stated that the slopes for the existing CPS Unit 2 facility are approximately 30 ft deep and are located over 500 ft from the ESP site, and therefore do not pose a hazard. In addition to slopes associated with the potential future intake structure, the applicant stated that it will analyze the slopes associated with the construction of the power block or the outfall at the COL stage. Currently, the foundation depth of the new generating system is unknown, and the applicant stated that these depths are necessary to assess the potential height of slopes required for construction.

The applicant stated that the starting point for future slope stability analyses will be the information in the CPS USAR. The applicant stated that the licensee performed an extensive evaluation of slope stability during design work for the CPS site. The licensee evaluated the stability of the slopes associated with the Clinton Lake main dam and the CPS UHS under both static and dynamic loading conditions. However, since the Clinton Lake dam is not considered a Category I structure, the licensee only evaluated the CPS UHS for the SSE ground motion. The applicant concluded from its review of the CPS USAR that potential future issues associated with slope stability will not result in any unusual construction requirements or constraints.

2.5.5.2 Regulatory Evaluation

SSAR Section 2.5.5 states that the applicant did not perform a slope stability analysis for the ESP site application. As such, the applicant did not list any regulatory guidance or cite any regulations as applicable to SSAR Section 2.5.5.

2.5.5.3 Technical Evaluation

In SSAR Section 2.5.5, the applicant provided a general description of its plan for future slope stability analyses at the COL stage. Although the general description was useful to the staff in performing a complete review, the COL or CP applicant will need to provide detailed slope stability analyses. This is **COL Action Item 2.5.5-1.**

2.5.5.4 Conclusions

SSAR Section 2.5.5 states that the applicant will provide slope stability analyses at the COL stage. As such, at this time the staff is unable to reach any conclusions regarding the stability of slopes that have not been designed or constructed.

2.5.6 Embankments and Dams

SSAR Section 2.5.6 describes the applicant's assessment of (1) the Clinton Lake main dam and the CPS UHS as they relate to a potential future nuclear facility on the ESP site and (2) the potential for seismically induced floods and water waves.

2.5.6.1 Technical Information in the Application

2.5.6.1.1 Design of Main Dam and CPS Ultimate Heat Sink

SSAR Section 2.5.6.1, "Design of Main Dam and CPS UHS," states that there are no plans to modify or rely on the Clinton Lake main dam for emergency cooling water for potential future nuclear facilities on the ESP site. The applicant stated that the ESP facility will use cooling towers for cooling, with Clinton Lake being used to provide makeup water to the cooling towers. Since the ESP facility will use the CPS UHS to supply makeup water to the cooling towers, the applicant stated that it would perform evaluations (if appropriate) at the COL stage to assess the performance of the submerged dam forming the UHS under the ESP SSE ground motion. The applicant stated that the starting point for its COL assessment of the CPS UHS will be the CPS USAR. SSAR Section 2.4.8, "Cooling Water Canals and Reservoirs," provides the main description of the applicant's plans to use the CPS UHS to supply shutdown cooling water for the existing CPS facility as well as makeup water to the ESP facility cooling towers.

2.5.6.1.2 Seismically Induced Floods and Water Waves

SSAR Section 2.5.6.2, "Seismically Induced Floods and Water Waves," describes the potential for seismically induced floods and water waves. Since there are no dams located upstream of the ESP site and no large water-retaining structures in proximity to the existing facilities, the applicant stated that the potential for seismically induced floods and water waves at the ESP site is negligible. In addition, the applicant stated that the potential for flooding from a seiche is also negligible because of the configuration of Clinton Lake and the relative elevation difference between the lake and the plant site grade. The ground surface at the ESP site is at an approximate elevation of 730 ft msl. In contrast, Clinton Lake is at an elevation of approximately 690 ft. In addition, the ESP site is also about 800 ft from the shoreline of Clinton Lake. The applicant stated that any seiche caused by an SSE would be too small to reach the ESP site because of the distance (800 ft) and the height difference (40 ft). SSAR Section 2.4.5, "Probable Maximum Surge and Seiche Flooding," provides additional discussion of the maximum surge and seiche flooding.

2.5.6.2 Regulatory Evaluation

The applicant did not state which regulations SSAR Section 2.5.6 addressed; however, in response to RAI 1.5-1, the applicant stated that it complied with all of the regulations listed in RS-002. RS-002 does not contain a specific section on embankments and dams; however, these topics are covered in RS-002 Sections 2.4.4 and 2.5.5. In SSAR Table 1.5-1, the applicant stated that it used RG 1.70 for general guidance on format and content. Section 2.5.6 of RG 1.70 describes the necessary information and analysis related to the investigation, engineering design, proposed construction, and performance of all embankments used for plant flood protection or for impounding cooling water.

Since the applicant decided to defer the analyses of dam failure and slope stability until the COL stage, the staff did not evaluate the regulatory compliance of SER Section 2.5.6. SER Section 2.4.5 presents the staff's regulatory evaluation concerning the potential for seiche flooding.

2.5.6.3 Technical Evaluation

SSAR Section 2.5.6 states that the ESP facility will use cooling towers for cooling, with Clinton Lake being used to provide makeup water to the cooling towers. Since the ESP facility will use the CPS UHS to supply makeup water to the cooling towers, the applicant stated that it would perform evaluations (if appropriate) at the COL stage to assess the performance of the submerged dam forming the UHS under the ESP SSE ground motion. The applicant's decision to delay this evaluation until the COL stage is acceptable to the staff. This is **COL Action Item 2.5.6-1.**

Concerning seismically induced floods and water waves, SSAR Section 2.5.6 states that since there are no dams located upstream of the ESP site and no large water-retaining structures in proximity to the existing facilities, the potential for seismically induced floods and water waves at the ESP site is negligible. In addition, the applicant stated that the potential for flooding from a seiche is also negligible because of the configuration of Clinton Lake and the relative elevation difference between the lake and the plant site grade. Since the ground surface at the ESP site is approximately 40 ft higher than Clinton Lake and about 800 ft from the shoreline of Clinton Lake, the staff concurs with the applicant's conclusion that any seiche caused by an SSE would be too small to reach the ESP site. SER Section 2.4.5 provides additional evaluation of the potential for seiche flooding.

2.5.6.4 Conclusions

Sections 2.4.4, 2.4.5, and 2.5.5 of this SER present the staff's conclusions regarding dam failures, seiche flooding, and slope stability, respectively.

3. SITE SAFETY ASSESSMENT

3.5.1.6 Aircraft Hazards

For an early site permit (ESP) application, the U. S. Nuclear Regulatory Commission (NRC) staff reviews the applicant's assessment of aircraft hazards to verify that the risks due to such hazards are sufficiently low for a new nuclear power plant that might be constructed on the proposed site.

3.5.1.6.1 Technical Information in the Application

In Section 2.2.2.5 of the Site Safety Analysis Report (SSAR), Exelon Generation Company, LLC (EGC or the applicant) presents information on airports and airways that could affect the design of systems, structures, and components important to the safety of a nuclear power plant or plants within the applicant's plant parameter envelope (PPE) that might be constructed on the proposed ESP site. This information is evaluated in SSAR Section 2.2.2.5.3.

Four private airports and airstrips are located within 10 kilometers (6 miles) of the proposed ESP site. The Spencer airport, owned by AmerGen and located 2 miles west-southwest of the site, is not operational. The remaining three airports or airstrips (Martin RLA Airport, Thorp Airport, and Bakers Strip) can only accommodate small single- or twin-engine aircraft. The Martin RLA Airport is about 4 miles south of the ESP site; the Thorp Airport is about 5 miles northwest of the site; and Bakers Strip is about 5.5 miles southeast of the site. These airports do not have commercial operations and are only available for public use in emergencies.

The closest public airports are the Central Illinois Regional Airport in Bloomington, about 23 miles north of the site; the Decatur Airport, about 23 miles south of the site; and the Rantoul National Aviation Center Airport (Frank Elliott Field), about 37 miles east of the site. The SSAR indicates that the Central Illinois Regional Airport and the Decatur Airport have scheduled commercial flights and have more than 50,000 operations per year. The Rantoul Airport, which does not have regularly scheduled commercial flights, has about 16,000 operations per year.

A detailed evaluation of potential hazards of airport flight operations was not necessary because the number of flights per year associated with the above airports does not exceed the threshold specified in Section 3.5.1.6 of NRC Review Standard (RS)-002, "Processing Applications for Early Site Permits." Therefore, the applicant did not include a detailed evaluation of the potential hazards of airport flight operations in the SSAR. However, the Clinton Power Station (CPS) Update Safety Analysis Report (USAR) contains an evaluation of the hazards of operations at the Martin RLA and Thorp Airports.

The SSAR states that a heliport is located at CPS for use by company helicopters.

Four low-altitude airways pass near the site. These airways, which are used by aircraft flying below 18,000 feet, are 8 nautical miles in width. The closest airway is V313, with a centerline passing less than 2 miles east of the site. The centerline of V233 passes less than 3 miles northwest of the site. The centerlines of V72 and V434 pass approximately 5 miles northeast of the site and 6 miles north-northeast of the site, respectively.

The applicant did not provide traffic data for these airways. However, the CPS USAR contains traffic estimates that were updated in November 2002 and have been extrapolated for a 40-year period on the basis of Federal Aviation Administration (FAA) estimates of the increase in air carrier operations between 1980 and 1992.

The airways are sufficiently close to the proposed site to require detailed evaluations of the potential hazards. In response to the staff's Request for Additional Information (RAI) 2.2.2-2, the applicant committed to revise SSAR Section 2.2.2.5.3 to provide detailed estimates of the probability of aircraft impacts from these Federal airways. The SSAR states that these airways are addressed in the CPS USAR and that the probability of an aircraft crash from these airways is within the guidelines of Section 3.5.1.6 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (also referred to as the SRP). AmerGen updated the USAR evaluation in November 2002. The USAR analysis concludes that the probability of an aircraft crash on the CPS site from flights along the four airways is 5.42×10^{-8} per year. In the SSAR, the applicant estimates that the allowable footprint for the ESP safety-related facilities could be as large as 386,000 ft^2 (about 0.014 mi^2) without exceeding the impact probability criterion of 1.0×10^{-7} per year in RS-002. The applicant further notes that the effective impact area computed for CPS is about 200,000 ft^2 (about 0.01 mi^2).

The SSAR does not discuss hazards associated with military training routes. The aviation charts in SSAR Figure 2.2-3 do not show any military training routes near the proposed site.

3.5.1.6.2 Regulatory Evaluation

In RAI 1.5-1, the staff asked the applicant to provide a comprehensive list of NRC regulations applicable to its ESP SSAR. In its response to RAI 1.5-1, the applicant stated that RS-002 identifies the NRC regulations applicable to its ESP SSAR. The staff considered the regulatory requirements in Title 10 of the *Code of Federal Regulations* (10 CFR), Part 100, "Reactor Site Criteria," Subpart B, [in particular, the requirements of 10 CFR 100.20(b) and 10 CFR 100.21(e)], as identified in RS-002, Attachment 2, Section 3.5.1.6, in reviewing information regarding aircraft hazards that could affect the safe design and siting of a nuclear power plant(s) falling within the applicant's PPE that might be constructed at the proposed site. The staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance.

According to Section 3.5.1.6 of RS-002, the 10 CFR 100.20 requirement that individual and societal risks of potential plant accidents be low is met if the probability of aircraft accidents having the potential for radiological consequences greater than the exposure criteria in 10 CFR 50.34(a)(1) is less than about 1×10^{-7} per year.

The probability is considered to be less than about 1×10^{-7} per year if the distances from the site meet these three criteria:

(1) The site-to-airport distance, D, is between 5 and 10 statute miles and the projected annual number of operations is less than 500 D^2, or D is greater than 10 statute miles and the projected annual number of operations is less than 1000 D^2.

(2) The site is at least 5 statute miles from the edge of military training routes, including low-level training routes, except for routes used by more than 1000 flights per year or where activities (such as practice bombing) may create an unusual stress situation.

(3) The site is at least 2 statute miles beyond the nearest edge of a Federal airway, holding pattern, or approach pattern.

If these three proximity criteria are not met, or if sufficiently hazardous military activities are identified, a detailed review of aircraft hazards should be performed. Section 3.5.1.6 of RS-002 provides guidance on performing such reviews.

In SSAR Table 1.5-1, the applicant identifies the applicable NRC guidance on identifying and evaluating aircraft hazards:

- RG 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Pants—LWR Edition"
- SRP Section 3.5.1.6
- RS-002 Section 3.5.1.6

3.5.1.6.3 Technical Evaluation

The applicant identified three private airfields near the proposed ESP site. The SSAR concludes that none of the fields has enough flight operations to require a detailed analysis of the risk to a plant at the proposed ESP site based on a criterion in RG 1.70 similar to the first criterion in the list above. This criterion only applies to the Thorp Airport and Bakers Strip. The criterion does not apply to the Martin RLA Airport because the distance from that airport to the ESP site is less than 5 miles.

The staff concurs with the applicant's conclusion that the hazards associated with Thorp Airport and Bakers Strip do not require a detailed analysis because their distance from the site and the number of annual operations at each airfield satisfy the first criterion.

The staff did an independent evaluation of the hazards associated with the Martin RLA Airport because it is within 5 miles of the ESP site. Since Martin RLA Airport is a private airfield, the staff finds it conservative to assume 500 general aviation operations per year from the facility. The staff conservatively assumed an effective area of 0.02 mi^2 for safety-related structures in the ESP site powerblock footprint on the basis of Figure 2.1-4 of the environmental report submitted with the ESP application and that 50 percent of the operations result in flights near the proposed ESP site. Using the procedure set forth in Section III.3(a) of Section 3.5.1.6 in Attachment 2 to RS-002, the staff estimates that an aircraft from the Martin RLA Airport has a probability of about 6×10^{-8} per year of impacting the ESP facility. This probability is lower than the 10^{-7} threshold in the acceptance criteria in SRP Section 3.5.1.6. Thus, the staff concludes that aircraft hazards associated with the Martin RLA Airport do not pose a significant risk to facilities at the proposed ESP site. The staff has not identified any additional private airfields within 16 kilometers (10 miles) of the site.

The applicant identified three public airports near the proposed ESP site and determined that the number of operations at each airport was lower than in criterion 1 above. The staff did an independent review of public airports in the vicinity of the proposed ESP site and identified 10 airports within 50 miles of the site. Table 3.5.1.6-1 below lists these airports, including the three identified by the applicant. The table provides the distance from each airport to the proposed ESP site, the number of operations per year, and a description of the distribution of operations by aircraft type (the information on airport location and operations was obtained from AirNav.com on November 16, 2004 at http://www.airnav.com/airports/us/IL). FAA information regarding the site was updated on September 30, 2004. On the basis of the airport distances from the airports to the site and the annual number of operations, these airports satisfy criterion 1. Hence, hazards of operations at these airports near the proposed ESP site do not pose a significant risk to safety-related structures that might be built at the site.

The applicant identifies four airways that pass near or over the proposed ESP site. The SSAR does not present an analysis of the risks associated with the airways. Rather, it relies on the CPS USAR analysis of the risk. AmerGen updated this analysis in November 2002. The USAR analysis follows the guidance in SRP Section 3.5.1.6, which is similar to the guidance for the review of ESP applications in RS-002. Using the results of the USAR analysis, the applicant estimates that a safety-related structure of an ESP facility could have an effective footprint of about 386,000 ft^2 (about 0.014 mi^2) and still meet the SRP criterion of about 10^{-7} per year.

The staff performed an independent assessment of the risks associated with the airways. The staff assumed a powerblock footprint of 0.02 mi^2 (on the basis of Figure 2.1-4 of the environmental report submitted with the ESP application). The staff based its estimate of the traffic along each airway in 2065 on the traffic estimates in the USAR and an annual growth rate of 1.5 percent. This growth rate is slightly larger than the rate assumed in the USAR. Table 3.5.1.6-2 lists the resulting risk estimates by airway, using the in-flight crash rate of $4x10^{-10}$ per mile from RS-002. The total risk is estimated to be about $5.0x10^{-8}$ per year. This estimate is about the same as the USAR risk estimate for a crash into the current CPS unit. Because many aircraft using the low-altitude airways are small and the assumptions used in the probability estimates are conservative, the staff concludes that the probability of an aircraft crash on the ESP site having radiological consequences greater than the 10 CFR 50.34(a)(1) criteria is less than $5.0x10^{-8}$.

3.5.1.6.4 Conclusions

The staff reviewed the applicant's aircraft hazard analysis using the procedures set forth in RS-002, Section 3.5.1.6. As discussed above, the staff reviewed the applicant's assessment of aircraft hazards at the site with a probability of less than about 10^{-7} per year for an accident having the potential for radiological consequences greater than the exposure criteria in 10 CFR 50.34(a)(1). The staff also did independent analyses. Based on these analyses, the staff concludes that aircraft hazards at the proposed ESP site pose no undue risk to the health and safety of the public. Therefore, the staff concludes that, from the perspective of aircraft hazards, the proposed site is acceptable for siting a plant or plants of the types specified by the applicant. In addition, the site meets the relevant requirements of 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," and 10 CFR Part 100.

Table 3.5.1.6-1 Public Airports Near the Proposed ESP Site

Airport	Distance from ESP Site (mi)	Reported Operations Per Year	Operations by Aircraft Type
Central Illinois Regional	20	57,305	71% general, 23% air taxi, 5% commercial
University of Illinois	31	129,575	91% general, 9% air taxi
Decatur	23	55,480	69% general, 15% air taxi, 12% military, 5% commuter
Piatt County	19	5,996	100% general
Abraham Lincoln Capital	50	66,795	70% general, 20% air taxi, 9% military
Rantoul	37	20,075	100% general
Frasca Field	34	14,965	90% general, 10% air taxi
Logan County	26	6,987	80% general, 19% air taxi, 1% military
Pekin	49	9,125	77% general, 22% air taxi
Paxton	42	4,015	95% general, 5% air taxi

Table 3.5.1.6-2 Probability of Aircraft Impacts from Federal Airways

Airway	Distance to Airway Centerline (mi)	Present (2002) Traffic (Flights per Year)	Projected Traffic for 2065 (Flights per Year)	Effective Footprint Area (mi^2)	Width of Airway Plus 2x Distance to Edge of Airway (mi)	Probability of Impact (yr^{-1})[(a)]
V313	1.5	7,300	18,650	0.02	9.21	1.62×10^{-8}
V233	2.0	7,300	18,650	0.02	9.21	1.62×10^{-8}
V434	6.0	5,475	13,988	0.02	12.0	9.3×10^{-9}
V72	4.75	3,650	9,325	0.02	9.5	7.9×10^{-9}
					Total	4.96×10^{-8}

(a) Assuming an inflight crash probability of 4×10^{-10} per mile.

11. RADIOLOGICAL EFFLUENT RELEASE DOSE CONSEQUENCES FROM NORMAL OPERATIONS

11.1 Source Terms

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the information on radiological effluents and solid radioactive waste provided in Site Safety Analysis Report (SSAR) Section 3.1 of the Exelon Generation Company, LLC (EGC or the applicant) early site permit (ESP) application to determine whether site characteristics are such that the radiation dose to members of the public would be within regulatory requirements.

11.1.1 Technical Information in the Application

The applicant provided information on the radioactive gaseous and liquid effluents and solid radioactive waste material that would be generated as a normal byproduct of nuclear power operations. These radioactive materials would be collected, processed, stored, and discharged in a controlled manner to the local environment or transported offsite for long-term storage or disposal. The facility to be built on the ESP site would have the ability to handle these radiological effluents and solid waste material in a manner that minimized radioactive releases to the environment and maintained exposure to the public and plant personnel during normal plant operation and maintenance at levels that were as low as is reasonably achievable (ALARA).

11.1.2 Regulatory Evaluation

NRC regulations require that applicants for an ESP address characteristics of the proposed site that could affect the radiation dose to a member of the public from radiological effluents. In Request for Additional Information (RAI) 1.5-1, the staff asked the applicant to provide a comprehensive list of NRC regulations applicable to its ESP SSAR. In its response to RAI 1.5-1, the applicant stated that SSAR Section 3.1 addresses radiological effluents in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR), Section 52.17(a)(1)(iv). Specifically, 10 CFR 52.17(a)(1)(iv) states that an ESP application should describe the anticipated maximum levels of radiological effluents that each facility will produce. The staff reviewed this portion of the application for conformance with the applicable regulations.

11.1.3 Technical Evaluation

11.1.3.1 Gaseous Effluents

The gaseous waste management system would control, collect, process, store, and dispose of radioactive gases during plant operation, including startup, normal operation, shutdown, refueling, and anticipated operational occurrences. Routine radioactive gaseous effluents would be released to the environment through the waste gas processing systems, which minimize the releases to the environment. Radioactive gases that might be present in the plant buildings as a result of leakage from systems would also be monitored and released through the building ventilation systems. The release of radioactive gaseous effluents from the facility would be controlled and monitored to be within the regulatory limits in 10 CFR Part 20, "Standards for Protection Against Radiation," and maintained ALARA in accordance with

10 CFR Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as Is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents."

The applicant estimated the bounding quantity of radioactive gaseous effluents that might be released from the gaseous waste management and building ventilation systems. The applicant determined the gaseous radioactive effluent concentrations based on a composite of the highest activity content of the individual isotopes it anticipated would be released from the alternative reactors designs under consideration.

The applicant also provided bounding gaseous effluent release data to support compliance with the gaseous effluent release concentration limits in Table 2 of 10 CFR Part 20, Appendix B, "Annual Limits on Intakes (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage."

The applicant calculated the estimated dose to a hypothetical maximally exposed member of the public from the gaseous effluents, using radiological exposure models based on Regulatory Guide (RG) 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," and the GASPAR II program (NUREG/CR-4653, "GASPAR II—Technical Reference and User Guide," March 1987). The applicant evaluated several exposure pathways, including direct radiation from immersion in the gaseous effluent cloud and from particulates deposited on the ground, inhalation of gases and particulates, ingestion of milk contaminated through the grass-cow-milk pathway, and ingestion of foods contaminated by gases and particulates.

11.1.3.2 Liquid Effluents

The liquid waste management system would control, collect, process, store, and dispose of potentially radioactive liquids during plant operation, including startup, normal operation, shutdown, refueling, and anticipated operational occurrences. The system would typically be operated in a manner that minimized the release of radioactivity into the environment. Normal liquid effluents would discharge through the existing discharge of the Clinton Power Station (CPS).

Currently, the CPS facility does not routinely discharge radioactive liquid wastes into Clinton Lake. EGC stated that it would likely continue this practice with its ESP facility. However, to provide operating flexibility, the applicant gave a bounding estimate to demonstrate its capability to comply with the regulatory requirements in 10 CFR Part 20 and Appendix I to 10 CFR Part 50.

The applicant provided the estimated bounding annual average quantity of radioactivity projected to be released in Table 1.4-4 of the SSAR. This quantity represents the highest activity content of the individual isotopes from the alternative reactor designs presented in SSAR Section 1.4, "Plant Parameters Envelope," and would bound the activity of the isotopes for any selected reactor design. SSAR Table 3.1-5 compares the projected liquid effluent release concentrations to the 10 CFR Part 20 liquid effluent concentration limits. The data shows that the bounding liquid effluent release concentrations are within the 10 CFR Part 20 effluent concentration limits.

The applicant estimated the dose to a hypothetical maximally exposed member of the public from the liquid effluents, using radiological exposure models based on RG 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," and the LADTAP II program (NUREG/CR-4013, "LADTAP II—Technical Reference and User Guide," April 1986).

The applicant evaluated several exposure pathways, including eating fish or invertebrates caught near the point of discharge, using the shoreline for activities (e.g., sunbathing or fishing), and swimming and boating on the lake near the point of discharge.

11.1.3.3 Solid Waste

The solid waste management system of the EGC ESP facility would control, collect, handle, process, package, and temporarily store the wet and dry solid radioactive waste materials generated during normal plant operations before they are shipped offsite. The solid waste materials might consist of wet waste sludge, dewatered resins, and contaminated solids such as cartridge filters, rags, paper, clothing, tools, and equipment. The applicant would periodically ship solid radioactive waste material between the EGC ESP site and the permanent waste disposal facility.

The applicant estimated that it would ship an average of 15,087 ft^3 of radioactive waste offsite each year. The applicant estimated the maximum curie content of the shipped waste at 5100 curies. The waste would be packaged and shipped in accordance with the applicable regulations in 10 CFR Part 71, "Packaging and Transportation of Radioactive Material," and 49 CFR Part 173, "Shippers—General Requirements for Shipments and Packagings."

11.1.4 Conclusion

The applicant has provided adequate information to provide reasonable assurance that it would control, monitor, and maintain radioactive gaseous and liquid effluents and solid waste from the EGC ESP facility within the regulatory limits in 10 CFR Part 20, 10 CFR Part 71, and 49 CFR Part 173 and maintain them at ALARA levels in accordance with the effluent design objectives set forth in Appendix I to 10 CFR Part 50. A COL applicant that references an ESP for the EGC ESP site should verify that the calculated radiological doses to members of the public from radioactive gaseous and liquids effluents for any facility to be built on the EGC ESP site are bounded by the radiological doses in the SSAR for the ESP application and reviewed by the NRC staff as described above. This is **COL Action Item 11.1-1.**

13. CONDUCT OF OPERATIONS

13.3 Emergency Planning

The U.S. Nuclear Regulatory Commission (NRC) evaluates emergency plans for nuclear power reactors to determine whether there is reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. An early site permit (ESP) application, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 52.17(b), must identify any physical characteristics unique to the proposed site that could pose a significant impediment to the development of emergency plans. The application must also describe contacts and arrangements the applicant has made with Federal, State, and local governmental agencies with emergency response planning responsibilities. In addition, the application may propose major features of emergency plans, as described in Supplement 2 to Revision 1 of NUREG-0654/FEMA-REP-1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants--Criteria for Emergency Planning in an Early Site Permit Application—Draft Report for Comment" (hereafter referred to as Supplement 2), issued April 1996, or may propose complete and integrated emergency plans.

The Exelon Generation Company, LLC (EGC or the applicant), ESP application includes the "Emergency Plan for the Exelon Generation Company, LLC Early Site Permit" (hereafter referred to as the EGC ESP Emergency Plan), that addresses the major features option allowed for ESP applications under 10 CFR 52.17(b)(2)(i). Because the proposed ESP site footprint consists of a portion of the existing Clinton Power Station (CPS) facility, and is located immediately adjacent to CPS, very little distinction exists between the CPS site and the ESP site for purposes of emergency response planning.

The staff, in consultation with the Federal Emergency Management Agency (FEMA), has reviewed the applicant's proposed EGC ESP Emergency Plan, Volume I of the Illinois Plan for Radiological Accidents (IPRA) dated May 2001, Volume VIII of the IPRA dated July 2003, and responses to requests for additional information (RAIs), in accordance with NRC Review Standard (RS)-002, "Processing Applications for Early Site Permits," issued in May 2004.

In RAI 13.3-2, the staff requested copies of the versions of the State and local emergency plans that EGC refers to in the application. On December 15, 2004, the applicant provided copies of the State and local plans in response to RAI 13.3-2. However, EGC provided a more recent version of IPRA Volume VIII than referenced in its application. The applicant also provided a summary of the changes to IPRA Volume VIII in the more recent version. The staff was unable to complete its review of this information before preparation of the draft safety evaluation report (DSER). Therefore, the staff characterized its review and acceptance of the information the applicant provided on December 15, 2004, in response to RAI 13.3-2, as Confirmatory Item 13.3-1. The staff reviewed the summary of the changes to IPRA Volume VIII in the applicant's letter dated December 15, 2004, and determined that it did not affect this SER. The staff also determined that the application was updated to reference the current version of IPRA Volume VIII (2003). Therefore, the staff considers Confirmatory Item 13.3-1 to be resolved.

Because the applicant elected to present and seek NRC acceptance of the major features of emergency plans, the staff's evaluation addresses, in order, the three aspects of such a submission. The following identifies each aspect and the section of this safety evaluation report (SER) that is discussed:

(1) identification of physical characteristics that could pose a significant impediment to the development of emergency plans (SER Section 13.3.1)

(2) description of contacts and arrangements made with Federal, State, and local governmental agencies with emergency planning responsibilities (SER Section 13.3.2)

(3) proposed major features of the emergency plans (SER Section 13.3.3)

The applicant identified 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," as applicable to the major features it proposed. Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities," to 10 CFR Part 50, however, applies to the "major features" option of 10 CFR 52.17(b)(2) only to the extent that it requires a description of the "essential elements of advance planning that have been considered" (see Section III of Appendix E to 10 CFR Part 50). The staff approved the applicant's identification of 10 CFR Part 50 as one of the regulatory requirements applicable to the staff's review of the major features proposed by the applicant. The staff's findings are set forth throughout Section 13.3.3 of this SER and are limited to those particular portions of Appendix E to 10 CFR Part 50 that the staff considered during the course of its review of a particular major feature. More importantly, any staff finding that a proposed major feature complies with a particular requirement of Appendix E to 10 CFR Part 50 is limited to the description of the major feature approved by the staff in this SER.

Notwithstanding any staff approval of a proposed major feature in this SER, all features of the emergency plan requiring a description pursuant to Appendix E to 10 CFR Part 50, but that are not described in the ESP application, will be reviewed in the context of a combined license (COL) or operating license (OL) application. The staff will review complete and integrated emergency plans submitted in a COL or OL application to determine whether they comply with such requirements, as well as the requirements of 10 CFR 50.47, "Emergency Plans."

The staff's evaluation of the proposed major features of the applicant's emergency plans parallels the major features and planning standards in Supplement 2.

13.3.1 Significant Impediments to the Development of Emergency Plans

13.3.1.1 Technical Information in the Application

In Section 2.3, "Evacuation Time Estimate Analysis," of the EGC ESP Emergency Plan, the applicant stated that the evacuation time estimate[1] (ETE) performed in 1993 for the CPS plume exposure pathway served as the basis for the ETE analysis supporting its ESP application. The applicant further stated that the 1993 ETE assesses the relative feasibility of an evacuation for the 10-mile (mi) emergency planning zone (EPZ) plume exposure pathway. The applicant evaluated the assumptions that served as the basis for the 1993 ETE; Section 2.3.1,

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[1] "Evaluation Time Estimates for the Clinton Power Station," July 1993.

"Assumptions," of the EGC ESP Emergency Plan lists these assumptions. The applicant found that these assumptions remain valid for the area surrounding the ESP site.

Sections 2.2, "Summary of Methodology," and 5.5, "Evacuation Simulation," of the 1993 ETE describe the methodology used, including the NETVAC computer simulation model. This model has many features that enable a reasonably sophisticated modeling of the road network, the use of evacuation preparation and departure time distributions, and the use of population and vehicle demand distribution data to simulate a variety of evacuation scenarios.

The 1993 ETE identifies the worst-case ETE for the entire EPZ as a summer weekday, with an ETE of 200 minutes for fair weather and 255 minutes for adverse weather. The Apple and Pork Festival on summer weekends results in an ETE of 380 minutes for fair weather and 530 minutes for adverse weather.

Volumes I and VIII of the IPRA reference the 1993 ETE in the "Planning Standards and Evaluation Criteria Correlation Document" for each volume. The 1993 ETE uses 1990 population data. An assessment of changes in population, using the 2000 census data, was conducted in 2003 in the "Phase One Report—Assessment of Changes within the Emergency Planning Zone for Clinton Nuclear Generating Station," issued in December 2003 (hereafter referred to as the Phase One Report). In RAI 13.3-15, the staff asked whether the information contained in the Phase One Report documenting the assessment of population changes in the plume exposure pathway EPZ should be considered as an update to the 1993 ETE. In response to RAI 13.3-15, the applicant stated that it did not use the Phase One Report in the preparation of the EGC ESP Emergency Plan and that it need not be referenced or considered because Section 2.3.3, "Analysis—Comparison of Infrastructure and Population," of the EGC ESP Emergency Plan independently develops and describes the report's conclusions.

Section 2.2.1, "Plume Exposure Pathway Emergency Planning Zone," of the EGC ESP Emergency Plan states that the EGC ESP site EPZ boundary is identical to the CPS EPZ, that is within approximately a 10-mile radius of the ESP site. Figure 2.1-1, "ESP EPZ with Radial Grid," of the EGC ESP Emergency Plan illustrates the radial boundary of the ESP site plume exposure pathway EPZ. The figure also shows transportation networks, topographical features, and political boundaries. Figure 2.2-1, "ESP EPZ Subareas, Evacuation Routes, and Relocation Centers," of the EGC ESP Emergency Plan delineates the actual EPZ, superimposed on the 10-mile radial grid, along with evacuation routes, subareas, and relocation centers.

In RAI 13.3-17, even though some extrapolated population data have been provided for the addition of two reactors at the Clinton site and refueling outages, the staff asked the applicant to provide additional extrapolated population data for the next 20 years (i.e., the life of the ESP application) and discuss their impact on ETEs. In response to RAI 13.3-17, the applicant stated that Section 2.1, "Geography and Demography," of the EGC ESP Site Safety Analysis Report discusses the population data extrapolated for 60 years (i.e., the life of the ESP plus the life of the operating license). The applicant further stated that the extrapolated population results do not represent a significant change from those considered in the 1993 ETE; therefore, the applicant expects minimal impact.

Section 2.3.2, "Population Data," of the EGC ESP Emergency Plan estimates the number of people within the 10-mile EPZ who would require evacuation. The applicant developed population estimates for the number of permanent residents within the 10-mile EPZ from 2000 U.S. Census Bureau data; Table 2.1-1, "Census 2000 Demographics within 10 Miles of the Clinton Power Station in 1-mi Bands by Radial Grid Sector," and Figure 2.3-2, "ESP EPZ Permanent Population by Radial Grid Sector," in the EGC ESP Emergency Plan provide these data. The applicant derived the seasonal resident population from the 2000 U.S. Census Bureau data category, "Vacant Housing for Seasonal, Recreational or Occasional Use." In Section 2.3.2.2, "Seasonal Population," of the EGC ESP Emergency Plan, the applicant stated that it multiplied the value in Table 2.3-1, "Census 2000 Demographics Data within 10 miles of the Clinton Power Station by Radial Grid Sector," by the previously accepted household occupancy rate of 3, resulting in a total seasonal population of the 10-mile EPZ of 105. Section 2.3.2.3, "Transient Population," of the EGC ESP Emergency Plan addresses the population estimates for transient facilities (e.g., hotels/motels, major employers, visitors to recreational areas). Tables 2.3-2, "2002 Transient Population," and 2.3-3, "Estimated EPZ Size Transient Population," referenced in Section 2.3.2.3 of the EGC ESP Emergency Plan, also provide transient population data. Table 3.11, "Clinton EPZ Population by Subareas: All Conditions," in the 1993 ETE provides similar tabulations of data based on the 1990 census. The 1993 ETE and the ESP application consider the Apple and Pork Festival, that is a special event when the total summer weekend transient population increases to 65,676 persons. The auto occupancy factor for transients depends on whether they are at campsites or are employees. Section 2.1, "Sources of Data and General Assumptions," of the 1993 ETE provides these data.

The applicant stated in Section 2.3.2.3 of the EGC ESP Emergency Plan that it developed the estimates from 2002 survey data and that the DeWitt County Emergency Services and Disaster Agency (ESDA) coordinator verified them. Section 2.3.2.3 also states that the transient population statistics include migrant farm workers because of the nature of the farming in the region. This section of the EGC ESP Emergency Plan also discusses the CPS site population.

To evaluate the significant impediments to the development of an emergency plan, the applicant used the sequence of constructing and operating dual AP1000 units on the site. Section 2.3.2.3.1, "Special Population," of the EGC ESP Emergency Plan addresses special populations. Table 2.3-4, "2002 Special Population in 10-mile EPZ," in Section 2.3.2.3.1 of the EGC ESP Emergency Plan presents the special population estimates for the four seasons and the weekday or weekend scenarios. The applicant developed the population estimates for special facilities (schools, hospitals, nursing homes, and correction facilities) from 2002 survey data, and the DeWitt County ESDA coordinator verified them. The 1993 ETE provides similar data tabulations in Table 3.11.

Section 2.3.3 of the EGC ESP Emergency Plan describes the analysis to test the current validity of the 1993 ETE conclusions. The applicant drew the following conclusions from its analysis:

- The infrastructure baseline used in the 1993 ETE has not changed and, therefore, does not impact the conclusions of estimated evacuation time.

- The permanent and seasonal population increase is considered negligible and has no negative impact on the 1993 ETE.

- The resulting special population increase of 26 individuals has no negative impact on the estimate for evacuation time.

- The total population estimate for the limiting summer weekday case has not changed significantly and, therefore, has no negative impact on the ETE.

- The population and its distribution have not changed significantly; therefore, the modeling of vehicle entry into the roadway network has not changed. With no changes to the roadway network and no significant changes to the total population, there is no impact on the 1993 ETE and the conclusions of that analysis remain valid.

Section 2.3.4, "Analysis—Special Event," of the EGC ESP Emergency Plan describes the analysis of the ETE for the annual Apple and Pork Festival. The applicant concluded that the evacuation times for fair and adverse weather contained in the 1993 ETE remain valid.

The ETE analysis in Section 2.3 of the EGC ESP Emergency Plan assesses the relative feasibility of an evacuation for the 10-mile plume exposure pathway EPZ. The applicant based the evacuation times on a detailed consideration of the plume exposure pathway EPZ roadway network and population distribution. The information in Table 2.3-5, "Evacuation Time Estimates," of the EGC ESP Emergency Plan details representative evacuation times for daytime and nighttime scenarios under fair and adverse weather conditions for the evacuation of various areas within the EPZ (once a decision has been made to evacuate). In Section 2.3.1 of the EGC ESP Emergency Plan, the applicant described adverse weather as sudden rainstorms that would reduce effective roadway capacity by 20 percent for summer conditions and snowstorms that would reduce roadway capacity by 30 percent for winter conditions. The evacuation times noted include notification, mobilization, and travel time for the general population, including the permanent population and special facilities (e.g., schools, nursing homes, hospitals, and recreational areas).

The 1993 ETE for the CPS plume exposure pathway EPZ served as the basis for the ETE analysis supporting the application. The applicant evaluated the assumptions listed in Section 2.3.1 of the EGC ESP Emergency Plan and found that they remain valid for the area surrounding the ESP site. The applicant further stated in Section 2.3.1 that the preparation and mobilization times developed for each population component (i.e., permanent residents, seasonal residents, transient, and special facilities) in the 1993 ETE analysis are reasonable.

Section 2.3.3 of the EGC ESP Emergency Plan compares the road and highway infrastructure that was the basis of the links and nodes input to the NETVAC program employed in the 1993 ETE to the current infrastructure. This analysis also compares a geographic information system (GIS) plot of roads and highways, based on data obtained from the 2000 census TIGER/Line Files, to the plume exposure pathway EPZ blue-line drawing and the written description of the 1993 ETE. The applicant took three approaches in this infrastructure comparison. In the first approach, the applicant evaluated EPZ zones defined by 22.5-degree sectors and 1-mile incremental radii overlaying the current GIS plot by comparing them to the similar zones on the blue-line drawing. This comparison revealed no differences in the infrastructure, although there were slight differences in the overlay locations resulting from differences in the accuracy of the GIS data versus the 1993 drawing. In the second approach, that occurred in May 2002, the applicant drove the principal roadways described in the 1993 ETE. The verification of roadways included the links and nodes shown in Figure 2.1-1 of the EGC ESP Emergency Plan. In the third approach, the applicant directly compared the link evacuation routes, 901–905 and 801–815, to nodes 1–75 indicated on the drawing and the GIS plot. The applicant noted no differences. Regarding the second approach (i.e., the May 2002 drive of the principal roadways), the staff requested, in RAI 13.3-20(f), that the applicant discuss any road changes identified, including new or changed access points, roadway conditions, and roadway constrictions that could reduce the capacity of sections of the route. In response to RAI 13.3-20(f), the applicant stated that a verification of roadways was indeed performed in May of 2002 as part of a validity test of the 1993 ETE conclusions and that it noted no differences.

In RAI 13.3-20(a), the staff asked the applicant to discuss its rationale for excluding shadow or voluntary evacuation in the 1993 ETE. In response to RAI 13.3-20(a), the applicant stated that the 1993 ETE study for CPS did not address shadow or voluntary evacuation because the population density in the area within 1 to 2 miles outside of the EPZ boundaries is very sparse. The largest communities located along primary evacuation routes and within a few miles outside of the EPZ are Maroa, located along State Route 51 south of the EPZ, and Heyworth, located along State Route 51 north of the EPZ. The 2000 census stated the population of Maroa City as only 1654 (651 households), and the population of Heyworth Village as only 2431 (897 households). The ETE simulations indicate that Route 51 has the capacity to accept traffic from these communities, in addition to the traffic evacuating from the EPZ. Voluntary evacuation of the entire resident population from Maroa City would contribute only about 325 vehicles per hour, while voluntary evacuation of the entire resident population from Heyworth would contribute about 450 vehicles per hour. Route 51 and the other roadways serving these communities could accommodate these traffic volumes, without interfering with traffic evacuating from the EPZ. The evacuation simulations do not indicate any expected congestion on Route 51, proceeding north or south from Clinton, for any of the evacuation scenarios. The conditions that control the predicted evacuation times reflect local congestion on roadways within the city of Clinton. The applicant's responses to RAI 13.3-20(u) and (v) provide more details concerning predicted traffic flow.

The 1993 ETE states that the road network was obtained by a field survey in 1984 and verified through discussions with the Illinois Power Company, as discussed in Section 2.1 of the 1993 ETE. Section 2.3, "Conditions Modeled," of the 1993 ETE states that the county agency officials agreed that no significant changes to the EPZ roadway network had occurred since 1984. This section also states that the roadways are unchanged and that no major construction projects are planned.

Section 2.1 of the 1993 ETE provides the assumptions used for vehicle occupancy rates. Permanent resident rates in the 1993 ETE are based on the 1990 census average household occupancy rates. Seasonal resident rates are based on the average seasonal resident household size as reported in the 1990 census data. Transient population rates in the 1993 ETE are based on the peak occupancy of recreational and hotel/motel facilities within the EPZ (as determined by a telephone survey). The vehicle occupancy rates are (1) major places for employment—1 vehicle per employee, except the rate for CPS, that is 1.5 people per vehicle,

(2) recreation areas—1 vehicle per campsite and 3 people per vehicle for all other areas, (3) students—60 persons per bus, and (4) hospitals/nursing homes/correctional facilities—40 people per bus.

Section 2.1 of the 1993 ETE also contains the assumptions for adverse weather conditions. The applicant analyzed sudden rainstorms that would reduce roadway capacity by 20 percent for summer conditions and snowstorms that would reduce capacity by 30 percent for winter conditions. The reductions in capacity and speed in Section 2.3 of the ETE analysis are consistent with the Highway Capacity Manual; however, the difference in the ETE for the winter weeknight adverse and the normal conditions (Table 6.2, "Evacuation Time Estimate Summary, Winter Weeknight") is almost negligible, with no difference in many instances and a 5-minute difference for evacuation of the entire EPZ. In RAI 13.3.20(h), the staff asked the applicant to discuss the reason for the almost negligible difference in the ETE for the evacuation of the entire plume exposure pathway EPZ for the winter weeknight adverse conditions and the normal conditions described in the 1993 ETE analysis. In response to RAI 13.3-20(h), the applicant stated that winter weeknight scenarios have the lowest vehicle demand and the shortest ETEs. The relatively short evacuation times for the winter weeknight scenarios (180 minutes for normal weather, 185 minutes for adverse weather) indicate that NETVAC predicts few delays from traffic congestion. Based on a review of the simulation results, the primary controlling factor that determines the ETEs for these two cases is intersection capacity at a few locations in the city of Clinton. The primary effect of adverse weather on NETVAC simulations is to reduce roadway capacity and travel speeds; intersection capacity is largely unaffected. Since the number of vehicles is identical for "normal" and "adverse" weather conditions, the time for traffic to clear the critical intersections is the same for both cases. The small difference in ETEs reflects the travel time from Clinton to the EPZ boundaries. The travel distance is roughly 4 miles; at 30 miles per hour (mph), this requires 8 minutes, while at 21 mph, it takes about 12 minutes.

The 1993 ETE provides the time distributions for the evacuation components for the transient and special populations. For school children, the 1993 ETE assumes that it could take up to 1 hour to assemble buses. School buses are loaded into the evacuation network within 30–90 minutes following the decision to evacuate. Some buses are assumed to be located at the school.

For hospitals, nursing homes, and correctional facilities, the 1993 ETE uses data from other, nonsite-specific studies to arrive at the assumption that these facilities would commence evacuation between 1 to 2 hours after the 15-minute notification. In RAI 13.3-20(b), the staff asked the applicant to provide site-specific data for those hospitals, nursing homes, and correctional facilities addressed in the 1993 ETE or to describe the other studies that it used to arrive at this assumption. In response to RAI 13.3-20(b), dated January 24, 2005, the applicant stated that the departure time distribution used in the 1993 ETE study for the special facilities (including hospitals, nursing homes, and correctional facilities) was formulated with departures following the decision to evacuate as indicated in the revisions to Attachment A, "Analysis of Special Facility Evacuation Times," and Table 1, "Evacuation Time Estimates for Special Facilities in EPZ for Clinton Station." The 1993 ETE study was based on information obtained from individual facilities and from county emergency management officials responsible for coordinating transportation resources for transport-dependent residents and special facilities. The applicant reviewed these assumptions with the Illinois Emergency Management Agency

(IEMA) and the responsible county agencies before performing the ETE analysis. For the evacuation simulations, the goal is to estimate evacuation times for the entire evacuating population, including special facilities. The evacuation model, NETVAC, does not distinguish among vehicles originating from different nodes or facilities, and the evacuation model design does not allow a different departure time distribution to be specified for each facility. Analysis for individual facilities is generally a manual effort, utilizing the evacuation model results to estimate travel times along specific routes. The applicant's response to RAI 13.3-20(c) described below provides additional information.

The 1993 ETE analysis for the total population, provided in Tables 6.1 through 6.4, "Evacuation Time Estimate Summary: Winter Weekday, Winter Weeknight, Summer Weekday, and Summer Weekend," for the season of year and weather scenarios, includes the ETE for special facilities/population. In RAI 13.3-20(c), the staff asked the applicant to provide a separate analysis of the ETE for special populations for normal and adverse conditions. In response to RAI 13.3-20(c), the applicant provided an analysis of ETEs for individual special facilities in Attachment A, "Analysis of Special Facility Evacuation Times," to its letter to the NRC dated January 24, 2005.

Sections 3.1.2, "Transport-Dependent Permanent Population" and 5.3, "Transportation Dependent Population," of the 1993 ETE analysis characterize the nonauto-owning population as contributing one vehicle per household, that neighbors or State/local authorities would provide. In RAI 13.3-20(d), the staff asked the applicant to provide the following information:

- the basis for the assumption that neighbors and State/local authorities would contribute one vehicle per household for the transport-dependent (nonauto-owning) population, as described in the 1993 ETE study
- site-specific data regarding the number of nonauto-owning households within the plume exposure pathway EPZ
- the methodology for determining the transport-dependent population
- an estimate of the number of auto-owning residents versus transport-dependent residents
- the initiation/mobilization time distribution for the transport-dependent population
- a separate estimate of the time required to evacuate the transport-dependent population

In response to RAI 13.3-20(d), the applicant stated in its letter to the NRC dated January 24, 2005, that Table B-1, "Estimates of Transport-Dependent Population in Clinton Station EPZ," and Attachment B, "Transport-Dependent Population," to the letter provide estimates of the number of transport-dependent households by subarea for the EPZ. These data indicate that the large majority of transport-dependent households (259 out of 302) are located in the city of Clinton (subarea 7). However, a footnote was added to revised Table B-1 in the letter dated October 27, 2005, that states that the total of subareas 1–8 is only 301 due to round-off of the subarea values to whole numbers. The 2000 census (SF-3) tabulates the number of vehicles per household; transport-dependent households were estimated on the reported number of occupied households with no vehicles. The DeWitt County ESDA indicates that the transport-dependent residential population within the city of Clinton will evacuate via buses provided by the city, in addition to assistance from auto-owning residents (generally neighbors or relatives). The buses will evacuate residents from a designated set of pickup locations in the city. The buses will evacuate residents from Clinton to the reception center in Decatur, Illinois. According to ESDA, the number of buses available should be able to evacuate transport-dependent residents in a single pass. If residents arrive at pickup points after the buses have departed, one or more buses will return to Clinton to evacuate any remaining residents. It is assumed that the small number of transport-dependent residents in other subareas will evacuate with assistance from neighbors or relatives. For the 1993 ETE study, one vehicle per household was assigned for the entire residential population, including transport-dependent households. The analysis in the 1993 study assumed the distribution of mobilization times for the transport-dependent population to be the same as for the general residential population. The ETEs for the general population in Clinton are, therefore, considered representative (or conservative) for transport-dependent residents.

Section 2.3 of the 1993 ETE provides the methodology for determining the number of vehicles and the auto occupancy rates for the different population groups based primarily on studies done elsewhere.

Section 4.0, "The Evacuation Roadway Network," and Appendix 3, "Roadway Network Listings and Capacities from NETVAC," to the 1993 ETE provide a description of the road network, a printout of the network characteristics, and the roadway network listing and capacities. In RAI 13.3-20(e), the staff asked the applicant to clarify whether the 1993 ETE analyzed the characteristics of each segment for the narrowest section or bottleneck of nonuniform roadways. In response to RAI 13.3-20(e), the applicant stated that when roadway conditions are not uniform over the length of a link, roadway dimensions (e.g., lane width, side width) represent the most restrictive conditions over the link. In general, multiple links are used when a significant change in roadway conditions is encountered (e.g., change in lane width, addition or deletion of lane, change in speed limit).

Section 5.4, "Evacuation Preparation Times and Departure Distributions," of the 1993 ETE analysis discusses the time distributions used for the different population types. The time distribution for the permanent resident population did not use site-specific data. Instead, the applicant used data from other studies to arrive at the notification and preparation time distribution. Figure 5.1, "Notification/Preparation/Mobilization Time Distributions," provides this distribution, that assumes that no one begins evacuation for the first 30 minutes (i.e., during the notification period). The permanent resident population time distribution for mobilization and preparation for evacuation spans a period of 2 hours.

Section 6.1, "Evacuation Time Estimate Summary," of the 1993 ETE analysis describes the locations where queuing is likely to occur under the various scenarios. Sections 7.2, "Evacuation Traffic and Access Control Locations," and 7.3, "Evacuation Traffic Management Locations and Other Potential Mitigating Measures," of the 1993 ETE analysis describe the locations identified in the NETVAC simulation that may require traffic management personnel during the evacuation. Section 7.2 includes traffic management at locations warranted by vehicle queuing and delays. The applicant used the NETVAC model results to identify these locations. In RAI 13.3-20(g), the staff asked the applicant to discuss how the NETVAC model accounts for traffic control or whether the ETE would be reduced if these traffic control measures were implemented. The staff also asked the applicant to clarify whether existing traffic control devices would prevail during an evacuation or if emergency personnel would staff traffic control points. In response to RAI 13.3-20(g), the applicant stated that the NETVAC evacuation model has two operating modes. The first of these modes assumes traffic flow at intersections consistent with existing traffic controls (signals operating on normal cycles, stop signs observed), while the second mode assumes that those controls would be overridden by emergency personnel, who would then direct traffic at designated control points to optimize the flow of evacuating vehicles. The decision on what mode to use for a given ETE study is based on discussions with emergency response agencies responsible for managing the evacuation. If the agencies indicate that plans call for emergency personnel to override existing traffic controls, then NETVAC is run in the "override" mode. If plans call for emergency personnel to manage traffic flow, while existing controls remain in operation, then NETVAC is run in "normal" mode. For the 1993 study, the NETVAC model was run assuming existing traffic controls would remain in place.

Table 4.1, "Primary Evacuation Routes by Township/Incorporated Area," of the 1993 ETE analysis provides a map of the roadwork in the EPZ. Section 6.1 of the 1993 ETE identifies and discusses road intersections with the potential for delays (queuing) during evacuation. The main access road from CPS to Route 54 is one of the roadways that could experience queuing under both fair and adverse weather conditions for all cases. This delay affects the ETEs for all evacuation scenarios because it originates within the 0–2-mile ring included in all evacuation scenarios.

The 1993 ETE considers a variety of factors necessary for ETEs. For example, Section 6.2, "Apple and Pork Festival," addresses the Apple and Pork Festival, that brings nearly 50,000 transients to the township of Clinton. In RAI 13.3-20(i), the staff asked the applicant for the following information:

- the basis for the assumption that 50,000 people, in 16,500 additional vehicles, will enter the evacuation route during the Apple and Pork Festival
- the dependency of the people attending the festival on public transportation to get to their vehicles (if park-and-ride shuttles are used during the event)
- whether any of these vehicles would return home to pack or pick up relatives before evacuating the plume exposure pathway EPZ
- the estimated time to mobilize from the festival to start of the evacuation
- trip generation times for this event

In response to RAI 13.3-20(i), the applicant stated that the correct numbers for the 1993 ETE study are 50,000 people in 16,667 vehicles (3 persons per vehicle). For the Apple and Pork Festival scenario, this population is separate from (in addition to) the residential population. Consequently, the applicant assumed that these vehicles would depart directly from the Apple and Pork Festival and exit the EPZ. (This obviously represents a substantial amount of double-counting.) Vehicles departing from the festival were assigned to eight departure nodes in the city of Clinton.

The assigned distribution of departure times for vehicles from the Apple and Pork Festival was 30 to 60 minutes, the standard time distribution used for recreation activities. As a practical matter, however, the NETVAC simulations indicate that it would take more than 3 hours for the local roadway network to absorb this many vehicles, regardless of the assigned distribution of departure times. (At the assigned entry nodes, "spillback" conditions persist for more than 3 hours.) According to local officials, the park-and-ride shuttles can move up to 20,000 people per hour to remote parking areas, or 50,000 people in 2.5 hours. Local officials were unable to provide a breakdown of festival attendance based on location of residence. Since the population residing inside the EPZ is only 13,268, the large majority of the 50,000 attending the festival must reside outside of the EPZ. If the scenario were revised to account for residents returning home from the festival, before evacuating the EPZ, this would lengthen the departure times for the residential population, but it would also reduce the number of vehicles evacuating directly from Clinton, thereby reducing the total number of evacuating vehicles. In RAI 13.3-20(j), the staff asked the applicant to discuss the basis for the population estimate of 22,000 people per day for the festival used in Section 2.3.4 of the EGC ESP Emergency Plan, since the 1993 ETE study adds 50,000 people to the transient population for the Apple and Pork Festival. In response to RAI 13.3-20(j), the applicant stated that the value of 22,000 people per day for the festival in Section 2.3.4 of the EGC ESP Emergency Plan is incorrect. According to the DeWitt County ESDA, evacuation planning is based on an estimated maximum attendance of 50,000 people. The applicant stated that Section 2.3.4 of the EGC ESP Emergency Plan will be revised to state, "The current estimate of peak population for the festival remains the same as in 1993: about 50,000 people. Therefore, the evacuation times of 380 minutes for fair weather and 530 minutes for adverse weather during the Apple and Pork Festival remain valid (see Table 2.3.5)."

Section 2.1, "Site Description," of the EGC ESP Emergency Plan states that the Weldon Springs State Recreation Area has camping, fishing, and picnicking facilities. Section 2.1 also states that Lake Clinton State Recreation Area has facilities to accommodate boating, camping, fishing, picnicking, and hiking. In RAI 13.3-3, the staff asked the applicant to provide additional information concerning the availability of adequate shelter facilities for the public in the Weldon Springs State Recreation Area and Lake Clinton State Recreation Area. In response to RAI 13.3-3, the applicant stated that the Weldon Springs State Recreation Area and the Lake Clinton State Recreation Area do not include any identified shelter facilities. In the case of an emergency, the applicant assumed that the public in these locations would leave the recreation area and proceed either to their own homes (if applicable) or to the designated shelter facilities, as identified in Section 10.1, "Notification of On-site Personnel," of the EGC ESP Emergency Plan. In addition, the applicant stated that the ETE analysis discussed in Section 2.3 of the EGC ESP Emergency Plan considers this relocation.

In Section 2.4, "Results—Significant Impediments to the Development of an Emergency Plan," of the EGC ESP Emergency Plan, the applicant stated that there are no geographic or political impediments to the development of an emergency plan. The applicant also stated that Table 2.3-5, "Evacuation Time Estimates," contains those ETEs from the 1993 ETE analysis that remain valid for the current ESP application.

13.3.1.2 Regulatory Evaluation

In Section 1.1, "Overview," of the EGC ESP Emergency Plan, the applicant stated that it developed the EGC ESP Emergency Plan to comply with the requirements of 10 CFR 52.17, "Contents of Application," using the guidance in Supplement 2. In Section 1.2, "Planning Standards and Evaluation Criteria," of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. Therefore, the staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(1), that mandate that the applicant for an ESP identify physical characteristics unique to the proposed site, such as egress limitations from the area surrounding the site, that could pose a significant impediment to the development of emergency plans. The staff further considered 10 CFR 52.18, "Standards for Review of Applications," that requires consultation with FEMA to determine whether the information required of the applicant by 10 CFR 52.17(b)(1) demonstrates that no significant impediment to the development of emergency plans exists. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency response planning information given in an ESP application.

Supplement 2 defines a significant impediment as a physical characteristic or combination of physical characteristics that would pose major difficulties for an evacuation or the taking of other protective actions. Such unique physical characteristics may be identified by performing a preliminary analysis of the time needed to evacuate various sectors and distances within the 10-mile EPZ for transient and permanent populations, noting major difficulties for an evacuation (e.g., significant traffic-related delays) or the taking of other protective actions.

According to RS-002, the applicant should address factors, such as the availability of adequate shelter facilities, local building practices, and land use (e.g., outdoor recreation facilities, including camps, beaches, hunting or fishing areas), and the presence of large institutional or other special needs populations (e.g., schools, hospitals, nursing homes, prisons), when identifying significant impediments to the development of emergency plans. Any ETE or other identification of physical impediments should include the latest population census numbers and the most recent local conditions. In addition, the applicant should describe the proposed means for resolving any impediments identified.

13.3.1.3 Technical Evaluation

The staff finds the applicant's clarification regarding the use of the information in the Phase One Report in the response to RAI 13.3-15 to be acceptable. The staff finds that the applicant's response to RAI 13.3-17 regarding extrapolated population data is consistent with the guidance in Supplement 2 and is, therefore, acceptable. The staff finds the applicant's clarification regarding the availability of adequate shelter facilities for the public in the Weldon Springs and Lake Clinton State Recreation Areas in response to RAI 13.3-3 to be acceptable.

In RAIs 13.3-20(a) through (j), the staff requested information regarding the ETE for CPS as part of its review of physical characteristics unique to the site that could pose significant impediments to the development of emergency plans. The staff identified the need for this information as Open Item 13.3-1. In its submission to the NRC dated January 24, 2005, the applicant responded to RAIs 13.3-20(a) through (j). The information related to the 1993 ETE for Clinton provided by the applicant in response to RAIs 13.3-20(a) through (j) is consistent with the guidance in Supplement 2 and is, therefore, acceptable. The staff considers Open Item 13.3-1 to be resolved.

The staff notes that the ESP application site is adjacent to CPS. Integrated onsite and offsite radiological emergency plans currently exist for CPS, that is an operating nuclear power plant. Because CPS is an operating nuclear power plant, with integrated onsite and offsite emergency plans, no significant impediments exist to the development of an emergency plan for the site.

In addition, the applicant adequately identified physical characteristics unique to the proposed site by performing a preliminary analysis of the time required to evacuate various sectors and distances within the plume exposure pathway EPZ for transient and permanent populations and did not note any major impediments for an evacuation or other protective actions.

The ETE analysis includes a map showing the proposed site and plume exposure pathway EPZ, as well as transportation networks, topographical features, and political boundaries. The boundaries of the EPZ, in addition to the evacuation subareas within the EPZ, are based on factors such as current and projected demography, topography, land characteristics, access routes, and jurisdictional boundaries. The applicant's 1993 ETE does not require updating, since the guidance in NUREG/CR-4831, "State of the Art in Evacuation Time Estimate Studies for Nuclear Power Plants," states that, as a general rule, a 10-percent increase in the population indicates a need to check evacuation times.

The ETE analysis in the application includes an estimate of the number of people to be evacuated, using the latest population census numbers and the most recent local conditions. The population estimate also considers permanent residents, transients, and persons in special facilities, including those confined to institutions such as hospitals, nursing homes, and prisons. The applicant also evaluated the school population in the special facility segment of the analysis.

The ETE analysis in the application included a complete review and description of the road network in the proposed site area. The applicant included the assumptions for determining the number of vehicles that should be provided, as well as the methodology for determining the transport-dependent population. The applicant also analyzed travel times and potential locations for serious congestion along the evacuation routes. The ETE analysis considered normal and adverse weather conditions, such as flooding, snow, ice, fog, or rain, as well.

The ETE analysis focused on site factors that are considered to be impediments to emergency planning and preparedness. The analysis did not identify any of the ETEs as being unduly high. In addition, the analysis did not identify any major difficulties for an evacuation or the taking of other protective actions, such as sheltering in the plume EPZ.

The staff finds that the applicant adequately addressed other factors, such as the availability of sufficient shelter facilities, taking into consideration local building practices and land use (e.g., outdoor recreation facilities, including camps, beaches, and hunting or fishing areas).

The applicant did not identify any other physical characteristics that could pose a significant impediment to the development of an emergency plan, such as new home or shopping center construction, an industrial park, a major increase in the number of new employers, or new roads or highways.

13.3.1.4 Conclusions

As discussed above, the applicant has demonstrated through the use of the 1993 ETE that no physical characteristic unique to the proposed ESP site could pose a significant impediment to the development of emergency plans. Based on its review, as set forth above, the staff concludes that the information the applicant provided is consistent with the guidance in RS-002 and Supplement 2. Therefore, the information is acceptable and meets the requirements of 10 CFR 52.17(b)(1) and 10 CFR 52.18.

13.3.2 Contacts and Arrangements with Federal, State, and Local Agencies

13.3.2.1 Technical Information in the Application

Section 3.1.1.2, "State Agencies," of the EGC ESP Emergency Plan states that the Director of IEMA has acknowledged support of the EGC ESP Emergency Plan. A letter dated December 9, 2002, from Mr. Jeffrey A. Benjamin, Vice President, Licensing & Regulatory Affairs (EGC), to Mr. Michael Chamness, Director, IEMA, requests IEMA support of the EGC ESP application. The letter states that Mr. Chamness's signature attests to his awareness of the intent of EGC to take credit for the existing IPRA Volumes I and VIII in the ESP application and that no significant impediments exist to implementing the emergency plan for the ESP plant.

Appendix A, "Contacts and Arrangements" to the EGC ESP Emergency Plan contains a letter dated December 9, 2002, from Mr. Jeffrey A. Benjamin, Vice President, Licensing & Regulatory Affairs (EGC), to Mr. Thomas W. Ortciger, Director, Illinois Department of Nuclear Safety (IDNS), requesting IDNS support of the EGC ESP application. The letter states that Mr. Ortciger's signature attests to his awareness of the intent of EGC to take credit for the existing IPRA Volumes I and VIII in the ESP application and that no significant impediments exist to implementing the emergency plan for the ESP plant.

Section 3.2.5, "Agreements in Planning Effort," of the EGC ESP Emergency Plan states that IDNS and IEMA are aware of and have concurred with the applicant's intent to take credit for IPRA Volumes I and VIII in the ESP application.

In RAI 13.3-4, the staff requested documentation of the applicant's contacts and arrangements with local governmental agencies having emergency planning responsibilities within the plume exposure EPZ. This documentation should specifically address the expanded responsibilities associated with an additional reactor (or reactors) at the Clinton site. In its response to RAI 13.3-4, the applicant stated that the IEMA agreement letter, which was included in

Appendix A to the EGC ESP Emergency Plan, provides documentation of the necessary contacts and arrangements with local governmental agencies having emergency planning responsibilities within the plume exposure EPZ. The applicant also stated that the State of Illinois established IEMA to coordinate and assist the counties and municipalities in the event of radiological accidents. The applicant referenced and provided the staff with a copy of the State of Illinois Statute 20 ILCS 3305/2, "Illinois Emergency Management Act."

Section 3.2.5 of the EGC ESP Emergency Plan also states that agreement letters with those Federal agencies that are legally required to respond are not necessary.

13.3.2.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17 using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(3), which mandate, in part, that an ESP application describe the contacts and arrangements made with Federal, State, and local governmental agencies with emergency planning responsibilities. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application.

Supplement 2 states that the description of contacts and arrangements should include the name and location of the organization contacted, the title and/or position of the person(s) contacted, and the role of the organization in emergency planning. The evaluation criteria in Supplement 2, Section V, provide additional guidance, that applies to the submission of emergency plans under the major features option of 10 CFR 52.17(b)(2)(i).

According to RS-002, for an operating reactor site, the ESP application should clearly indicate the impact of applying an existing emergency preparedness program element to the expanded use of the site, including any necessary changes to the program in support of a new reactor(s). For example, letters of agreement, reflecting contacts and arrangements made with local and State governmental agencies with emergency planning responsibilities might need revision to reflect the anticipated presence of an additional reactor(s) at the site. Such revised letters of agreement should reflect any impact an additional reactor(s) would have on the agencies' emergency response planning responsibilities and should include acknowledgment by the agencies of the proposed expanded responsibilities. The use of separate correspondence would also be acceptable. If the applicant cannot make arrangements with Federal, State, and local governmental agencies with emergency response planning responsibilities, for whatever reason, the applicant should discuss its efforts to make such arrangements, along with a description of any compensatory measures it has taken or plans to take because of the lack of such arrangements.

13.3.2.3 Technical Evaluation

The applicant's initial description of contacts and arrangements made with Federal, State, and local governmental agencies did not clearly address the presence of an additional reactor(s) at the site and any resulting impact on the agencies' emergency planning responsibilities, including the agencies' acknowledgment of the proposed expanded responsibilities. Further, the additional information provided by the applicant in its response to RAI 13.3-4 did not adequately address the request. Therefore, the staff identified in Open Item 13.3-2 that the applicant's documentation of contacts and arrangements with local governmental agencies having emergency planning responsibilities within the plume exposure EPZ (potentially DeWitt, Macon, McLean, and Piatt Counties; the municipalities of Clinton, Wapella, and Weldon; and the Village of DeWitt) did not address the expanded responsibilities associated with an additional reactor(s) at the Clinton site. In its submission to the NRC dated April 4, 2005, the applicant responded to Open Item 13.3-2. The applicant stated that, as indicated in the original response to RAI 13.3-4 (submitted October 5, 2004), documentation of contacts and arrangements with local governmental agencies with emergency planning responsibilities within the plume exposure EPZ is provided through IEMA and the State of Illinois Statute 20 ILCS 3305. Specifically, Section 3305/2 of the statute establishes the IEMA and authorizes "emergency management programs with the political subdivision of the State." Section 3305/4 of the statute defines political subdivisions as "any county, city, village, or incorporated town or township...." Section 3305/5(f) indicates that the IEMA shall (among other things) take the following actions:

(1) Coordinate the overall emergency management program of the State.

(4) Promulgate rules and requirements for political subdivision emergency operations plans that are not inconsistent with and are at least as stringent as applicable federal laws and regulations.

(5) Review and approve, in accordance with Illinois Emergency Management Agency rules, emergency operations plans for those political subdivisions required to have an emergency services and disaster agency pursuant to this Act.

(5.5) Promulgate rules and requirements for the political subdivision emergency management exercises, including, but not limited to, exercises of the emergency operations plans.

(5.10) Review, evaluate, and approve, in accordance with Illinois Emergency Management Agency rules, political subdivision emergency management exercises for those political subdivisions required to have an emergency services and disaster agency pursuant to this Act.

(6) Determine requirements of the State and its political subdivisions for food, clothing, and other necessities in event of a disaster.

These sections show that IEMA coordinates and provides all necessary contacts and arrangements with the political subdivisions of the State, including the local governmental agencies with emergency planning responsibilities within the plume exposure EPZ.

Based on the applicant's above description of contacts and arrangements with Federal, State, and local governmental agencies with emergency planning responsibilities, that included the name and location of the organization contacted, the title of the persons contacted, and the role of the organization in emergency planning, the staff considers Open Item 13.3-2 to be resolved.

13.3.2.4 Conclusions

As discussed above, the applicant provided an acceptable description of contacts and arrangements made with Federal, State, and local governmental agencies with emergency planning responsibilities. Based on its review as set forth above, the staff concludes that the information the applicant provided is consistent with the guidance of RS-002 and Supplement 2. Therefore, the information is acceptable and meets the requirements of 10 CFR 52.17(b)(3).

13.3.3 Major Features of the Emergency Plans

13.3.3.1 Emergency Planning Zones

13.3.3.1.1 Technical Information in the Application

Section 2.2.1 of the EGC ESP Emergency Plan states that the EPZ boundary of the EGC ESP site is identical to the CPS EPZ boundary, that was defined in 1985 following a detailed review of the demography, topography, characteristics of the land, access routes, and jurisdictional boundaries in the area surrounding the power facility. The review determined that the primary basis for the EPZ boundary definition should be political jurisdictions, strong topographical features (e.g., rivers and mountains), or manmade features (e.g., highways and railroads). The area of the plume exposure EPZ is about 10 miles in radius. Figure 2.2-1 of the EGC ESP Emergency Plan shows the radial boundary of the EGC ESP site plume exposure pathway EPZ.

Section 2.2.2, "Ingestion Pathway Emergency Planning Zone," of the EGC ESP Emergency Plan states that Map E, "Dairies and Food Processing Plants, Water Basins and Public Water Supply Intakes, and Illinois Department of Public Health Medical Facility Map," of IPRA Volume VIII identifies major roads, population centers, and public drinking water system intakes from surface water sources within Illinois that are located within a 50-mile radius of the EGC ESP site. The map also identifies the county boundaries.

13.3.3.1.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i) and 10 CFR 52.18. In addition, the staff considered the regulatory requirements in 10 CFR 50.33(g), 10 CFR 50.47(c)(2), and Sections I, III, and IV of Appendix E to 10 CFR Part 50 in its review of the size and configuration of the EPZs. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of a complete and integrated emergency plan. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of the emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for the major features of emergency plans, including those that apply to determining the size and configuration of the EPZs.

Section III.A of Supplement 2 states that an ESP applicant choosing the option of proposing the major features of an emergency plan should give special emphasis to the exact size of the EPZs. Generally, the 10-mile and 50-mile EPZs consist of an area about 10 miles and 50 miles in radius, respectively. Applicants should determine the exact size and configuration of the EPZs with respect to local emergency response needs and capabilities, since the EPZs can be affected by conditions, such as demography, topography, land characteristics, access routes, and jurisdictional boundaries.

13.3.3.1.3 Technical Evaluation

The applicant described the exact sizes of the EPZs. The applicant also described the exact size and configuration of the EPZs in relation to local emergency response needs and capabilities, as they are affected by such conditions as demography, topography, land characteristics, access routes, and jurisdictional boundaries.

13.3.3.1.4 Conclusions

As discussed above, the applicant proposed a plume exposure pathway EPZ of approximately a 10-mile radius and an ingestion pathway EPZ of approximately a 50-mile radius, both that reflect local emergency response needs and capabilities. Based on its review, the staff concludes that the proposed major feature, that addresses the size and configuration of the EPZs, is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 50.33(g), 10 CFR 50.47(c)(2), 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections I, III, and IV of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning the applicant considered for the EPZs, as set forth above. EGC provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.2 Assignment of Responsibility (Organization Control) (Major Feature A)

13.3.3.2.1 Technical Information in the Application

Section 3.1, "Concept of Operation," of the EGC ESP Emergency Plan identifies the Federal, State, local, and private sector organizations that are intended to be part of the overall response organization for EPZs as the NRC, the U.S. Department of Energy (DOE), the Federal Bureau of Investigation (FBI), the U.S. National Weather Service (NWS), the EGC ESP facility organization, the corporate organization, and the public information organization. Section 3.4, "Emergency Response Support and Resources," of the EGC ESP Emergency Plan identifies the support services organizations to the EGC ESP facility as the Institute of Nuclear Power Operations; American Nuclear Insurers; Environmental, Inc.; Teledyne Brown Engineering; DOE Radiation Emergency Assistance Center/Training Site (REAC/TS); Murray and Trettel, Inc.; ICN Worldwide Dosimetry Service; Framatome Technologies, the future nuclear steam supply system vendor; John Warner Hospital and Ambulance Service; Decatur Memorial Hospital; DeWitt County Sheriff's Department; Clinton Fire Department; IDNS; and IEMA.

Volume I of the IPRA lists the State and local governmental agencies with responsibility for emergency response in Sections F, "Overview, Operational Centers;" 1I, "Overview, Utility Emergency Plans;" 1J, "Overview, Contiguous States;" 2A, "Direction and Control, Office of the Governor;" 2B, "Direction and Control, Chain of Command;" 3A, "Agency Responsibilities, State Agencies;" 3B, "Agency Responsibilities, Federal Agencies;" and 3C, "Agency Responsibilities, Private Organizations."

Volume VIII of the IPRA lists the State and local governmental agencies with responsibility for emergency response in Sections 1C, "General Information, Concept of Operations;" 1D, "General Information, Participating State Agencies;" 2A, "DeWitt County, Functional Summary Descriptions;" 2B, "DeWitt County, Initial Contact and Operational Response Levels;" 2E, "DeWitt County, Emergency Facilities;" and 2F, "DeWitt County, Concept of Operations;" as well as Annexes 2A, "DeWitt County Checklist Procedures;" 2B, "Clinton Checklist Procedures;" 2C, "Weldon Checklist Procedures;" 2D, "Wapella Checklist Procedures;" 2E, "DeWitt Village Checklist Procedures;" and 2F, "Support County Checklist Procedures."

Volume I of the IPRA describes State and local functions and responsibilities for major elements of emergency response in Sections 1E, "Overview, Basic Functions," 2A, 2B, 3A, 3B, and 3C. Section 2A describes the responsibilities for the Office of the Governor, and Section 3A describes the responsibilities of the 11 State agencies in the event of a radiological emergency at CPS. The State of Illinois has overall command responsibility for radiological and nonradiological aspects of a nuclear incident. Section 1E describes the basic emergency response functions and Section 3A provides the specific duties of each State agency for implementing these basic responsibilities. Section 2B describes the Illinois chain of command. Section 3B notes the responsibilities of Federal agencies, while Section 3C details the American Red Cross responsibilities.

In IPRA Volume VIII, Sections 2A and 2F and Annex 2A identify the major functions to be performed by DeWitt County. In the area of protective actions, DeWitt County would undertake traffic and access control; evacuation support; food, water, and milk control; exposure control; law enforcement; emergency medical services; fire and rescue; and social services. Annex 2F provides the support county functions and responsibilities, and Annexes 2B, 2C, 2D, and 2E provide the functions and responsibilities for the three municipalities and one village in DeWitt County. Tables F.2.c.1 through F.2.c.5 of IPRA Volume VIII relating to DeWitt County, the municipalities of Clinton, Weldon, Wapella, and DeWitt Village, respectively, display agency responsibilities by organization in matrix format.

Section 1A, "Purpose and Authorization," of IPRA Volume I, provides the following legal citations to support the activities of IDNS and IEMA in developing and maintaining the IPRA:

- Illinois Emergency Management Agency Act (20 ILCS 3305)
- Directive from Governor James R. Thompson, dated May 17, 1979
- Illinois Nuclear Safety Preparedness Act (420 ILCS 5)
- Department of Nuclear Safety—Powers Enabling Statute (20 ILCS 2005/2005-1)
- Radiation Protection Act of 1990 (420 ILCS 40)
- Illinois Nuclear Facility Safety Act (420 ILCS 10)

IDNS and IEMA are the primary State agencies with responsibilities for responding to a radiological emergency. The IPRA protects the citizens of Illinois in the event of a radiological accident. Other State agencies also have major responsibilities in an emergency, as described in Section 3A of IPRA Volume I.

Section 2F of IPRA Volume VIII states that the principal executive officers of DeWitt County and the risk municipalities are authorized to initiate actions and command emergency personnel in any effort to protect the residents of their jurisdictions by their respective bylaws and charters and by the Illinois Emergency Management Agency Act. In RAI 13.3-13(a), the staff asked the applicant to describe the legal basis (i.e., reference specific acts, codes, or statutes) for county or municipal authorities to comprise part of the overall response organization for the EPZs. In response to RAI 13.3-13(a), the applicant stated that Section 1A of IPRA Volume I describes this legal basis. This authorization document includes the political subdivisions of the State (e.g., the county and municipal authorities). Specifically, one purpose of 20 ILCS 3305/2 is to "confer upon the Governor and upon the principal executive officer of the political subdivisions of the State the powers provided herein."

Section 3.1.1.1.1, "United States Nuclear Regulatory Commission," of the EGC ESP Emergency Plan describes the role of the NRC in the event of an incident. Section 3.1.1.1.4, "United States Department of Energy," of the EGC ESP Emergency Plan describes the role of DOE in the event of an incident. Section 3.1.1.1.6, "Federal Bureau of Investigation," of the EGC ESP Emergency Plan describes the role of the FBI in the event of an incident. Section 3.1.1.1.7, "United States National Weather Service," describes the role of the NWS in the event of an incident. Section 3.1.2, "Applicant Response Organization," describes the applicant's emergency response organization (ERO) that would replace the normal plant organization during an emergency. The ERO will consist of the EGC ESP facility, corporate, and public information response suborganizations. Section 3.4 of the EGC ESP Emergency Plan describes the contractors that will be retained to provide supporting services to the EGC ESP facility. The applicant will use a contract/purchase order with a private contractor in lieu of an agreement letter for the specified duration of the contract. Appendix A to the EGC ESP Emergency Plan describes support services under agreements or contracts. For the support services listed in Section 3.4 of the EGC ESP Emergency Plan, the specific contractors may change but the functions will be maintained. The applicant will only ensure that the agreements and contacts with the necessary third parties will be in place when the attributes of this plan need to be in effect.

Section 3.1.1.3, "County Government Agencies," of the EGC ESP Emergency Plan states that the surrounding communities that comprise the plume exposure pathway EPZ have developed integrated emergency response programs that call upon the resources of the community. Section 3.1.1.3 also states that the community organizations will implement and coordinate the community response to an emergency. In addition, Section 3.1.1.3 identifies the surrounding communities as DeWitt, Macon, McLean, and Piatt Counties; the municipalities of Clinton, Wapella, and Weldon; and the Village of DeWitt. In RAI 13.3-18, the staff requested a copy of a letter of agreement with the DeWitt County Sheriff's Department that is dated 2003 or later. The applicant provided a copy of such a letter in its response to RAI 13.3-18.

Section 3.2.5 of the EGC ESP Emergency Plan states that written agreements establishing the concept of operations developed between the applicant and its support organizations having an emergency response role within the CPS EPZ have been developed. These arrangements identify the emergency measures to be provided, the mutually accepted criteria for implementation, and the agreements for the exchange of information. Appendix A to the EGC ESP Emergency Plan provides letters of agreement, contracts, and purchase orders between the applicant and the various support organizations having a response role.

Chapter 2, "DeWitt County," in IPRA Volume VIII contains letters signed by the county board chairmen of DeWitt, Macon, McLean, and Piatt Counties, as well as the mayors of Clinton, Weldon, Wapella, and DeWitt, acknowledging these duties, responsibilities, and relationships.

13.3.3.2.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.A of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP can propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for the major features of emergency plans, including those that apply to major feature A, "Assignment of Responsibility—Organization Control."

Major feature A calls for the applicant to identify EROs, including functions and responsibilities for major elements of response, and the legal bases for State and local authorities. The ESP application should also describe contacts and arrangements between agencies and other support organizations having a response role within the EPZs, and it should include any written letters of agreement.

13.3.3.2.3 Technical Evaluation

As described above, the EGC ESP Emergency Plan, IPRA Volumes I and VIII, and the applicant's response to RAI 13.3-13(a) identify the Federal, State, local, and private sector organizations (including utilities) that are intended to be part of the overall response organization for the EPZs.

Volumes I and VIII of the IPRA identify the functions and responsibilities for major elements of emergency response, such as command and control, alerting and notification, communications, public information, accident assessment, public health and sanitation, social services, fire and rescue, traffic control, emergency medical services, law enforcement, transportation, protective response, and radiological exposure control. In addition, IPRA Volumes I and VIII (by reference to specific acts, codes, or statutes) identify the legal basis for the State, local, and private sector organizations that are part of the overall response organization for the EPZs to carry out their identified functions and responsibilities.

The EGC ESP Emergency Plan, IPRA Volumes I and VIII, and the EGC response to RAI 13.3-18 adequately describe contacts and arrangements pertaining to the concept of operations developed among Federal, State, and local agencies and other support organizations having an emergency response role within the EPZs. The plan includes letters of agreement. Sections 13.3.2," Contacts and Arrangements with Federal, State, and Local Agencies;" 13.3.3.4, "Emergency Response Support and Resources;" 13.3.3.7, "Emergency Communications;" 13.3.3.10, "Accident Assessment;" and 13.3.3.13, "Medical and Public Health Support;" of this SER also describe these contacts and arrangements.

13.3.3.2.4 Conclusions

As discussed above, the applicant identified the EROs, including the functions and responsibilities for major elements of response, and the legal bases for State and local authorities. In addition, the applicant described contacts and arrangements among the agencies and other support organizations having a response role within the EPZ. Based on its review, the staff concludes that the proposed major feature A is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.A of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for organization control, as set forth above. EGC provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.3 Onsite Emergency Organizations (Major Feature B)

13.3.3.3.1 Technical Information in the Application

In Section 3.1.2.4, "Interrelationships," of the EGC ESP Emergency Plan, the applicant stated that Figures 3.1-1, "Applicant Emergency Response Organization Interrelationships," and 3.1-2, "Agency Response Organization Interrelationships," illustrate the major applicant organizations and suborganizations, as well as government interrelationships, in the total response effort. In RAI 13.3-5, the staff asked the applicant to provide additional information related to ERO interfaces between and among the on-shift emergency response functional areas, local support services, and State and local governmental response organizations. In its response to RAI 13.3-5, the applicant noted that Figure 3.1-2 in the EGC ESP Emergency Plan provides the interfaces between and among the on-shift emergency response functional areas and local support services. However, Figures 3.1-1 and 3.1-2 do not show specific details for all of the possible interrelationships because they vary with time (e.g., before and after activation of the emergency operations facility (EOF) and the various State and local emergency operations centers (EOCs)) and with the declared level of event (e.g., an unusual event versus a general emergency). For example, for the declaration of an unusual event, the interrelationship occurs directly between the control room and the required State or local service. However, in the latter stages of a general emergency, interrelationships would occur through the established communications paths and generally include the emergency director in the EOF placing a specific request through the State EOC (SEOC).

In general, for significant events, the emergency response functional areas (see "Applicant" in Figure 3.1-2 in the EGC ESP Emergency Plan) interface with the local support services through the EOF and the State and local governmental response agencies (within their respective EOCs), as shown on Figure 3.1-2 and as discussed in Sections 3.1.2.2, "Corporate Organization," and 3.1.2.5, "Corporate Emergency Director," of the EGC ESP Emergency Plan. Section 3.3.5, "Emergency Response Organization Positional Responsibilities," identifies specific exceptions to this general diagram under the responsibilities for the individual ERO positions. For example, Sections 3.3.5.1.1, "Shift Manager (Shift Emergency Director), Control Room;" 3.3.5.1.2, "Station Emergency Director, Technical Support Center;" and 3.3.5.2.2, "Corporate Emergency Director, Emergency Operations Director;" indicate the command and control functions, that direct these interfaces to cycle through the shift emergency director (in the control room), the station emergency director (in the technical support center (TSC)), and the corporate emergency director (in the EOF) as the activation of the organization progresses. The current Figure 3.1-2 best reflects the majority of these permutations by showing the on-shift emergency organization generally as "Applicant" and the State and local agencies and services as "State Agencies" and "County Agencies." Volume VIII of IPRA also addresses this interface. For example, the figure titled, "DeWitt County Initial Notification," in Chapter 2 of IPRA Volume VIII shows the DeWitt County interfaces.

Section 3.2.3, "Non-applicant Nuclear Support Services," and Appendix A to the EGC ESP Emergency Plan, that includes a signature page documenting the annual review of the agreement between CPS and the DeWitt County Sheriff's Department, address an agreement to provide traffic control and law enforcement services.

Sections 3.2.3 and 12.4, "Medical Transportation," as well as Appendix A to the EGC ESP Emergency Plan, describe arrangements that will be made, as necessary, with Clinton Ambulance (John Warner Hospital) for prompt ambulance transport of persons with injuries involving radioactivity to designated hospitals.

Sections 3.2.3 and 12.1, "Off-site Hospital and Medical Services," of the EGC ESP Emergency Plan address arrangements, confirmed by letter of agreement or contract every 2 years, that will be maintained with a qualified hospital located in the vicinity of the EGC ESP facility for receiving and treating contaminated or exposed persons with injuries requiring immediate hospital care. The applicant identified John Warner Hospital in Clinton, Illinois, as the primary supporting medical facility for injured persons who are contaminated with radioactivity. Appendix A to the EGC ESP Emergency Plan includes a letter of agreement with the hospital.

Section 3.2.3 and Appendix A to the EGC ESP Emergency Plan identify arrangements with Decatur Memorial Hospital to act as a supporting medical facility and provide medical services. Appendix A to the ESP application includes a letter of agreement with the hospital.

Section 3.2.3 and Appendix A to the EGC ESP Emergency Plan identify arrangements with the Clinton Fire Department to provide fire protection services and confined space rescue operations. Appendix A includes a copy of a letter of agreement with the Clinton Fire Department to provide fire response support.

13.3.3.3.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.A of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP can propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those that apply to major feature B, "Onsite Emergency Organizations."

Major feature B calls for the applicant to identify interfaces between and among the onsite functional areas of emergency activity, local services support, and State and local government response organizations, including the services to be provided by local agencies.

13.3.3.3.3 Technical Evaluation

As discussed above, the applicant identified, in the EGC ESP Emergency Plan and in its response to RAI 13.3-5, the interfaces between and among the onsite functional areas of emergency activity, local services support, and State and local government response organizations.

The applicant also identified in the EGC ESP Emergency Plan the services to be provided by local agencies for handling emergencies (e.g., police, ambulance, medical, hospital, and firefighting organizations). The EGC ESP Emergency Plan adequately describes the arrangements involving these services. The applicant also included written letters of agreement.

13.3.3.3.4 Conclusions

As discussed above, the applicant identified the interfaces between and among the onsite functional areas of emergency activity, local services support, and State and local government response organizations for the ESP site. In addition, the applicant identified the services and described the arrangements to be provided by various local agencies, and it submitted adequate letters of agreement. Based on its review, the staff concludes that the proposed major feature B is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.A of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for the onsite ERO, as set forth above. The applicant provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.4 Emergency Response Support and Resources (Major Feature C)

13.3.3.4.1 Technical Information in the Application

Section 3.4.5, "United States Department of Energy Radiation Emergency Assistance Center/Training Site," of the EGC ESP Emergency Plan states that the DOE REAC/TS will provide services of medical and health physics support. The applicant has made provisions for requesting assistance from the DOE REAC/TS through a letter of agreement, as noted in Appendix A to the EGC ESP Emergency Plan.

Section 3.1.1.1.7, "United States National Weather Service," of the EGC ESP Emergency Plan states that the NWS provides meteorological information during emergency situations. Therefore, no special provisions for requesting assistance are needed.

Section 3.1.1.1.4, "United States Department of Energy," describes the applicant's procedure for seeking assistance from DOE, as outlined in the Federal Radiological Monitoring and Assessment Plan.

Sections 3A(8), "Illinois Department of Nuclear Safety," and 3B in IPRA Volume I provide the State's procedures for requesting Federal assistance. The IDNS is authorized to request

Federal assistance depending on the severity of a radiological incident, as outlined in the Federal Radiological Emergency Response Plan (FRERP) and in the Radiological Assistance Program.

Section 3.4.3, "Environmental, Inc.," of the EGC ESP Emergency Plan states that the applicant will rely on Environmental, Inc., to provide radiological environmental monitoring services in an emergency situation. In addition, Section 3.4.5, "United States Department of Energy Radiation Emergency Assistance Center/Training Site," of the EGC ESP Emergency Plan states that the DOE REAC/TS will provide medical and health physics support services. The REAC/TS will also provide advice on the health physics aspects of situations requiring medical assistance. Section 3.4.7, "ICN Worldwide Dosimetry Service," of the EGC ESP Emergency Plan states that ICN Worldwide Dosimetry Service will provide extremity dosimetry services. In an emergency, ICN Worldwide Dosimetry Service will also provide additional dosimetry to the affected nuclear facility and EOF. Section 3.4.8, "Framatome Technologies (Post-accident Sample Analysis Program)," of the EGC ESP Emergency Plan states that Framatome Technologies (Post-accident Sample Analysis Program) will maintain its hot-cell in a state of readiness so that a sample analysis can be completed within 24 hours of sample receipt.

Section 3A(8) in IPRA Volume I provides the State's procedures for requesting Federal assistance. IDNS is authorized to request Federal assistance depending on the severity of a radiological incident, as outlined in the FRERP and in the Radiological Assistance Program. In RAI 13.3-13(b), the staff requested a description of the general capabilities of radiological laboratories (besides the two IDNS mobile laboratories) to provide radiological monitoring and analyses services. In response to RAI 13.3-13(b), the applicant stated that Section E1 in IPRA Volume 1 describes the general capabilities of radiological laboratories (besides the two IDNS mobile laboratories). These labs include the IDNS laboratory in Springfield and the laboratories to be provided by the Federal government under the FRERP.

Section 3.4 of the EGC ESP Emergency Plan states that the applicant will retain contractors to provide supporting services to the EGC ESP facility. Section 3.4 also describes the support services available under the agreements or contracts listed in Appendix A to the EGC ESP Emergency Plan. The applicant further stated that, for the support services listed in Section 3.4, the specific contractors may change but the functions will be maintained.

Section 2F of IPRA Volume VIII provides matrices of the DeWitt County and participating municipal emergency response agencies and all of the State, local, and private agency organizations that are expected to play an active role in an emergency. Section 2J, "DeWitt County, Evacuation Plan," of IPRA Volume VIII briefly summarizes the evacuation plan and the agencies responsible for different aspects of the evacuation. Section 3D, "Sheltering Guide, Registration Centers and Congregate Care Shelter Spaces," of IPRA Volume VIII lists the registration centers and congregate care shelters. Appendix D, "Registration Centers and Congregate Care Shelters," to IPRA Volume VIII is a list of the registration centers and congregate care centers, while Appendix E, "Shelter Profiles," to IPRA Volume VIII is a compilation of the sheltering profiles (i.e., the location, contact number, and amenities of the congregate care centers). Map C in IPRA Volume VIII displays the location of the registration centers and congregate care shelters in relation to the EPZ.

13.3.3.4.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, IV.C, IV.D, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for the major features of emergency plans, including those that apply to major feature C, "Emergency Response Support and Resources."

Major feature C calls for the applicant to describe contacts and arrangements for requesting Federal assistance, as well as assistance from radiological laboratories and nuclear or other facilities and organizations. The application should also identify the general capabilities and expected availability of radiological monitoring and analyses services.

13.3.3.4.3 Technical Evaluation

The Federal government maintains an in-depth capability to assist licensees, State, and local governments through the FRERP. The ESP application adequately addresses provisions for requesting Federal assistance through the EGC ESP Emergency Plan and IPRA Volume I.

The EGC ESP Emergency Plan, IPRA Volumes I and VIII, and the applicant's response to RAI 13.3-13(b) identified radiological laboratories, their general capabilities, and their expected availability to provide radiological monitoring and analytical services during an emergency. The EGC ESP Emergency Plan and IPRA Volumes I and VIII also identify nuclear and other facilities and organizations that can provide assistance in an emergency. In addition, the EGC ESP Emergency Plan describes the contacts and arrangements the applicant has made with the response organizations identified in Section 13.3.3.2.1 of this SER.

13.3.3.4.4 Conclusions

As discussed above, the applicant described provisions for requesting Federal assistance, and identified nuclear and other facilities and organizations that can be relied on to provide assistance in an emergency, including the general capabilities and availability of radiological laboratories. In addition, the applicant described the contacts and arrangements made with the response organizations. Based on its review, the staff concludes that the proposed major feature C is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, IV.C, IV.D, and IV.E of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for emergency response support and resources, as set forth above. EGC provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.5 Emergency Classification System (Major Feature D)

13.3.3.5.1 Technical Information in the Application

Sections 4.1, "Unusual Event," 4.2, "Alert," 4.3, "Site Area Emergency," and 4.4, "General Emergency," of the EGC ESP Emergency Plan identify four emergency classes—unusual event, alert, site area emergency, and general emergency, respectively.

Section 1C, "Overview, Accident Classification," of IPRA Volume I states that the emergency classification scheme to be used in the event of an emergency would include unusual event, alert, site area emergency, and general emergency. The applicant's four classifications, as defined in the EGC ESP Emergency Plan, are consistent with these.

Section 1C of IPRA Volume VIII also provides a listing of the four emergency classification levels—unusual event, alert, site area emergency, and general emergency. The applicant's scheme is consistent with this listing as well.

13.3.3.5.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.C of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for the major features of emergency plans, including those that apply to major feature D, "Emergency Classification System."

Major feature D calls for the applicant to establish a standard emergency classification scheme that is consistent with Appendix 1 to Revision 1 to NUREG-0654/FEMA-REP-1. Major feature D also calls for the State and local organizations to establish an emergency classification scheme that is consistent with that proposed by the applicant.

13.3.3.5.3 Technical Evaluation

The applicant established an emergency classification scheme comprising four categories—unusual event, alert, site area emergency, and general emergency. These four categories meet the guidance in Appendix 1 to Revision 1 of NUREG-0654/FEMA-REP-1. The applicant's scheme also includes a fifth emergency class, "recovery," as stated in Section 4.5, "Recovery," of the EGC ESP Emergency Plan. The staff did not regard this fifth emergency class as essential to its review and, therefore, did not consider it. The applicant's emergency classification scheme is consistent with that established in Volumes I and VIII of IPRA.

13.3.3.5.4 Conclusions

As discussed above, the applicant specified a standard emergency classification scheme, that is consistent with that set forth in Appendix 1 to NUREG-0654/FEMA-REP-1 and with those established by the State and local EROs. Based on its review, the staff concludes that the proposed major feature D is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.C of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for the emergency classification system, as set forth above. EGC provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.6 Notification Methods and Procedures (Major Features E)

13.3.3.6.1 Technical Information in the Application

In Section 5.1, "Bases for Emergency Response Organization Notification," of the EGC ESP Emergency Plan, the applicant stated that, in cooperation with the State of Illinois and county authorities, it has established mutually agreeable methods and procedures for notifying offsite response organizations consistent with the action level scheme discussed in the previous section. These methods and procedures apply to CPS and other EGC facilities within the State of Illinois.

Sections 1D, "Overview, Operational Response Levels," 3A, and 4A,"Communications, Nuclear Accident Reporting System," in IPRA Volume I list procedures for the notification of State agencies and local communities based on emergency classification levels.

Sections 1C, 1D, and 2B, as well as Annexes 2A, 2B, 2C, 2D, 2E, and 2F of IPRA Volume VIII, describe detailed notification procedures, based on the CPS and State emergency classification levels, for the counties and risk municipalities.

Sections 5.2.1, "On-site," 5.2.2, "Off-site," and 5.2.3, "Support Organizations," of the EGC ESP Emergency Plan describe the methods for alerting, notifying, and mobilizing onsite, offsite, and support organization emergency response.

Sections 3A, 4B, "Communications, Nuclear Accident Reporting System," 4C, "Communications, IDNS Radio Network," and 4D, "Communications, State Agency Communications Networks," in IPRA Volume I provide the procedures that Illinois State agencies use to mobilize and activate emergency response personnel. Sections 3A(3), "Agency Responsibilities, State Agencies, Illinois Emergency Management Agency," and 3A(8) in IPRA Volume I state that the IEMA and the IDNS, respectively, receive notification of an unusual event concurrently from CPS through the nuclear accident reporting system (NARS). As described in Section 3A of IPRA Volume I, each agency has procedures to mobilize staff by commercial telephone, pager, or radio commensurate with his or her responsibilities in an emergency. The IEMA notifies the county and municipal governments as appropriate via NARS.

Sections 1C, 1D, 2B, 2C, "DeWitt County, Call List," and 2D, "DeWitt County, Flow Diagram Notes for DeWitt County Initial Notification," as well as Annexes 2A, 2B, 2C, 2D, 2E, and 2F of IPRA Volume VIII, provide specific mobilization and activation procedures for the counties and municipalities within the plume exposure pathway EPZ.

Section 5.5, "State and County Information Dissemination," of the EGC ESP Emergency Plan explains that the State of Illinois and county emergency response plans include procedures for how State and county officials should make a public notification decision promptly (within about 15 minutes) once the plant has informed them of an emergency. Currently, the applicant's system for disseminating information to the public includes notification by prescripted messages through appropriate broadcast media, such as the emergency alert system (EAS). Subsections 5.5.1, "Notification of the Public," and 5.5.2, "Messages to the Public," of the EGC ESP Emergency Plan describe dissemination systems that are already in service and will be used for a future EGC ESP facility.

Section 1G, "Overview, Notification of the Public," of IPRA Volume I discusses activation of the alert notification sirens, deployment of emergency service vehicles, and operation of the EAS. The electronic and mechanical sirens emit a blast and have voice capabilities. The siren system, supplemented by mobile public address (PA) systems, provides coverage to essentially 100 percent of the plume exposure EPZ. After the sounding of the sirens or notification by mobile units, radio broadcast informs members of the public within the plume exposure pathway EPZ of what actions to take.

Section 2A, "DeWitt County, Functional Summary Descriptions," in IPRA Volume VIII specifies that DeWitt County activates the alert notification sirens upon instruction from IEMA. The county prepares messages, provided in the annexes, to be sent out over the EAS, once approved by IEMA.

13.3.3.6.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the EGC ESP Emergency Plan to comply with the requirements of 10 CFR 52.17, using the guidance in

Supplement 2. In Section 1.2, "Planning Standards and Evaluation Criteria," of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.D of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in ESP applications. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those that apply to major feature E, "Notification Methods and Procedures."

Major feature E calls for the applicant to describe the mutually agreeable bases for notifying response organizations, consistent with the emergency classification scheme in Appendix 1 to NUREG-0654/FEMA-REP-1, including the method for alerting, notifying, and mobilizing personnel. The application should also describe the administrative and physical means for notifying and promptly instructing the public within the 10-mile EPZ.

13.3.3.6.3 Technical Evaluation

The EGC ESP Emergency Plan and IPRA Volumes I and VIII describe a mutually agreeable basis for the notification of response organizations that is consistent with the emergency classification scheme set forth in Appendix 1 to Revision 1 of NUREG-0654/FEMA-REP-1. These documents also describe a method for alerting, notifying, and mobilizing emergency response personnel. In addition, the EGC ESP Emergency Plan and IPRA Volumes I and VIII describe the administrative and physical means for notifying and promptly instructing the public within the plume exposure pathway EPZ.

13.3.3.6.4 Conclusions

As discussed above, the applicant described the mutually agreeable bases for notifying response organizations, that is consistent with Appendix 1 to NUREG-0654/FEMA-REP-1, and includes the method for alerting, notifying, and mobilizing personnel. In addition, the applicant described the administrative and physical means for notifying and promptly instructing the public within the 10-mile EPZ. Based on its review, the staff concludes that the proposed major feature E is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.D of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for notification methods and procedures, as set forth above. EGC provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.7 Emergency Communications (Major Feature F)

13.3.3.7.1 Technical Information in the Application

Section 6.1, "Communications/Notifications," of the EGC ESP Emergency Plan states that, for the EGC ESP facility, the applicant will maintain the capability to make initial notifications to the designated offsite agencies on a 24-hour-per-day basis. The offsite notification system, referred to as the NARS, is a dedicated communications system that links the facility control room, EOF, TSC, and State and local authorities. Facsimile and commercial telephone lines will back up the NARS. State and county warning points will be continuously staffed. In addition, the applicant has established several dedicated communication systems that will ensure reliable and timely exchange of information necessary to the effective command and control of any emergency response. This includes information (1) between EGC and State and local agencies within the EPZs, (2) between EGC and the Federal EROs, (3) between the plant, the EOF, and the State and county EOCs, and (4) between the emergency response facilities (ERFs) and field monitoring teams. In addition, facility communication links will exist to ensure appropriate information transfer capabilities during an emergency. The facility may also use PA systems, facility radios, and pagers to augment its communication capabilities.

Sections 3A(3), 3A(8), and 4A of IPRA Volume I identify NARS as the primary source of communications among the ESP site, State agencies, and local governments. Commercial telephones will be used for confirmation. No State, other than Illinois, is located within the EPZ of the EGC ESP site.

Section 2G," DeWitt County, Communications," in IPRA Volume VIII specifies the communications systems utilized by DeWitt County (NARS and telephone). Annexes 2A, 2B, 2C, 2D, 2E, and 2F of IPRA Volume VIII specify the communications systems used by DeWitt County, the risk municipalities, and the support counties.

Section 6.3, "USNRC Communications (Emergency Notification System and Health Physics Network)," in the EGC ESP Emergency Plan states that the applicant will install dedicated telephone equipment between the EGC ESP facility's control room and the NRC, with an extension of that line into the TSC. The EOF will have available a separate line capable of being patched into the facility through the NRC. The NRC will use this line for event notifications and status updates.

A separate dedicated telephone, the health physics network, will also be available to convey health physics information to the NRC from the TSC and EOF, as requested. This telephone can also be used as an open line. The NRC will direct the installation and the use of its own telephones as indicated in Figure 6.1-3, "USNRC Communications for Nuclear Response."

Section 6.1.8, "Emergency Response Data System," of the EGC ESP Emergency Plan states that the Emergency Response Data System (ERDS) will supply the NRC with selected plant data points on a near-real time basis. The ERO will activate the ERDS as soon as possible, but no later than 1 hour after declaration of an alert, a site area emergency, or a general emergency. The selected data points will be transmitted via modem to the NRC at approximately 1-minute intervals.

Section 2B of IPRA Volume I lists some of the Federal agencies that may be needed in the event of an incident at a nuclear plant. Section 3A(8) of IPRA Volume I describes the duties of IDNS in an emergency, including the responsibility for contacting the appropriate Federal agencies whenever an accident more severe than an alert is reported. Section 3A(8) also references the FRERP and Radiological Assistance Program. In RAI 13.3-13(c), the staff requested a description of the provisions for prompt communications between the Federal and State EROs. In response to RAI 13.3-13(c), the applicant stated that Section F1(1), "Overview, Operations Centers, State Emergency Operations Center," and Section 2B of IPRA Volume 1 describe the provisions for communications between the Federal and State EROs. Section 6A, "Preparedness Functions, Exercises and Drills," of IPRA Volume I and Section 1C of IPRA Volume VIII also discuss these communications provisions. Section 3A(8) of IPRA Volume I indicates that the Radiation Emergency Assistance Center (REAC) will contact the Federal agencies, and Section 3B of IPRA Volume I states that the Governor or his designee is authorized to request Federal assistance.

The applicant stated that the shift manager will be responsible for initiating a call-out to activate the ERO. The applicant will use an automated notification system to rapidly notify members of the ERO. The system, in use at the CPS and planned for use at the EGC ESP facility, consists of a computer with modem equipment capable of initiating and receiving telephone calls. When contact is made, the system will automatically request security identification and then respond. The system will call the paging system vendor. The pager vendor's system will accept group and individual numbers from the ERO notification system, activating several radio transmitters that in turn will activate personal pagers belonging to members of the ERO. The system will incorporate redundant power, phone, and computer components with geographic separation. Implementing procedures will specify the course of action to be taken, should the ERO notification system fail. In case of system failure, facility personnel will manually activate the ERO group page feature and/or directly call-out key emergency response personnel.

Section 3A of IPRA Volume I contains a list of State agencies and gives details of the notification process for their staffs.

Sections 1C and 1D of IPRA Volume VIII state that DeWitt County receives initial notification from IEMA via NARS and notifies the risk municipalities and support counties. Annexes 2A, 2B, 2C, 2D, 2E, and 2F of IPRA Volume VIII detail the emergency personnel notification procedures of DeWitt County, local municipalities, and support counties.

Section 6.4, "Medical Communications," of the EGC ESP Emergency Plan states that communications will be established with the primary and backup medical hospitals described in Section 12.1, "Off-site Hospital and Medical Services," of the plan. Facility personnel will establish communications with medical transportation services via commercial telephone lines.

Section 3A(9), "Agency Responsibilities, State Agencies, Public Health," of IPRA Volume I describes the Illinois Department of Public Health (IDPH) communications as relying on an emergency management system using radio, telephone, or telemetry. The system links the IDPH to hospitals, ambulances, and other emergency vehicles.

Section 2G and Annexes 2A, 2B, 2C, 2D, 2E, and 2F of IPRA Volume VIII state that the John Warner Hospital representative at the DeWitt County EOC is responsible for communicating with the hospital and arranging for ambulance support (Annex 2B), although the means of communication are not specified. The DeWitt County EOC will coordinate medical support for risk counties and municipalities.

13.3.3.7.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of a complete and integrated emergency plan. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those that apply to major feature F, "Emergency Communications."

Major feature F calls for the applicant to identify communication provisions with State and local governments within the EPZs, with Federal EROs, and with fixed and mobile medical support facilities. The application should also describe provisions for alerting and activating emergency personnel.

13.3.3.7.3 Technical Evaluation

The staff reviewed the applicant's response to RAI 13.3-13(c) and found it to be acceptable based on the evaluation below.

The communication plans for emergencies described in the EGC ESP Emergency Plan and IPRA Volumes I and VIII have provisions for communications among contiguous State/local governments within the EPZ, and, as needed, with Federal EROs. In addition, these communication plans for emergencies have provisions for alerting and activating emergency personnel in each response organization. Finally, the plans describe the communication arrangement for fixed and mobile medical support facilities.

13.3.3.7.4 Conclusions

As discussed above, the applicant identified communication provisions with State and local governments within the EPZs, with Federal EROs, and with fixed and mobile medical support facilities. In addition, the applicant described provisions for alerting and activating emergency personnel. Based on its review, the staff concludes that the proposed major feature F is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.D, and IV.E of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for emergency communications, as set forth above. EGC provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.8 Public Education and Information (Major Feature G)

13.3.3.8.1 Technical Information in the Application

Section 7.1, "Public Information Publication," of the EGC ESP Emergency Plan explains that the State has an overall responsibility to maintain a continuing disaster preparedness public education program. Section 7.1 also states that the emergency public information publication for the applicant's generating facilities is and will be updated annually, in coordination with State and county agencies, to address how the general public is notified and what their actions should be in an emergency. The applicant also stated that it will distribute the EGC ESP site-specific publication on an annual basis by mail to residents within the 10-mile plume exposure pathway EPZ, as well as to appropriate locations where the transient population may obtain a copy.

Section 7.2, "Public Education Materials," of the EGC ESP Emergency Plan states that public information publications will instruct members of the public to go indoors and turn on their radios when they hear the alert notification sirens operating. These publications will also identify the local radio stations that the public should listen to for emergency-related information.

Sections 7.1 and 7.2 of the EGC ESP Emergency Plan state that the public information publication will include educational information on radiation, a description of the events that require public notification and what to do if a "take shelter" or "evacuate" recommendation is given, a map of major evacuation routes, a list of communities likely to serve as host shelter areas, and instructions on how to obtain additional information, especially for the disabled or their caretakers and those without transportation. In addition, the publication will include an address, telephone number, and email address to contact for further information. In RAI 13.3-7, the staff requested that the applicant provide the respiratory protection information included in its emergency information program. In its response to RAI 13.3-7, the applicant stated that the public information publications for CPS currently provide respiratory protection information. These publications address respiratory protection information by providing general radiation information, actions to be taken for a "shelter-in-place" recommendation, and contacts for additional information. The current "shelter-in-place" actions include the following statements regarding respiratory protection (i.e., protective measures) consistent with Section 5.5.2 of the EGC ESP Emergency Plan:

> Go indoors and stay there. Close all doors and windows and shut off any systems that draw in outside air, such as furnaces, fireplaces and air conditioners.

As indicated in Section 16.4, "Emergency Plan and Agreement Revisions," of the EGC ESP Emergency Plan, when an application for a COL references the EGC ESP Emergency Plan pursuant to Subpart C, "Combined License," of 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," it is anticipated that the application will incorporate the EGC ESP Emergency Plan into the EGC nuclear standardized radiological emergency plan in effect at that time, including, in an appropriate annex, the addition of plant-specific information associated with the EGC ESP facility. Along with the adoption of the EGC nuclear standard radiological emergency plan, the COL facility will adopt consistent public information publications and distribution practices.

Section 5C, "Public Information," of IPRA Volume I describes a program whereby the State of Illinois, the operating utilities, and the affected county governments distribute information booklets on an annual basis. The State coordinates this activity with the utility as described in Section 7.1 of the EGC ESP Emergency Plan. The public information booklets entitled, "Emergency Information," are distributed by mail to the public residing within the 10-mile EPZ. Utility billing records or zip codes are used to compile distribution lists and are updated annually. In addition to direct mailing, booklets are available to transients and EPZ visitors at area motels, health care facilities, recreational areas, and other public areas.

Section 2K, "DeWitt County, Public Information Considerations," in IPRA Volume VIII indicates that the emergency information booklet includes instructions on how to obtain additional information, instructions to follow if shelter-in-place or evacuation is recommended, educational information concerning radiation, a map of major evacuation routes, and a list of communities that are likely to serve as host communities for evacuees. The booklet also contains information that is used to identify persons within the EPZ who have special concerns related to their ability to follow protective actions. These special concerns include hearing and walking difficulties, transportation issues, and special medical needs.

Section 7.5, "Media Orientation," of the EGC ESP Emergency Plan states that the applicant's Midwest Regional Operating Group (MWROG) Emergency Preparedness Department, in conjunction with the Communications and Public Affairs Department, will annually provide the applicable news media with information concerning the emergency plan, radiation, and points of contact for release of public information in an emergency.

Section 5D, "Public Information, Media Education," in IPRA Volume I and Section 2K in IPRA Volume VIII describe the program for acquainting the media with the emergency plans, information concerning radiation, and points of contact for release of public information in an emergency. To acquaint the news media with the IPRA, information is provided annually to the media in the vicinity of each nuclear power station. Information is provided by a briefing session, participation in an IPRA exercise, or a mailing of informational material. Any one of these three methods provides information on the IPRA concept of operations, accident classification scheme, communications, protective actions, parallel actions, public information, and the EPZ.

In RAI 13.3-13(d), the staff requested a description of the State and local programs for acquainting news media with emergency plans, information concerning radiation, and points of contact for the release of public information in an emergency. In response to RAI 13.3-13(d), the applicant stated that Section 5D in IPRA Volume 1 provides a description of the State and local programs for acquainting news media with emergency plans, information concerning radiation, and points of contact for the release of public information in an emergency.

13.3.3.8.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.B, IV.D, IV.E, and IV.F of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those that apply to major feature G, "Public Education and Information."

Major feature G calls for the applicant to describe a program to provide information to the public and news media on a periodic basis. The program should address how the applicant would notify the public, including what actions they would take in an emergency, and the applicant's means for acquainting the news media with emergency information.

13.3.3.8.3 Technical Evaluation

The staff reviewed the applicant's responses to RAIs 13.3-7 and 13.3-13(d) and found them to be acceptable based on the evaluation below.

The EGC ESP Emergency Plan and IPRA Volumes I and VIII describe programs to provide a coordinated dissemination of information to members of the public on a periodic basis (at least annually) regarding how they will be notified and what their actions should be in an emergency. The programs described in State and local emergency plans include information on the following:

- educational information on radiation
- *contact for additional information*
- protective measures (e.g., evacuation routes, relocation centers, and sheltering)
- special needs of the handicapped, transient population, and special facilities

The EGC ESP Emergency Plan and IPRA Volumes I and VIII adequately describe a program for acquainting the news media on a periodic basis (at least annually) with emergency plans, information concerning radiation, and points of contact for release of public information in an emergency.

13.3.3.8.4 Conclusions

As discussed above, the applicant described a program to provide information to the public and news media on a periodic basis, that addresses public notification and emergency actions. Based on its review, the staff concludes that the proposed major feature G is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.B, IV.D, IV.E, and IV.F of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for public education and information, as set forth above. The applicant provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.9 Emergency Facilities and Equipment (Major Feature H)

13.3.3.9.1 Technical Information in the Application

Section 8.1.2, "Technical Support Center," of the EGC ESP Emergency Plan states that a TSC will be established for use during emergency situations by facility management, technical, and engineering support personnel. The TSC will be activated for emergencies classified as an alert or higher. Activation for other events will be optional. When activated, the TSC functions will include the following:

- supporting the control room's emergency response
- performing the nondelegable functions when in command and control
- continually evaluating event classification
- assessing the plant status and potential offsite impact
- coordinating emergency response actions
- notifying appropriate corporate and station management
- providing notification and update information to the NRC via the emergency notification system (ENS), including activation of ERDS

The TSC will be the onsite location used to support the control room for assessment of plant status and potential offsite impact, as well as for the implementation of emergency actions. The TSC will provide technical data and information to the EOF.

The TSC will provide reliable voice communications to the control room, operations support center (OSC), EOF, the NRC, and State and local EOCs. In addition, the TSC will provide facsimile transmissions capability, as described in Chapter 6, "Emergency Communications," in the EGC ESP Emergency Plan.

The TSC will be sized for a minimum of 25 spaces and supporting equipment. Of the 25 spaces, 5 will be reserved for the NRC, and adequate space will be available for the appropriate State representative(s). Under accident conditions, personnel in the TSC will be protected from radiological hazards, including direct radiation and airborne contaminants, with similar radiological habitability as the control room personnel. To ensure adequate radiological protection, permanent radiation monitoring systems will be installed in the TSC and/or periodic radiation surveys will be conducted. These systems will be used to indicate radiation dose rates and airborne radioactivity inside the TSC. In addition, protective breathing apparatus (full-face air purifying respirators) and potassium iodide (KI) will be available for use as required. The TSC will have access to a complete set of as-built drawings and other records, including general arrangement diagrams, piping and instrumentation drawings, and the electrical schematics. The TSC will have the capability to record and display vital plant data, in real time, to be used by knowledgeable individuals responsible for engineering and management support of reactor operations and for implementation of emergency procedures.

Section 8.1.3, "Operations Support Center," in the EGC ESP Emergency Plan states that facility support personnel will report to the OSC, an onsite location used during an emergency. Assignments or duties will be dispatched in support of emergency operations. The OSC will be activated whenever the TSC is activated, but the OSC need not remain activated at the alert level, if the station emergency director judges it to be unnecessary. At the site area and general emergency levels, the OSC or an alternate OSC will be activated at all times. Activation for other events will be optional. Station disciplines reporting to the OSC will include, but not be limited to, the following:

- operating personnel not assigned to the control room
- radiation protection personnel
- chemistry personnel
- maintenance personnel (mechanical, electrical, and instrumentation and control)

The OSC will be equipped with communication links to the control room, TSC, and EOF, as described in Chapter 6 of the EGC ESP Emergency Plan. A limited inventory of supplies will be kept in the OSC. This inventory will include respirators, protective clothing, flashlights, and portable survey instruments.

Sections 8.1.2 and 8.1.3 of the EGC ESP Emergency Plan provide brief, general statements and do not give facility-specific or equipment-specific information. In RAI 13.3-12, the staff requested that the applicant discuss the extent that it intended the application for an ESP to address evaluation criteria V.H.1 and V.H.2 of Supplement 2 for the TSC, OSC, and EOF for an ESP, including whether it intended the application to address NUREG-0696, "Functional Criteria for Emergency Response Facilities—Final Report," dated February 1981. In addition, the staff asked the applicant to state whether EGC intends to utilize the existing TSC, OSC, and EOF, which support CPS, for the ESP site. In response to RAI 13.3-12, the applicant stated that the EGC ESP Emergency Plan addresses evaluation criterion V.H.1 of Supplement 2 in Section 8.1, which provides the full ESP discussion of the major features of the TSC and OSC, including the NUREG-0696 criteria applicable for a major features discussion. Because the

COL application is expected to reference a certified design that has already addressed the details of the design of these facilities, EGC did not include them in the ESP application. The specific designs vary; thus, providing these details in the ESP application could result in discrepancies with the to-be-selected certified design. The COL application will address any details not included in the combined to-be-referenced ESP and design certification document. The EGC ESP facility does not intend to use the TSC or OSC that support the existing Clinton unit and, thus, there will be no impact from the new facility on the existing CPS TSC and OSC.

Section 8.2, "Emergency Operations Facility," of the EGC ESP Emergency Plan addresses evaluation criterion V.H.2 of Supplement 2. Section 8.2 provides a full discussion of the major features of the EOF, including the NUREG-0696 criteria applicable for a major features discussion. The applicant also stated that, as indicated in Section 8.2, the EGC ESP facility intends to use the existing common EOF currently located in the EGC Cantera facility in Warrenville, Illinois. This facility supports the existing Clinton unit, as well as other existing units in Illinois, and has been previously evaluated against the NUREG-0696 criteria. Since the EOF is already established to support numerous nuclear facilities, the only impact is incorporating the appropriate documents and any necessary communication inputs. Thus, including the EGC ESP facility in the existing EOF is expected to have minimal impact. Completion of the activities will occur at the COL stage and these and other NUREG-0696 criteria can be readily confirmed by inspection at that time (consistent with the process utilized for the previously licensed facilities).

Section 8.2 of the EGC ESP Emergency Plan states that the EOF will be the location where the corporate emergency director will direct a staff to evaluate and coordinate the overall company activities involved with an emergency. Activation of the EOF is mandatory upon declaration of an alert or higher classification. The EOF will provide for the management of overall emergency response, the coordination of radiological and environmental assessments, the determination of recommended public protective actions, the management of recovery operations, and the coordination of emergency response activities with Federal, State, and local agencies. The common MWROG EOF is currently (i.e., in 2003) located in the applicant's Cantera facility, west of Chicago, in Warrenville, Illinois. The EOF was designed with the following considerations in mind:

- The location provides optimum functional and availability characteristics for carrying out the overall strategic direction of the applicant's onsite and support operations, determining public protective actions to be recommended to offsite officials, and coordinating with Federal, State, and local organizations.

- The EOF is well engineered and of sufficient size to accommodate about 50 people.

- The EOF is equipped with reliable voice communications capabilities to the TSC, OSC, control room, NRC, and State and local EOCs. In addition, the EOF has facsimile transmission capability.

- Equipment is provided to gather, store, and display data needed in the EOF to analyze and exchange information on plant conditions within the facility. The EOF technical data system receives, stores, processes, and displays information sufficient to perform assessments of the actual and potential onsite and offsite environmental consequences of an emergency condition.

- The EOF has (and will have for the EGC ESP facility) ready access to plant records, procedures, and emergency plans needed for effective overall management of the applicant's emergency response resources.

Section 1F(1), "Overview, Operations Centers," in IPRA Volume I fully describes the SEOC and its use in directing and controlling response functions. The IPRA describes the role of IEMA in coordinating and directing response, the State agencies participating at the SEOC, agency roles, physical characteristics of the facility, and communications systems. The SEOC operations can also be conducted from the State forward command post (SFCP).

Sections 1C and 2E in IPRA Volume VIII describe the county and municipal emergency response functions that take place at the DeWitt County EOC. Volume VIII of IPRA describes the location and operation of the EOC in coordinating county and municipal response and in coordinating with the SEOC or the SFCP.

13.3.3.9.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.B, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including the criteria that are apply to major feature H, "Emergency Facilities and Equipment."

Major feature H calls for the applicant to describe a TSC, onsite OSC, and EOF, in accordance with the guidance in NUREG-0696. The following are the general guidance criteria from NUREG-0696 for these facilities:

- The TSC is an onsite facility located close to the control room that shall provide plant management and technical support to the reactor operating personnel located in the control room during emergency conditions. It shall have technical data displays and plant records available to assist in the detailed analysis and diagnosis of abnormal plant conditions and any significant release of radioactivity to the environment. The TSC shall be the primary communications center for the plant during an emergency.

- The OSC is an onsite assembly area separate from the control room and the TSC where licensee operations support personnel shall report to in an emergency. There shall be direct communications between the OSC and the control room, and between the OSC and the TSC, so that the personnel reporting to the OSC can be assigned to duties in support of emergency operations.

- The EOF is a near-site support facility for the management of the overall licensee emergency response (including coordination with Federal, State, and local officials), coordination of radiological and environmental assessments, and determination of recommended public protective actions. The EOF shall have appropriate technical data displays and plant records to assist in the diagnosis of plant conditions to evaluate the potential or actual release of radioactive materials to the environment.

In addition, major feature H calls for the ESP application to describe an EOC for each offsite organization for use in directing and controlling response functions.

13.3.3.9.3 Technical Evaluation

The staff finds that the ESP application adequately describes the State and local EOCs for use in directing and controlling response actions.

In Sections 8.1.2, 8.1.3, and 8.2 of the EGC ESP Emergency Plan, the applicant provided general descriptions of the OSC, TSC, and EOF and equipment. With regard to the applicant's response to RAI 13.3-12, the applicant did not address the adequacy of the facilities and related equipment in support of emergency response. In addition, the applicant did not address, with specificity, such facility and equipment details such as location, size, structure, function, habitability, communications, staffing and training, radiological monitoring, instrumentation, data system equipment, power supplies, technical data and data systems, and record availability and management. In Open Item 13.3-3, the staff identified the need for additional specific information related the OSC, TSC, and EOF. In its submission to the NRC dated April 26, 2005, the applicant responded to Open Item 13.3-3. The applicant stated that as indicated in its response to RAI 13.3-12, the EGC ESP addresses evaluation criterion V.H.1 of Supplement 2 to NUREG-0654/FEMA-REP-1 in Section 8.1 of the emergency plan and provides the EGC ESP discussion of the major features of the TSC and OSC. Because the COL application is expected to reference a certified design that has already addressed the details of the design of these facilities, the ESP does not include these details. The specific designs vary; thus, providing these details in the ESP could result in discrepancies with the to-be-selected certified design. The COL application will address any details not included in the combined to-be-referenced ESP and design certification document.

Similarly, Section 8.2 of the EGC ESP Emergency Plan provides the discussion of the major features of the EOF to address evaluation criterion V.H.2 of Supplement 2 to NUREG-0654/FEMA-REP-1. As indicated in Section 8.2, the EGC ESP facility intends to use the existing common EOF currently located in the EGC Cantera facility in Warrenville, Illinois. This facility supports the existing Clinton unit, as well as other existing units in Illinois, and has been previously approved as an acceptable centralized EOF, as addressed in SECY-02-0033, "Amergen's Request to Consolidate the Clinton Power Station Emergency Operations Facility (EOF) into the Centralized EOF Operated by Exelon Generation Co.," and its associated Commission staff requirements memorandum. Since the EOF is already established to support numerous nuclear facilities, the only impact is incorporating the appropriate documents and any necessary communication inputs. Thus, including the EGC ESP facility in the existing EOF is expected to have minimal impact. Completion of the activities will occur at the COL stage and these and other NUREG-0696 criteria can be readily confirmed by inspection at that time (consistent with the process utilized for the previously licensed facilities).

Based on the additional information provided above, the staff considered the part of Open Item 13.3-3 related to the EOF to be resolved. However, the applicant did not provide sufficient information to resolve the portions of Open Item 13.3-3 related to the OSC and TSC.

13.3.3.9.4 Conclusions

As discussed above, the applicant did not describe in sufficient detail the facilities and related equipment in support of emergency response for the OSC and TSC, as specified in RS-002 and Supplement 2. The applicant did not address, with specificity, such facility and equipment details such as location, size, structure, function, habitability, communications, staffing and training, radiological monitoring, instrumentation, data system equipment, power supplies, technical data and data systems, and record availability and management for the OSC and TSC. Based upon its review, the staff concludes that the proposed major feature H is not consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is unacceptable. EGC provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.10 Accident Assessment (Major Feature I)

13.3.3.10.1 Technical Information in the Application

In Sections 3.1.1.1.7 and 9.1.3, "National Weather Service," of the EGC ESP Emergency Plan, the applicant stated that meteorological information can be acquired and used through the NWS. Available data will include existing and forecast wind directions, wind speed, and ambient air temperature. Appendix A to the EGC ESP Emergency Plan identifies an arrangement with Murray and Trettle, Inc., for meteorological support. In Section 5.3 of the EGC ESP Emergency Plan, the applicant established, in conjunction with State and county authorities, the contents of the initial notification message transmitted during a classified emergency. Meteorological information contained in this message will include wind direction and speed. Section 5.4 of the EGC ESP Emergency Plan states that followup messages will also contain the same information as that provided in the initial notification message.

Section 9.2.3, "State Monitoring Capabilities," of the EGC ESP Emergency Plan explains that the State of Illinois can currently dispatch its own field monitoring teams to track the airborne radioactive plume. The State also has the ability and resources to coordinate with Federal and utility monitoring teams to compare sample results. Appendix A to the EGC ESP Emergency Plan includes letters confirming the State of Illinois commitment to implement IPRA.

Sections 1E and 3A(8) of IPRA Volume I explain that the State of Illinois, in the form of IDNS, has the responsibility and resources to dispatch its own field monitoring teams to perform field monitoring within the plume exposure EPZ. The State also has the ability and resources to coordinate with Federal and utility monitoring teams. Section 3A(8) also details the IDNS response, that will deploy a radiological assessment field team (RAFT) to perform plume exposure rate verification, air sampling, and sampling of food, water, milk, and other media. If requested by IDNS, DOE and other Federal and State agencies may provide additional field teams. The RAFT conducts field monitoring using suitable radiation detection instruments in the downwind portion of the EPZ. The team analyzes samples in a mobile laboratory utilizing a gamma spectroscopy system. The team is also responsible for the assessment of radioactive plume pathways, and they direct other field teams in determining the composition and location of the plume and in collecting of samples.

Sections 1D, 2F, and 2O, "DeWitt County, Radiological Considerations," of IPRA Volume VIII state that IEMA is responsible for performing confirmatory accident assessment. This includes, in part, deployment of field survey teams for radiation exposure monitoring and sample collection.

Section 3.1.1.1.4 of the EGC ESP Emergency Plan states that, if the applicant or the State of Illinois deemed assistance from DOE to be necessary or desirable, the State of Illinois would notify the appropriate DOE operations office.

Section 1E of IPRA Volume I explains that the State of Illinois has the responsibility and resources to dispatch its own field monitoring teams to track the radioactive airborne plume. The State also has the ability and resources to coordinate with Federal and utility monitoring teams.

13.3.3.10.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.A, IV.B, IV.C, IV.D, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for the major features of emergency plans, including those that apply to major feature I, "Accident Assessment."

Major feature I calls for the applicant to describe the methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition. The applicant should also describe the capability and resources associated with acquiring meteorological information and performing field monitoring, as well as contacts and arrangements with offsite organizations (including Federal and State resources).

13.3.3.10.3 Technical Evaluation

In the EGC ESP Emergency Plan, the applicant provided a description of the contacts and arrangements made with offsite organizations for acquiring and evaluating meteorological information. The applicant also described how suitable meteorological data will be made available to the State.

The EGC ESP Emergency Plan and IPRA Volumes I and VIII describe the contacts and arrangements made for field monitoring within the plume exposure EPZ. The EGC ESP Emergency Plan and IPRA Volume I describe contacts and arrangements to locate and track the airborne radioactive plume, using either or both Federal and State resources.

13.3.3.10.4 Conclusions

As discussed above, the applicant described adequate methods, systems, and equipment for assessing and monitoring actual or potential offsite radiological consequences of a radiological emergency condition at the ESP site, including associated contacts and arrangements. Based on its review, the staff concludes that the proposed major feature I is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, IV.C, IV.D, and IV.E of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for accident assessment, as set forth above. EGC provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.11 Protective Response (Major Features J)

13.3.3.11.1 Technical Information in the Application

Figure 2.2-1 of the EGC ESP Emergency Plan identifies three relocation centers, including the Illinois State University field house, Monticello High School, and Richland Community College. These facilities provide multiple alternatives for relocating evacuated site personnel depending on wind direction and other factors that may impede relocation of evacuated site personnel. Figures 2.2-1 and 2.3-1, "Evacuation Routes to Relocation and Congregate Care Centers," of the EGC ESP Emergency Plan show evacuation routes. Section 10.1.1, "Evacuation Locations," of the EGC ESP Emergency Plan states that personal transportation, if available, will normally be used. The applicant will identify personnel without transportation and provide transportation, as necessary. In RAI 13.3-8, the staff requested that the applicant discuss the means it will use to transport visitors and nonessential personnel without transportation in the event of a site evacuation. In response to RAI 13.3-8, the applicant stated that Section 10.1.1 of the EGC ESP Emergency Plan discusses this. Section 10.1.1 explains that visitors on site will assemble with and follow the instructions of their escorts. Both visitors and nonessential personnel will be transported by the same conveyance they were brought to the site, typically by bus or personal vehicle. Determinations of personnel and visitors without vehicles can be made at the assembly area, and these individuals provided transportation, as necessary (e.g., they could be paired with other nonessential personnel for evacuation from the site by personal vehicle).

Section 10.1.3, "Evacuation," of the EGC ESP Emergency Plan states that evacuation will commence in accordance with future EGC ESP facility procedures as directed by the emergency director or his/her designee, unless one of the following conditions exists:

- Severe weather conditions threaten safe transport.
- A significant radiological hazard would be encountered.
- A security threat occurs that would have an adverse impact on the personnel while leaving the site.
- A condition similar to these in magnitude occurs that, in the opinion of the station emergency director, would adversely affect the site personnel.

Section 10.1.6, "Mechanism for Implementing Protective Action Recommendations," of the EGC ESP Emergency Plan discusses a mechanism for implementing protective action recommendations to the offsite agencies responsible for implementing protective actions for the general public within the 10-mile EPZ. Section 10.2, "Protective Actions Recommendations," of the EGC ESP Emergency Plan states that, for incidents involving actual, potential, or imminent releases of radioactive material to the atmosphere, the U.S. Environmental Protection Agency's (EPA) 400-R-92-001, "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents," dated May 1992 (hereafter referred to as EPA 400); Supplement 3 to NUREG-0654/FEMA-REP-1, dated July 1996; and Volume 4 of the NRC's "Response Technical Manual," Revision 4, dated March 1996 (hereafter referred to as RTM-96), will be used as the basis for the general public protective action recommendations.

Section 6.0, "Analysis of Evacuation Times," of the 1993 ETE provides the results of the analysis. The ETE analysis was conducted for peak populations under a variety of scenarios. The applicant calculated the ETEs for winter weekday, winter weeknight, summer weekday, and summer weekend. These scenarios were evaluated for normal and adverse weather conditions in accordance with Revision 1 of NUREG-0654/FEMA-REP-1.

Section 1.2, "Site Location and Emergency Planning Zones (EPZ)," of the 1993 ETE provides a description of the nuclear power plant's general location, and Figure 1.2, "EPZ Evacuation Network," of the 1993 ETE is a map depicting the EPZ boundaries. Section 1.1, "General," of the ETE generally discusses how the analysis was conducted. The applicant developed the ETEs by using existing population data and the NETVAC computer simulation model.

Figures 2.1-1 and 2.2-1 of the EGC ESP Emergency Plan show the plume exposure pathway planning zone, EPZ subareas, evacuation routes, and relocation centers. In RAI 13.3-20(k), the staff requested the applicant to clarify the location of the registration and congregate care centers. The applicant responded to RAI 13.3-20(k) in its submission to the NRC dated January 24, 2005. In its submission, the applicant stated that the three items listed—Section 1.3 of the 1993 ETE, Map C of IPRA Volume VIII, and Figure 2.3-1 of the EGC ESP Emergency Plan—all correctly specify locations for evacuated persons to gather, but each use different terminology. The following table shows the differences in terminology used.

Source	**Terminology**
1993 ETE Study	Reception Centers
Map C of IPRA Volume VIII	Registration and Congregate Care Shelters
Figure 2.3-1 of the EGC ESP Emergency Plan	Registration and Congregate Care Centers

Because of the difference in terminology, the EGC ESP Emergency Plan will be revised to reflect the terminology used in IPRA Volume VIII. For example, "registration and congregate care centers" will be revised to "registration and congregate care shelters," in Section 2.3.1, in the title of Figure 2.3-1, and in Section 10.1.8.1, "Evacuation Routes and Destinations."

Additionally, each source specifies evacuation locations that comply with the other sources, except for one discrepancy. For example, the 1993 ETE study directs evacuees to reception centers located in Bloomington (North), Champaign (East), Decatur (South), and Lincoln (West), Illinois. Map C of IPRA Volume VIII shows congregate care shelters in each of these cities. However, Figure 2.3-1 of the EGC ESP Emergency Plan only labels the following registration and congregate care centers:

- ISU Horton Field House (located in Bloomington, Illinois),
- Parkland College (located in Champaign, Illinois)
- Steven Decatur Middle School (located in Decatur, Illinois).

Therefore, Figure 2.3-1 of the EGC ESP Emergency Plan will be revised to include the Lincoln Community High School as the registration and congregate care shelter for the city of Lincoln, Illinois (west of EGC ESP site).

Sections 2.1 and 2.2 of the 1993 ETE describe the general assumptions, that include automobile occupancy factors, method of determining roadway capacities, and method of estimating populations.

The applicant used the computer model NETVAC to develop the ETEs. Sections 2.2 and 2.3 of the 1993 ETE describe the methodology. Section 5.5 of the 1993 ETE also describes the evacuation simulation and the structure and major features associated with NETVAC.

The 1993 ETE estimates permanent residents using 1990 census tract and block data. Section 3.1, "Permanent Residents," and Tables 1.1, "Townships/Incorporated Areas Partially or Entirely within the Clinton EPZ," and 1.2, "Subareas within the Clinton EPZ," of the 1993 ETE present the data. Census block maps of the EPZ were used to update and distribute the total 1990 population within each township or incorporated area and sector. The distribution of the total permanent resident population was based on land allocation using the detailed census block maps. The 1993 ETE estimates 12,404 permanent residents in the CPS EPZ. Section 2.3.2.1, "Permanent Population," of the 1993 ETE states that the resident population within the plume exposure pathway EPZ is 12,358. Sections 3.1.1, "Auto-owning Permanent Population," and 3.1.2, "Transport-dependent Permanent Population," of the 1993 ETE describe the assumptions regarding the auto-owning and transport-dependent populations. The auto occupancy assumption for auto-owning and transport-dependent populations is one vehicle per household.

In RAI 13.3-20(d), the staff requested that the applicant discuss the basis for neighbors and State/local authorities contributing one vehicle per household for the transport-dependent (nonauto-owning) population. The applicant responded to RAI 13.3-20(d) in its submission to the NRC dated January 24, 2005. In its submission, the applicant stated that the DeWitt County ESDA indicates that the transport-dependent residential population within the city of Clinton will evacuate via buses provided by the city, plus assistance from auto-owning residents (generally neighbors or relatives). The buses will evacuate residents from a designated set of pickup locations in the city. The buses will evacuate residents from Clinton to the reception center in Decatur. According to ESDA, the number of buses available should be able to evacuate transport-dependent residents in a single pass. If residents arrive at pickup points after the buses have departed, one or more buses would return to Clinton to evacuate any remaining residents. It is assumed that the small number of transport-dependent residents in other subareas will evacuate with assistance from neighbors or relatives. The 1993 study assigned one vehicle per household for the entire residential population, including transport-dependent households. The 1993 study also assumed the distribution of mobilization times for the transport-dependent population to be the same as for the general residential population. The analysis of evacuation times for special facilities the applicant provided in response to RAI 13.3-20(c) indicates that the population of special facilities located in the city of Clinton will mobilize and evacuate in less time than the general population. The ETEs for the general population in Clinton are, therefore, considered representative (or conservative) for transport-dependent residents.

Section 3.2, "Seasonal Residents," of the 1993 ETE also includes information on seasonal residents, who are residents that reside in the area on a temporary basis. The applicant obtained the seasonal residence (assuming three people per housing unit) from the 1990 census. The population was determined to be 54 people within the EPZ.

Section 3.3, "Transient Population," of the 1993 ETE describes the transient population, that includes people in the workforce, hotels/motels, and recreational areas. Tables 3.3, "Transient Population Distribution within the Clinton EPZ: Winter Weekday;" 3.4, "Transient Population Distribution within the Clinton EPZ: Winter Weeknight;" 3.5, "Transient Population Distribution within the Clinton EPZ: Summer Weekday;" and 3.6, "Transient Population Distribution within the Clinton EPZ: Summer Weekend" present the total transient population. Appendix 1, "Transient and Special Facility Population Data," to the 1993 ETE lists the transient population and the corresponding facilities. The applicant estimated the transient population for each of the scenarios evaluated (winter weekday, winter weeknight, summer weekday, summer weekend). For purposes of estimating the total number of vehicles associated with the transient population segment, the applicant used an auto occupancy factor of 1 employee per vehicle for all work places, except at CPS, where the applicant used an average occupancy factor of 1.5 persons per vehicle. For the hotel/motel population, the applicant assumed that there would be one vehicle per hotel/model unit. The applicant assumed three persons per vehicle at all recreational facilities, except Little Galilee Christian Assembly Church Camp and the Calvary United Pentecostal Christian Camp where buses are provided.

In RAI 13.3-20(s), the staff asked the applicant to explain why it assumed the automobile occupancy rate to be different for CPS workers than that for other factories. The applicant responded to RAI 13.3-20(s) in its submission to the NRC dated January 24, 2005. In its submission, the applicant stated that site-specific information on automobile occupancy was available for CPS, but was not readily available for other employers. In the absence of site-specific information, a conservative default value of one person per vehicle was used to estimate ETEs.

In addition, Section 2.3.2.3 of the EGC ESP Emergency Plan discusses changes to the transient population since the 1993 ETE. The applicant developed the estimates used in the ESP application from 2002 survey data. Table 2.3-2 of the EGC ESP Emergency Plan provides a summary of the transient population included in the counts.

Section 13.3.1.1 of this SER discusses the applicant's analysis of the transient population associated with the Apple and Pork Festival.

The 1993 ETE describes the special facility population in Section 3.4, "Special Facilities Population," and Appendix 1. Tables 3.7, "Special Facilities Population Distribution within the Clinton EPZ: Winter Weekday;" 3.8, "Special Facilities Population Distribution within the Clinton EPZ: Winter Weeknight;" 3.9, "Special Facilities Population Distribution within the Clinton EPZ: Summer Weekday;" and 3.10, "Special Facilities Population Distribution within the Clinton EPZ: Summer Weekend" of the 1993 ETE also present the special facility population totals by sector for all scenarios analyzed. The 1993 ETE assumes a vehicle occupancy factor for students of 60 persons per bus. The analysis also assumes the vehicle occupancy factor for hospitals, nursing homes, and correctional facilities to be 40 people per bus.

In RAI 13.3-20(l), the staff asked the applicant to explain its assumed automobile occupancy factors of 60 students per bus and 40 residents per bus for special facility populations. The staff asked the applicant to provide specific information regarding whether vans or ambulances will be needed in addition to the buses. If vans and ambulances are needed, the applicant should provide information on whether they are included in the vehicle estimate. The applicant responded to RAI 13.3-20(l) in its submission to the NRC dated January 24, 2005. In its submission, the applicant stated that the values of 60 students per bus for schools and 40 persons per bus for health care facilities were assigned based on information provided by the county agencies. The use of buses versus vans is primarily a logistical issue, since one bus is (for traffic purposes) equivalent to four autos, while a van, with roughly half the capacity of a bus, is equivalent to two autos. For health care facilities (hospitals and nursing homes), one ambulance (or wheelchair van) is assigned for every two nonambulatory patients or residents. These vehicles have been included in the analysis for special facilities. Additional information related to the analysis of special facility evacuation times is included in Attachment A, "Analysis of Special Facility Evacuation Times," to the applicant's submission to the NRC dated January 24, 2005.

In RAI 13.3-20(r), the staff asked the applicant to discuss the availability of buses and drivers and the process for mobilizing the migrant worker and transport-dependant populations during an evacuation, as well as whether these populations can be evacuated in a single trip or if return trips are necessary. The applicant responded to RAI 13.3-20(r) in its submission to the NRC dated January 24, 2005. In its submission, the applicant stated that the 1993 ETE study did not include the migrant worker population (estimated at 65 persons). According to the DeWitt County ESDA, most migrant workers are transported by bus. The buses generally remain on site with the workers, and therefore, would be available for an evacuation. For the 1993 ETE study, the transport-dependent resident population was assigned the same trip generation time distribution as the remainder of the resident population. According to the DeWitt County ESDA, buses will be used to evacuate the transport-dependent residential population in the city of Clinton. Adequate buses and drivers are available to accomplish the evacuation of this population in a single trip, but return trips might be necessary if additional people arrive at pickup locations after buses have departed.

Section 2.3.2.3 of the EGC ESP Emergency Plan also states that migrant farm workers are included in the transient population statistics because of the nature of the farming in the region. In RAI 13.3-20(t), the staff asked the applicant to provide trip generation times for the migrant worker population and information on the automobile occupancy rate for migrant workers. The applicant responded to RAI 13.3-20(t) in its submission to the NRC dated January 24, 2005. In its submission, the applicant stated that the 1993 ETE study did not include the migrant worker population (estimated at 65 persons). The county agencies do not consider these workers transport dependent. If they were to be included in the NETVAC analysis, the standard workforce mobilization time (30 to 60 minutes) would apply to these workers.

Section 2.3.2.3.1 of the EGC ESP Emergency Plan discusses changes to the special facility population that have occurred since the 1993 ETE. The applicant developed the estimates used in the ESP application from 2002 survey data. In RAI 13.3-20(q), the staff asked the applicant to provide a reference for community college enrollment. The applicant responded to RAI 13.3-20(q) in its submission to the NRC dated January 24, 2005. In its submission, the applicant stated that it based the population estimates for Richland Community College Extension in Clinton on numbers of classes and class size provided by the college. The college currently provides up to 15 classes in the winter and spring, and 6 classes in the summer. Each class has up to 15 students.

Section 5.1, "Evacuation Analysis Cases," and Table 5.1, "Clinton EPZ Analysis Areas," of the 1993 ETE describe the analysis areas for the time estimates. The applicant prepared time estimates for the areas within 2 miles of the CPS, for 67.5-degree sectors from 0–5 miles and 0–10 miles from the plant, and for the entire Clinton plume exposure EPZ. Tables 6.1, 6.2, 6.3, and 6.4 provide ETE data following a keyhole approach with a simultaneous evacuation of the 2-mile radius and combinations of three sectors for each condition. This approach is adequate for determining the ETE.

Section 6.1 of the 1993 ETE describes the locations where queuing is likely to occur under the various scenarios.

Section 7.2, "Evacuation Traffic and Access Control Locations," of the 1993 ETE describes the locations identified in the NETVAC simulation where traffic management personnel may be necessary during the evacuation. In RAI 13.3-20(m), the staff requested that the applicant provide information on whether passthrough traffic affects the roadway capacity and the ETE within the plume exposure pathway EPZ evacuation routes. The applicant responded to RAI 13.3-20(m) in its submission to the NRC dated January 24, 2005. In its submission, the applicant stated that the NETVAC simulations do not include any "background" or "passthrough" traffic. At the start of the simulation, the network is free of traffic. The applicant assumed that access control would prevent through traffic from entering the EPZ during the evacuation.

In RAI 13.3-20(o), the staff asked the applicant to discuss the roadway characteristics, traffic control measures, and area types that support the NETVAC model runs. The applicant responded to RAI 13.3-20(o) in its submission to the NRC dated January 24, 2005. In its submission, the applicant stated that no new NETVAC model runs were made for the ESP application. The 1993 study report documents the roadway characteristics and area types used in the analysis. (Attachment C, "Detailed NETVAC Output for Selected Scenarios," to the EGC submission also documents these parameters.) As explained in Section 2.4, the applicant determined that the CPS ETE performed in 1993 is valid for current conditions. The NETVAC runs were made with existing (normal) traffic controls in effect. The applicant's response to RAI 13.3-20(g) provides additional information related to traffic control measures.

Section 2.3.3 of the EGC ESP Emergency Plan describes the analysis conducted to test the validity of the 1993 road network capacities and the current state of the road network. The applicant evaluated the EPZ zones for changes in the infrastructure, drove the principal roadways, and conducted a direct comparison of some of the link evaluation routes and nodes. The applicant noted no major differences.

Figure 1.2 in the 1993 ETE shows the EPZ evacuation network and codes. The sector and quadrant boundaries are numbered and are indicated on the map.

Section 4.0 and Appendix 3 to the 1993 ETE provide a description of the road network and the roadway network listing and capacities. The table in Appendix 3 indicates the evacuation route segments and their characteristics, including capacity. In RAI 13.3-20(e), the staff requested that the applicant clarify whether the characteristics for each segment analyzed in the 1993 ETE are for the narrowest section or bottleneck, if the roadway is not uniform. The applicant responded to RAI 13.3-20(e) in its submission to the NRC dated January 24, 2005. In its submission, the applicant stated that when roadway conditions are not uniform over the length of a link, roadway dimensions (e.g., lane width, side width) represent the most restrictive conditions over the link. In general, multiple links are used when a significant change in roadway conditions is encountered (e.g., change in lane width, addition or deletion of a lane, change in speed limit).

The NETVAC model input files in Appendix 3 to the 1993 ETE assign the area type (AT) identified as "4," or "residential," for 100 percent of the EPZ. In RAI 13.3-20(n), the staff asked the applicant to explain why the NETVAC model input files in Appendix 3 assign the AT identified as "4," or "residential," for the entire plume exposure pathway EPZ. The applicant responded to RAI 13.3-20(n) in its submission to the NRC dated January 24, 2005. In its submission, the applicant stated that most of the EPZ is rural or residential. Three of the four area types (central business district, fringe area, outlying business district) are characteristic of larger cities or towns. If a roadway is used predominantly by through traffic, "residential" is the appropriate classification for the link, even if the road traverses a business district. The links and intersections in the center of Clinton, the largest city or town in the EPZ (population 7485), are not considered to comprise a central business district.

Section 6.0 of the 1993 ETE provides the results of the analysis. The analysis for the 1993 ETE was calculated for peak populations under a variety of scenarios. The applicant calculated ETEs for winter weekday, winter weeknight, summer weekday, and summer weekend. The applicant evaluated each of these scenarios for normal and adverse weather conditions, in accordance with Revision 1 of NUREG-0654/FEMA-REP-1.

Sections 2.2 and 2.3 of the 1993 ETE describe the method for computing the total evacuation time. The time estimates are based on a time distribution of evacuation events. Section 5.4 and Figure 5.1 of the 1993 ETE describe the assumptions used for the evacuation preparation times and departure distributions. Section 5.5 provides a description of the general structure and major features associated with NETVAC.

However, to better understand the assumptions used in the methodology for developing the distributions in Section 5.4, "Evacuation Preparation Times and Departure Distributions," of the 1993 ETE, the staff asked the applicant, in RAI 13.3-20(d), to provide site-specific data regarding how many nonauto-owning households are in the plume exposure pathway EPZ. The staff also asked the applicant to provide the methodology for determining the transport-dependent population. In addition, the staff asked the applicant to provide an estimate of the number of auto-owning residents versus transport-dependent residents, as well as information on the initiation/mobilization time distribution for transport-dependent population.

The applicant responded to RAI 13.3-20(d) in its submission to the NRC dated January 24, 2005. In its submission, the applicant provided estimates of the number of auto-owning and transport-dependent households by subarea for the EPZ, that are provided in Table B-1, "Estimates of Transport-Dependent Population in Clinton Station EPZ," of Attachment B, "Transport-Dependent Population," to the letter. The applicant also stated that Table B-1 summarizes the estimated number of transport-dependent households by subarea. The number of transport-dependent households in the EPZ is 302. (According to the data provided in Attachment B, the actual number is 301 instead of 302.) Most of these households are located in the city of Clinton (in Subarea 7). The 2000 census (SF-3) tabulates the number of vehicles per household; transport-dependent households were estimated based on the reported number of occupied households with no vehicles. The applicant used the census data on average household size and vehicles per household at the block group level to estimate values for each subarea. The 1993 study assumed the distribution of mobilization times for the transport-dependent population to be the same as for the general residential population. The ETEs for the general population in Clinton are, therefore, considered representative (or conservative) for transport-dependent residents.

Section 5.4 and Figure 5.1, "Notification/Departure/Mobilization Time Distributions," of the 1993 ETE describe the assumptions used for the evacuation preparation times and departure distributions. The applicant did not provide or discuss distribution times for the transport-dependent population. The mobilization distribution for hospitals and nursing homes is considered to be the same as the distribution for the correctional facility. In RAI 13.3-20(d), the staff asked the applicant to provide a separate estimate of the time required to evacuate the transport-dependent population and information on the initiation/mobilization time distribution for transport-dependent population. The applicant responded to RAI 13.3-20(d) in its submission to the NRC dated January 24, 2005. In its submission, the applicant stated that the 1993 study assigned one vehicle per household for the entire residential population, including transport-dependent households. The 1993 study also assumed the distribution of mobilization times for the transport-dependent population to be the same as for the general residential population. The ETEs for the general population in Clinton are, therefore, considered representative (or conservative) for transport-dependent residents.

The NETVAC model is acceptable for analysis of traffic queue and identification of traffic delays. Figure 1.2 of the ETE indicates the traffic queue locations. In RAI 13.3-20(u), the staff asked the applicant to provide on-road travel and delay times, as well as the estimated number of cars evacuating, for each segment. The applicant responded to RAI 13.3-20(u) in its submission to the NRC dated January 24, 2005. In its submission, the applicant provided detailed listings of NETVAC output for two evacuation scenarios (winter day adverse weather and summer weekday fair weather) in Attachment C to the submittal. These listings indicate the queue length and flow ("departures") by time step for each link in the roadway network. The departures for exit nodes indicate the number of vehicles leaving the EPZ during each time step.

Figure 5.1 of the 1993 ETE presents the notification and mobilization time distributions. In RAI 13.3-20(v), the staff asked the applicant to provide the percentage of the population as a function of time, since the 1993 ETE does not include the additive reporting format for time estimates when probability distributions are used. The applicant responded to RAI 13.3-20(v) in its submission to the NRC dated January 24, 2005. In its submission, the applicant provided a graph displaying the number of vehicles evacuating as a function of time for the winter day adverse weather scenario as Figure C-1, "Predicted Rate of Vehicles Leaving the EPZ for Winter Day Adverse Weather," in Attachment C.

In RAI 13.3-16, the staff asked the applicant to provide a description of the method(s) used to confirm evacuation and the estimated time required for confirmation of evacuation. In response to RAI 13.3-16, the applicant stated that several methods are available for confirmation of evacuation. One method is random sample telephone surveys with success based on the number of positive responses (i.e., someone still at home) within the expected range. The time required for such confirmation is dependent on the number of persons available to attempt telephone contact and the number of homes to be sampled. These can be varied as desired, and, therefore, specific time estimates are not meaningful and have not been performed.

In RAI 13.3-14, the staff asked the applicant to provide the results of the review of the draft ETE study by State and local organizations. In response to RAI 13.3-14, the applicant stated that it conducted the 1993 ETE for the exclusive use of the State and local organizations in developing their respective emergency plans. The results of the review state that the draft ETE represents a reasonable and reliable approach to the guidance detailed in NUREG-0654/FEMA-REP-1. The results also state that, given the small population base within the EPZ (i.e., a 10-mile radius of CPS), the projected evacuation time frames are appropriate in most instances and acceptable from an emergency preparedness and planning standpoint. The applicant included each comment resulting in an adaptation of the ETE in the final version of the ETE.

Figures 2.2-1 and 2.3-1 of the EGC ESP Emergency Plan show evacuation routes.

Figure 2.2-1 of the EGC ESP Emergency Plan identifies three relocation centers, including the Illinois State University field house, Monticello High School, and Richland Community College.

Maps A, "Clinton Traffic and Access Control Map," and C, "Clinton Sheltering and Evacuation Map," in IPRA Volume I show evacuation routes, sheltering and evacuation areas, and relocation centers. The local plan described in IPRA Volume VIII contains maps indicating the evacuation/sheltering areas and relocation centers. In RAI 13.3-13(e), the staff asked the applicant to provide references to maps in the local emergency plans that show evacuation routes. In response to RAI 13.3-13(e), the applicant stated that maps A through E in Section 1E of IPRA Volume VIII show the identified routes. In addition, Section 2J of IPRA Volume VIII generally discusses evacuation.

Figure 2.3-2 of the EGC ESP Emergency Plan is a map showing population distribution around the site with the information presented in sector format.

Section 1A, "General Information, Site Information," of IPRA Volume VIII states, "the 2000 permanent population within five miles of the CPS is 1,480...a projected total of 11,300 persons living between five and ten miles...," resulting in a total of 12,780 for the entire EPZ. Figure 1, "Clinton Station EPZ 2000 Permanent Residential Population Figures," in Section 1A of IPRA Volume VIII lists the total population as 13,268. In addition, Section 3C, "Shelter Guide, EPZ Population," of IPRA Volume VIII lists the EPZ population by township, that also totals 13,268.

Section 5.2.1, "Onsite," of the EGC ESP Emergency Plan states that, when an emergency is declared, reclassified, or terminated, an announcement will be made over the plant PA system or by other means. If the EGC ESP facility is a dual unit, the unaffected unit control room will be notified of the emergency declaration or change. The CPS control room will also be notified of the emergency declaration or change. These notifications will include the declaration of the emergency classification and response actions that site personnel are to take. In RAI 13.3-6, the staff asked the applicant to discuss the means that it will use for notifying transient and resident population in the owner-controlled area. In response to RAI 13.3-6, the applicant stated that Section 5.2, "Notification and Mobilization of Emergency Response Personnel," of the EGC ESP Emergency Plan does not address the means that will be used to notify transient and resident population in the owner-controlled area because this section is intended to address notification of the ERO personnel. However, the plant PA system and the siren systems would also notify the non-ERO personnel in the owner-controlled area, including transient and resident populations. Sections 5.5.1 and 10.1 of the EGC ESP Emergency Plan also discuss the means that will be used to notify transient and resident population, including sirens (both station alarms/siren system) and the alert notification system (ANS) and the EAS (i.e., local radio stations).

Section 1G, "Overview, Notification of the Public," of IPRA Volume I outlines the system for notification of the public. The primary system is an outdoor warning system (sirens), that county officials activate. Public announcements made over mobile PA systems can supplement the sirens.

Section 2G(1)(b), "Clinton Power Station EPZ Siren Warning System," of IPRA Volume VIII states, "When appropriate, the DeWitt County/Clinton ESDA Coordinator will initiate the activation of the Clinton Power Station EPZ Siren Warning System." Section 2.1 references Annexes 2A through 2E and Chapter 3, "Sheltering Guide," for the notification of special facilities. Section 2P is the prescripted messages for mobile PA systems and local emergency information radio stations. Annexes 2A through 2F in IPRA Volume VIII are the checklist procedures for DeWitt County, the towns of Clinton, Weldon, and Wapella, DeWitt Village, and the support counties, respectively. The support counties do not have responsibility for notifying the EPZ population. The risk jurisdiction procedures specify the methods necessary for notifying special facilities. The DeWitt County sheriff's procedures call for mobile PA systems to be used if the sirens were to fail. The Clinton police department chief has a "mobile public address warning scripts" attachment to the procedures.

Section 2A of IPRA Volume VIII states that the notification of the public will be through the CPS EPZ prompt notification system and commercial radio. This prompt notification system consists of a siren warning system throughout the CPS EPZ.

Section 5C of IPRA Volume I describes the public education material distributed annually. The public information booklets are also used to identify persons who have special concerns (e.g., the mobility impaired) related to their ability to follow protective actions that may be recommended.

Attachment 1, "Department Assignments and Responsibilities," of Annex 2A in IPRA Volume VIII identifies the Health Department administrator as being responsible for notifying mobility-impaired individuals, assisting in the identification of nonambulatory patients, and determining the total number of patients that would require transportation. Attachment 5, "Clinton Power Station Special Facilities," of IPRA Volume VIII is a list of the agencies that are responsible for contacting the facilities. The list includes recreational areas, schools, industries, group homes for the developmentally disabled, medical facilities, day care centers, preschools, and motels.

Attachment 4, "Mobility Impaired Individuals Shelter-in-place, Evacuation and Return Instructions," of Annex 2B of IPRA Volume VIII is a town of Clinton checklist procedure for notifying mobility-impaired individuals if shelter-in-place has been recommended. The checklist also includes instructions for the evacuation and return of mobility-impaired individuals. The same attachment is included in Annex 2C, "Weldon Checklist Procedures," for the town of Weldon; Annex 2D, "Wapella Checklist Procedures," for the town of Wapella; and Annex 2E, "DeWitt Village Checklist Procedures," for DeWitt Village.

Section 3B, "Sheltering Guide, Protective Action Instructions," of IPRA Volume VIII is a set of instructions for the county jail, mobility-impaired population, population with special transportation requirements (both medical needs and transients), and school students.

Section 1E(4), "Overview, Basic Functions, Protective Actions," of IPRA Volume VIII states the following:

When conditions warrant, IDNS will recommend that all facilities within the 10-mile EPZ that are incapable of timely evacuation (e.g., hospitals and nursing homes) administer potassium iodide (KI) to all individuals in the facility. IDNS will also recommend at that time that emergency workers in the EPZ take KI.... Details of these steps are described in IDNS SOPs.

Section 2O(3), "DeWitt County, Radiological Considerations, Potassium Iodide," of IPRA Volume VIII states, "The recommendation to administer KI to emergency personnel and immobile populations, if warranted, will normally be furnished to the DeWitt County DCO [dosimetry control officer] by the IEMA Liaison for dissemination to affected departments and municipalities." Section 1D in IPRA Volume VIII discusses the response for State agencies that have district or regional offices in the Clinton area. Annexes 2A though 2F in IPRA Volume VIII detail the procedures for implementing the recommendation to administer KI.

Section 1E(4) of IPRA Volume I states, "If evacuation is recommended, the public will be advised to leave their homes and go to congregate care shelters located in host communities where they may remain until it is safe to return to their homes." Section 1E(4) also discusses the proposed means of relocating the public.

Sections 2J and 3B, Annexes 2A through 2F, Appendix C, "Clinton Power Station EPZ Evacuation Guide," and Maps A, "Clinton Traffic and Access Control Map," and C, "Clinton Sheltering and Evacuation Map," of IPRA Volume VIII address the proposed means of relocation. Buses, ambulances, and sheriff's department vehicles will be used for the mobility-impaired population.

Appendix D, "Registration Centers and Congregate Care Shelters," to IPRA Volume VIII lists the registration centers and congregate care shelters. Map C indicates the location of the centers, that are more than 20 miles from the site. Section 1C of IPRA Volume VIII gives general information about the congregate care shelters, while Section 1E, "General Information, Maps," lists the maps. Appendix C to IPRA Volume VIII is a list of the host communities for each subarea and the primary evacuation routes.

In RAI 13.3-13(f), the staff requested that the applicant describe the State and local governments' concepts for using the traffic capacities of evacuation routes for implementing protective measures. In response to RAI 13.3-13(f), the applicant stated that the 1993 ETE (that does take into account the traffic capacities of the evacuation routes) is considered in the planning process when establishing the boundaries of the subareas. For instance, during an actual emergency, Illinois Department of Transportation (IDOT) representatives are available in the SEOC and SFCP to provide up-to-the-minute information on road repairs and traffic congestion. In addition, Section 3A(11), "Agency Responsibilities, State Agencies, Transportation," of IPRA Volume I discusses IDOT's responsibilities. The County Highway Department performs a similar function.

Section 1E(4) of IPRA Volume I states, "traffic and access control procedures are utilized to control traffic for all shelter-in-place and evacuation situations and to control access into sheltered and evacuated areas." Section 3A(2), "Agency Responsibilities, State Agencies, Illinois Commerce Commission," of IPRA Volume I details the Illinois Commerce Commission's responsibilities. Section 3A(6), "Agency Responsibilities, State Agencies, Illinois Department of

Military Affairs," of IPRA Volume I details the Illinois Department of Military Affairs' responsibilities. Section 3A(7), "Agency Responsibilities, State Agencies, Illinois Department of Natural Resources," of IPRA Volume I details the Illinois Department of Natural Resources' (IDNR) responsibilities.

Section 1D of IPRA Volume VIII details the regional response of the State agencies, primarily in the assistance of access control. Annexes 2A through 2F in IPRA Volume VIII provide details of the assignment of traffic/access control to the sheriff's department and the checklists associated with their activities. Appendix B, "Traffic and Access Control Guide," to IPRA Volume VIII lists the control posts and guidance (i.e., which direction to direct the traffic or prevent the traffic from flowing). Map A shows all of the points in the EPZ.

Section 3A(6) of IPRA Volume I includes information for the Illinois Department of Military Affairs and information concerning the use of wreckers and crews that can clear highways of debris and vehicles. Section 3A(7) of IPRA Volume I includes information for the IDNR, as well as information on assisting the evacuation by accommodating evacuees who intend to camp out or live in recreation vehicles on IDNR lands. Section 3A(11) of IPRA Volume I includes information for the IDOT and information concerning the use of department resources to control access to Federal and State highways.

Section 1D of IPRA Volume VIII details the regional response of the State agencies, primarily in the assistance of traffic and access control. Attachment 1 to Annex 2A in IPRA Volume I assigns the highway engineer the responsibility to ensure evacuation routes are clear of snow, obstacles, and debris. Annexes 2B through 2F to IPRA Volume I contain similar assignments in each of the towns, that should be included in the ESP application references.

In RAI 13.3-13(g), the staff asked the applicant to describe the State and local organizations' concepts for using ETEs when considering the evacuation of various sectors and distances. In response to RAI 13.3-13(g), the applicant stated that IPRA does not directly address such concepts. However, Section 3A(11) of IPRA Volume I discusses the IDOT responsibilities, that include ensuring the expeditious and safe movement of traffic. The County Highway Department performs a similar function. In addition, the planning process considers the 1993 ETE when establishing the boundaries of the subareas. For instance, during an actual emergency, IDOT representatives will be available in the SEOC and SFCP to provide up-to-the-minute information on road repairs and traffic congestion.

Section 1E(4) of IPRA Volume I states the following:

> Protective actions include shelter-in-place, evacuation, traffic and access control, and food, water, and milk control. Protective Action Guides (PAGs) are projected personnel radiation dose values at which certain protective actions should be implemented.... Plume exposure pathway PAGs are taken from the "EPA Manual of Protective Action Guides and Protective Actions for Nuclear Incidents."

In RAI 13.3-13(h), the staff asked the applicant to describe the IDNS standard operating procedures (SOPs) relating to the basis for choosing a recommended protective action for the plume. In response to RAI 13.3-13(h), the applicant stated that Section 2J i of IPRA

Volume VIII provides this information. In addition, Section 1E(4) of IPRA Volume I discusses the basis for protective action recommendations.

Section 1E(5)(b), "Overview, Basic Functions, Parallel Actions, Radiation Exposure Control," of IPRA Volume I states the following:

> Evacuees arriving at designated monitoring and decontamination centers (generally co-located with primary congregate care facilities) will be monitored for radioactive contamination and decontaminated, as necessary. The monitoring and decontamination of evacuees, emergency workers and their vehicles will be conducted by personnel under IDNS supervision, utilizing portal and hand-held monitoring instruments and decontamination equipment provided by IDNS for that purpose. Medical treatment, if required for a contaminated individual, will be provided under the State's emergency medical services delivery system with monitoring and decontamination support provided by IDNS staff.

Section 3C(1), "Agency Responsibilities, Private Organizations, American Red Cross," of IPRA Volume I details the American Red Cross' responsibility to provide mass care services for the evacuees and emergency workers. Its services will be provided in accordance with its current policies and procedures (i.e., including a registration component).

Section 3A(8) of IPRA Volume I details the IDNS responsibilities, including the monitoring and decontamination of evacuees.

Section 2J, paragraph 3.f, of IPRA Volume VIII states, "the local chapter of the American Red Cross has the responsibility of registering all evacuees in congregate care shelters in the host areas. Standard record keeping methodology will be used in registering evacuees." Section 2J(4), "DeWitt County, Evacuation," paragraph 4, of IPRA Volume VIII states, "provisions will be made for monitoring and decontamination of evacuees at host area congregate care shelters."

13.3.3.11.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, IV.D, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of the emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for the major features of emergency plans, including those that apply to major feature J, "Protective Response."

Major feature J calls for the applicant to describe protective actions within the 10-mile EPZ for the public and emergency workers, including evacuation routes, transportation, and handling of evacuees. The application should identify guidance for the choice of protective actions, consistent with Federal guidance, as well as the bases and mechanisms for recommending protective actions to State and local authorities. The application should describe each organization's concept for implementing protective actions and describe contacts and arrangements with offsite agencies. In addition, the applicant should prepare an ETE for the 10-mile EPZ.

13.3.3.11.3 Technical Evaluation

The staff finds the clarifications provided by the applicant in response to RAIs 13.3-20(e), (k), (l), (n), (q), (s) to be acceptable. The staff finds that the additional information related to the 1993 ETE for Clinton provided by the applicant in response to RAIs 13-3-20(m), (o), (r), (t) is consistent with the guidance in Supplement 2 and is therefore acceptable. The staff finds the additional data and information provided by the applicant in response to RAIs 13.3-20(d), (e), (f), (g), (h), (u), (v), and RAIs 13.3-6, 13.3-8, 13.3-14, and 13.3-16 are also consistent with the guidance in Supplement 2 and are, therefore, acceptable.

The application adequately describes the evacuation routes and transportation for onsite individuals to suitable offsite locations, including alternatives for inclement weather, high traffic density, and specific radiological conditions.

The application describes a mechanism for recommending protective actions to the appropriate State and local authorities, in accordance with EPA 400. The applicant references RTM-96. However, the NRC developed this manual for use in providing licensee oversight in the event of an emergency. Therefore, the staff did not consider the applicant's reference to RTM-96 in its review.

The application contains a vicinity map showing the plant location, along with a detailed map of the plume exposure pathway EPZ. The map is legible and identifies transportation networks, topographical features, and political boundaries.

The application includes all assumptions used in the analysis, that are automobile occupancy factors, the method of determining roadway capacities, and the method of estimating populations.

The application describes the method of analyzing the evacuation times and the algorithm used and provides a source for obtaining further information or documentation. NETVAC is an adequate model for use in ETE development. The applicant provides input files that are consistent with the ETE statements on evacuation routing and traffic loading.

The number of permanent residents is estimated using the U.S. Census data and other reliable data, adjusted as necessary, for growth. These population data are translated into two subgroups, those using autos and those without autos. The number of vehicles used by permanent residents is estimated using an appropriate auto occupancy factor. Special attention is given to those households not having automobiles. The public transport-dependent population is considered as a special case.

Estimates of transient populations are developed using local data such as peak tourist volumes and employment data for large factories. This population segment, along with the permanent population subgroup using automobiles, constitutes the general population group for which an ETE is made.

An estimate for the special facility population group is done on an institution-by-institution basis. The means of transportation are described. Schools are also included in the special facility population segment.

Although the application does not provide all combinations of radial sectors and ring distances as specified in Appendix 4, "Evacuation Time Estimates within the Plume Exposure Pathway Emergency Planning Zone," to Revision 1 of NUREG-0654/FEMA-REP-1, there are sufficient data to be representative of the guidance. Operationally, the subareas, not radial sectors and rings, are used for protective action decisionmaking.

The application adequately describes the different combinations of areas (and zones) used in the ETEs, including the inner area (and inner zone). Hence, the ETE for the outer areas (zones) will include the simultaneous evacuation of the adjacent inner areas (zones).

The subareas described in the application, that require ETEs, encompass the entire area within the plume exposure EPZ. The boundaries of the subareas are based upon the same factors as the EPZ (i.e., demography, topography, land characteristics, access routes, and local jurisdictions). To the extent practical, the sector boundaries do not divide densely populated areas. Special facilities are also noted on these maps, to the extent that their locations can be geographically specified. Populations are provided by evacuation areas. Separate totals are provided for permanent residents, transient populations, and special facility population.

Tables 6.1, 6.2, 6.3, and 6.4 in the application provide ETE data following a keyhole approach with a simultaneous evacuation of the 2-mile radius and combinations of three sectors for each condition. This approach is adequate for determining ETEs.

The application provides a map showing only those roads used as primary evacuation routes. Each segment of the network is numbered for reference. The sector and quadrant boundaries are also indicated.

A table is provided indicating all the evacuation route segments and their characteristics, including capacity. The characteristics of a segment are given for the narrowest section (or bottleneck), if the roadway is not uniform in the number of lanes throughout the segment.

Each of the evacuation time components is presented in the application along with the total evacuation time. The analysis considered both normal and adverse conditions. The applicant identified the adverse frequency used in the 1993 ETE, and this condition is severe enough to define the sensitivity of the analysis to the selected events.

The application describes critical assumptions that underlie the time estimates (e.g., day versus night, workday versus weekend, peak transient versus off-peak transient, and evacuation on adjacent sectors versus nonevacuation). The relative significance of alternative assumptions is addressed, especially with regard to time-dependent traffic loading of the evacuation roadway network segments.

The application specifies the method of computing total evacuation time. The analysis uses distribution functions and provides estimates of the likelihood that each stage in the evacuation sequence will be accomplished in a given period of time. The applicant developed distribution functions for notification of the various categories of the evacuee population. There are separate distributions for auto-owning households, school populations, and transit-dependent populations.

On-road travel and delay times are calculated. An estimate of the time required to evacuate that segment of the nonauto-owning population, that is dependent upon public transport, is made in a similar manner to that used for the auto-owning population. This estimate includes consideration of special services that might be initiated to serve this population subgroup.

Estimates for special facilities are made with consideration for the means of mobilization of equipment and manpower to aid in evacuation. This includes the need for designated persons to delay their evacuation to shut down industrial facilities. Each special facility is treated on an individual basis. Weather conditions and time of day conditions are considered. Consideration is given to the impact of peak populations, including behavioral aspects.

The 1993 ETE summarizes the maximum times for each component and for each sector. The percentage of the population as a function of time is reported.

The time required for confirmation of evacuation is estimated. Specific recommendations for actions that could be taken to significantly improve evacuation time are given. A review of the draft ETE submittal by the principal (State and local) organizations involved in emergency response for the site was solicited, and comments resulting from the review were included in the final submittal.

The application includes, in the EGC ESP Emergency Plan and State and local plans, maps showing evacuation routes, evacuation areas, shelter areas, and relocation centers in host areas. The application includes maps identifying population distribution around the site by evacuation subareas and describes the means for notifying all segments of the transient and resident population.

State and local plans contain the following:

- a proposed means for protecting those persons whose mobility may be impaired

- a proposed means for the use of radioprotective drugs for emergency workers and institutionalized persons within the plume exposure EPZ whose immediate evacuation may be infeasible or very difficult

- a proposed means of relocation

- a potential relocation center in host areas that are at least 5 miles, and preferably 10 miles, beyond the boundaries of the plume exposure EPZ

- control and access to evacuated areas and organization responsibilities for such control

- an identification of, and means for, dealing with potential impediments to the use of evacuation routes and contingency measures

In Open Item 13.3-4, the staff requested that the applicant provide additional information related to the 1993 ETE, as requested in RAIs 13.3-20(k) through (v), was needed. In addition, the staff noted that the applicant had not adequately addressed the estimated time required for confirmation of evacuation (RAI 13.3-16).

In its submission to the NRC dated April 4, 2005, the applicant responded to Open Item 13.3-4. The applicant also stated that it had submitted a response to RAIs 13.3-20(k) through (v) to the NRC on January 24, 2005. The applicant estimated the time required to confirm evacuation based on visual confirmation by ground vehicles, a specific method included in NUREG-0654/FEMA-REP-1. The applicant then calculated the evacuation confirmation times as the time required for emergency vehicles to conduct a "windshield survey" of the evacuated subareas, road by road, at an average travel speed of 15 mph. U.S. Census TIGER (Topologically Integrated Geographic Encoding and Referencing system) files determine the miles of roadway in each subarea. Based on discussions with IEMA, the applicant assumed that confirmation of evacuation would be performed using 25 vehicles. (More than 100 traffic and access control points have been designated for the EPZ and subareas. As the evacuation nears completion, some of the resources dedicated to traffic management will be available to perform other duties, such as evacuation confirmation.) The table titled, "Estimated Confirmation Times for EGC ESP EPZ," in the 1993 ETE summarizes the miles of roadway in each protective action recommendation evacuation zone and the estimated times for evacuation confirmation (rounded to the nearest 5 minutes). Based on the additional information related to the 1993 ETE provided in the applicant's responses to RAIs 13.3-20(k) through (v) and the estimated time required for confirmation of evacuation, the staff considered Open Item 13.3-4 to be resolved.

In Open Item 13.3-5, the staff requested that the applicant provide additional information concerning the protective measures identified in State and local emergency plans, including a description of the State and local governments' approach to using the traffic capacities of evacuation routes for implementing protective measures, a description of the State and local organizations' approach to using ETEs when considering the evacuation of various sectors and distances, and a description of the IDNS SOPs that serve as the basis for choosing a recommended protective action for the plume exposure pathway, as requested in RAIs 13.3-13(e) through (h). The applicant provided acceptable responses to RAIs 13.3-13(e) through (h) as discussed above.

Another aspect of Open Item 13.3-5 involved the adequacy of the information provided by the applicant, in its response to RAI 13.3-14, related to the review of the draft ETE submitted by the State and local organizations involved in emergency response for the site. In its submission to the NRC dated April 4, 2005, the applicant responded to this aspect of Open Item 13.3-5. In its submission, the applicant stated that the highway traffic capacities identified in the ETE are considered a tool for developing the State and local plans and procedures, but they are not a critical consideration during protective action decisionmaking. The State bases its protective action recommendations to localities primarily on reactor conditions and predictive modeling, with the aim of implementing preemptive protective actions before any radioactive release occurs. Thus, the projected timeframe (i.e., the ETE) for a given scenario is of less concern than the actual environmental conditions that might exist at the time of the emergency. The emergency plans and public information materials predesignate evacuation routes taking into account the various scenarios for wind direction and subarea designations.

The applicant also stated that there are provisions for adjusting the evacuation routes during an actual emergency or an exercise. For example, IPRA, Volume VIII, Chapter 2, Section J, indicates that the specific evacuation routes are determined through coordination of the DeWitt County EOC and IEMA; local officials then arrange the traffic and access control posts as discussed in subsections J.3.b and J.3.d. Under actual (and exercise) emergency conditions, the State and localities adjust the available and desirable routes to the current circumstances, using traffic and access control points to divert evacuees to the appropriate routes so as to avoid traffic moving within and across the plume path and to avoid impediments. These techniques are demonstrated during FEMA-evaluated exercises. There are no specific directions or procedures for these techniques because the conditions under which the action would be taken are dictated by circumstances and the knowledge of the local officials of the road networks in their communities.

The original response to RAI 13.3-14 indicates that "each comment resulting in an adaptation of the ETE was appropriately included in the final version of the ETE." The applicant also stated that it intended this statement to reflect that it had provided the draft ETE to the State organizations involved in emergency response for the site for comment, that the State provided comments on the draft ETE, and that the applicant had appropriately incorporated these comments into the final ETE delivered to the State.

Based on the additional information related to protective measures in State and local emergency plans and the review of the draft ETE by local and State organizations involved in emergency response for the site in its response to RAI 13.3-14, the staff considers Open Item 13.3-5 to be resolved.

Volumes I and VIII of the IPRA describe the means for registering and monitoring evacuees at reception centers in host areas.

13.3.3.11.4 Conclusions

As discussed above, the applicant described a range of protective actions for the plume exposure pathway EPZ for both the public and emergency workers, including guidance for the choice of protective actions that are consistent with Federal guidance and protective actions for the ingestion exposure pathway EPZ. Based on its review, the staff concludes that the proposed major feature J is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, IV.D, and IV.E of Appendix E to10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for accident assessment, as set forth above. The applicant provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.12 Radiological Exposure Control (Major Feature K)

13.3.3.12.1 Technical Information in the Application

Section 11.1, "Emergency Exposure Guidance," of the EGC ESP Emergency Plan states that, in emergency situations, workers may receive exposure under a variety of circumstances to assure safety and protection of others and of valuable property. These exposures can be justified if the maximum risks or costs to others that are avoided by their actions outweigh the risks that the workers are subjected to. Table 11.1-1, "Emergency Exposure Guidance," of the EGC ESP Emergency Plan provides the emergency worker dose limits. The emergency director must authorize dose extensions beyond the limits imposed by 10 CFR Part 20, "Standards for Protection against Radiation." Section 11.2, "Emergency Radiation Protection Program," of the EGC ESP Emergency Plan describes guidance on dose limits during an emergency.

Section 11.1 of the EGC ESP Emergency Plan states that the station emergency director shall have the nondelegable responsibility for authorizing personnel exposure levels under emergency conditions in accordance with the EPA emergency worker and lifesaving protective action guides (PAGs). Whenever possible, the concurrence of the radiation protection manager (RPM) should be secured before individuals are exposed to dose equivalents beyond the EPA 400 lower limit. Section 11.2 of the EGC ESP Emergency Plan describes an onsite radiation protection program to be implemented during an emergency.

Section 11.2.1, "Personnel Monitoring," of the EGC ESP Emergency Plan describes the use of thermoluminescent dosimetry (TLD) and personnel self-reading dosimeters capable of measuring expected exposures to monitor emergency workers. The capability exists to process TLDs 24 hours per day in emergencies, if necessary.

Section 1E(5)(b) of IPRA Volume I states that IDNS is responsible for all aspects of radiation exposure control. The RAFT exposure control officer (ECO) is responsible for protecting emergency workers from excessive exposure to ionizing radiation. The ECO is also responsible for maintaining a full legal record of exposure. Detailed monitoring of emergency workers is accomplished through the use of dosimetry, bioassay, and whole body counting, as warranted. The ECO will issue dosimetry and instructions for use to emergency workers. At the end of each day's assignment, State emergency workers will turn in their dosimetry to their ECO for processing.

Sections 2O(1), "DeWitt County, Radiological Considerations, Dosimetry Control," and 1D and Annexes 2A through 2F of IPRA Volume VIII state that the local dosimetry control officer (DCO) issues a direct-read dosimeter, a TLD, a bottle of KI, and instructions for use of dosimetry and

KI to all emergency workers. Workers are instructed to read their dosimeters every 30 minutes, unless otherwise directed. Emergency workers record their exposure on a radiation exposure record. Emergency workers are instructed to report an exposure of 3 roentgen R) to their responsible DCO. The DCO will contact the IEMA liaison at the DeWitt County EOC for exposure control guidance. Section 1E(4) of IPRA Volume I states that the 3-R reporting limit may be adjusted downward if conditions warrant, based on actual or projected doses under emergency conditions.

Annexes 2A through 2F in IPRA Volume VIII require that, as instructed or at the end of their assigned mission, emergency workers turn in their dosimetry and exposure control logs to the DCO. Section 2O(1) of IRPA Volume VIII states that TLDs and radiation exposure records should be returned to IEMA for processing.

In addition, the RPMs (as appropriate) will maintain emergency worker dose records in accordance with future emergency and radiological protection procedures. Emergency workers will be instructed to read their dosimeters frequently, and TLDs may be processed with increased periodicity.

Section 1E(5)(b) of IPRA Volume I states that the monitoring of the State of Illinois emergency workers is accomplished through the use of dosimetry, bioassay, and whole-body counting, as warranted. Section 3A(8) of IPRA Volume I states that, to perform tasks associated with the radiological response to a nuclear accident, IDNS maintains a comprehensive inventory of appropriate equipment, and that all emergency response equipment and instruments are inspected, inventoried, and operationally checked once each quarter. In RAI 13.3-13(i), the staff asked the applicant to describe how the State will acquire and distribute dosimeters, both direct-reading and permanent record devices. In response to RAI 13.3-13(i), the applicant stated that Sections 2H and 2O(1) in IPRA Volume VIII describe how the State will acquire and distribute dosimeters. In addition, Section 3A of IPRA Volume I provides information regarding dosimetry for State agency personnel who have field assignments, such as Illinois State police (ISP), IDNR, and IDOT. Section 1D of IPRA Volume VIII also discusses dosimetry for the ISP, IDNR, and IDOT districts and regions specific to the CPS.

Section 2O(1) of IPRA Volume VIII states that IEMA distributes dosimetry equipment and forms to DCOs and then receives the TLDs and radiation exposure records after use.

Sections 1E(4) and 3A(8) of IPRA Volume I state that IDNS is responsible for all aspects of radiation exposure control. The RAFT ECO is responsible for protecting emergency workers from excessive exposure to ionizing radiation. IDNS has adopted the exposure limits for emergency workers found in EPA 400 (identified in the following table). Section 2O(2), "DeWitt County, Radiation Exposure Control," of IPRA Volume VIII states that the following exposure limits are observed for all emergency workers within the State of Illinois:

13.3-1 State of Illinois Dose Limits for Emergency Workers

Dose Limit (Rem)	Dose Limit Approved for:
5	All activities
10	Protection of valuable property
25	Lifesaving or protection of large populations
>25	Lifesaving or protection of large populations, only on a voluntary basis to persons fully aware of the risks involved

In addition, for emergency worker exposure control purposes, IEMA has established a 3-R notification limit. If an emergency worker's exposure approaches 3 R, he or she must report to his or her DCO or ECO. The DCO/ECO will expeditiously notify IEMA, that will provide further instructions in accordance with SOPs.

Section 11.2.3, "Contamination and Decontamination," of the EGC ESP Emergency Plan states that, during emergency conditions, normal plant contamination control criteria will be adhered to as much as possible. However, these limits may be modified by the applicable RPM in accordance with existing radiological protection procedures, should conditions warrant.

Section 1E(5)(b) and Section 2O(4), "DeWitt County, Decontamination," of IPRA Volume VIII state that evacuees and emergency workers will be monitored for radioactive contamination and, if necessary, decontaminated at designated congregate care facilities. Section 3A(8) states that RAFT monitoring and decontamination teams are responsible for directing decontamination activities and for the radiation monitoring of emergency personnel, vehicles, and equipment. They will ensure that procedures are followed to avoid the unwarranted spread of radioactive contamination and will coordinate with other agencies, as necessary.

Section 1E(5)(b) of IPRA Volume 1 states that monitoring will be performed utilizing portal and hand-held monitoring instruments. The IDNS provides decontamination equipment. In RAI 13.3-13(j), the staff asked the applicant to describe the State and local organization-specific action levels for determining the need for decontamination of emergency workers, equipment and vehicles, and the general public and their possessions. In response to RAI 13.3-13(j), the applicant stated that Section 2O(4) of IPRA Volume VIII provides such a description. Section 1E(4) of IPRA Volume I also provides a general statement about decontamination.

Section 11.2.5, "Decontamination of Relocated Personnel," of the EGC ESP Emergency Plan states that nonessential onsite personnel may be evacuated to an offsite relocation center or assembly area. Radiological control personnel at that location will monitor evacuees and determine the need for decontamination. Existing and temporary facilities to limit contamination and exposure will be utilized and established at the site as necessary during an emergency situation. In the event that decontamination of evacuees is not possible locally, personnel will be sent to designated locations for monitoring and decontamination. Provisions for extra clothing will be made, and suitable decontaminates will be available for the expected type of contamination, particularly with regard to skin contamination.

Section 11.2.3.1, "Contamination Control Means," of the EGC ESP Emergency Plan states that personnel found contaminated will normally be attended to at decontamination areas located on site. Temporary decontamination areas can also be set up inside at various locations. Decontamination showers and supplies will be provided on site with additional personnel decontamination equipment and capabilities. Shower and sink drains in the controlled area will be routed to the miscellaneous waste processing system, where the liquid will be processed and monitored before discharge. Potentially contaminated emergency vehicles will be surveyed before they are allowed to leave the EGC ESP facility or offsite assembly area. If the survey area is not suitable for monitoring and decontamination because of radiological or other concerns, vehicles will be surveyed at an alternate location. Section 11.2.4 of the EGC ESP Emergency Plan, "Contamination Control Measures," also states that, if personnel leaving contaminated areas are found contaminated above acceptable levels, they will be decontaminated in accordance with future EGC ESP facility procedures. If normal decontamination procedures do not reduce personnel contamination to acceptable levels, the case will be referred to a competent medical authority.

Supplies, instruments, and equipment that are in contaminated areas or have been brought into contaminated areas will be monitored before removal. If found contaminated, they will be decontaminated using normal EGC ESP facility decontamination techniques or they may be disposed of as radioactive waste.

Sections 11.2.3.1 and 11.2.4 of the EGC ESP Emergency Plan discuss the means for decontaminating personnel, vehicles, supplies, instruments, and equipment. In RAI 13.3-9, the staff asked the applicant to describe the means for decontaminating personnel wounds. In response to RAI 13.3-9, the applicant stated that the means for decontaminating personnel wounds will be wound specific and determined on a case-by-case basis. Life-threatening wounds will be decontaminated at the John Warner Hospital's "hot" emergency room by trained medical personnel with the support of station radiological control personnel. Nonlife-threatening wounds will be decontaminated by radiological control personnel, with the assistance of emergency response personnel (e.g., emergency medical technicians or ambulance personnel, using procedures for decontamination of personnel with skin or clothing contamination.

In RAI 13.3-13(k), the staff asked the applicant to describe the State and local organizations' means for radiological decontamination of emergency personnel wounds, supplies, instruments, and equipment. In response to RAI 13.3-13(k), the applicant stated that Section 2O(4) of IPRA Volume VIII describes the State and local organizations' means for radiological decontamination of emergency personnel wounds, supplies, instruments, and equipment. This section of IPRA also states that such personnel will be transported to a health facility. Section 1E(4) of IPRA Volume I also provides a general statement about decontamination.

13.3.3.12.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50.

The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for the major features of emergency plans, including those that apply to major feature K, "Radiological Exposure Control."

Major feature K calls for the applicant to describe an onsite radiation protection program and the means for determining and controlling radiological exposures to emergency workers and volunteers (on site and off site), including a decision chain for authorizing exposures in excess of EPA dose limits. The application should also describe specific action levels and the means for radiological decontamination of personnel (including wounds), vehicles, equipment, supplies, and possessions.

13.3.3.12.3 Technical Evaluation

The staff finds the applicant provided sufficient information regarding decontaminating wounds, supplies, instruments, and equipment in response to RAIs 13.3-9 and 13.3-13(k) and is, therefore, acceptable.

In the EGC ESP Emergency Plan, the applicant adequately described guidance for dose limits appropriate to removing injured persons, undertaking corrective actions, performing assessment actions, performing field radiological measurements in the plume EPZ, providing first aid, performing personnel decontamination, providing ambulance service, and providing medical treatment services.

In the EGC ESP Emergency Plan, the applicant described an onsite radiation protection program to be implemented during emergencies, including methods to implement dose limits. The applicant used the general guidance on dose limits for workers performing emergency services found in EPA 400.

The EGC ESP Emergency Plan and IPRA Volumes I and VIII describe how each organization will determine the doses received by emergency personnel involved in any nuclear accident, including volunteers.

The EGC ESP Emergency Plan and the State and local plans describe a decision chain for each organization for authorizing emergency workers to incur exposures in excess of the EPA dose limits for workers performing emergency services.

The EGC ESP Emergency Plan describes how the applicant will acquire and distribute dosimeters, both direct-reading and permanent record devices.

However, the staff identified in Open Item 13.3-6 that the applicant's responses to RAIs 13.3-13(i) through (k) did not provide additional information about how the State will acquire and distribute dosimeters, both direct-reading and permanent record devices. The applicant also did not provide additional information related to the State and local organization-specific action levels for determining the need for decontamination of emergency workers, equipment and vehicles, and the general public and their possessions. Further, the applicant did not describe local and State organizations' means for radiological decontamination of emergency personnel wounds, supplies, instruments, and equipment. In its submission to the NRC dated April 26, 2005, the applicant responded to Open Item 13.3-6. The applicant stated that the State (IEMA) maintains a statewide inventory of approximately 9000 direct-read dosimeters and approximately 9000 TLDs (for permanent record). Over 90 percent of this inventory is prepositioned (predistributed) with the response organizations identified in the plan for distribution to emergency workers when an emergency is declared. For example, dosimetry control actions for various groups are described under the "Parallel Actions" discussions in IPRA, Volume VIII, Sections D.1, D.2, D.3, D.4, D.5, and O.1. Included with the dosimetry is an individual 14-d supply of KI. The dosimetry is field tested and calibrated in accordance with FEMA guidance and replaced when necessary. IEMA has the capability to read the TLDs in the field and in-house for an initial dose determination, and has established a contract with the supplier to read the devices for a certified record.

The contamination "action level" is defined in IEMA procedures as "twice-background." The State reserves the right to make case-by-case determinations on whether equipment, vehicles, and personal possessions can be released with contamination levels above the twice-background threshold (e.g., critical emergency equipment, fixed contamination).

The means for radiological decontamination are also embodied in IEMA's operational procedures and are part of the process associated with monitoring evacuees and emergency workers. Evacuees are directed to reception centers where monitoring occurs either by or under the supervision of trained IEMA staff. These dedicated facilities have decontamination showers and designated areas outside for the decontamination of vehicles and other equipment. These same facilities will be available for use by emergency workers. (Note: The radiological accident field teams' personnel dispatched to take plume measurements and collect environmental samples return to their independent operations center for monitoring and, if necessary, decontamination.)

The reference to "wounds" in the staff's question relates to the availability of medical services. The standing procedures provide that anyone (evacuee or emergency worker) injured and potentially contaminated will be directed to a designed hospital for treatment and their wounds handled in accordance with accepted contamination control protocols. If the patient originates at a reception center, IEMA will provide monitoring personnel to accompany the individual to the treatment facility. In any instance that a patient self-presents and the hospital is concerned about contamination issues, hospital staff can request assistance from IEMA.

The Department of Nuclear Safety Standard Operating Procedures 4-SOP-29 and 4-SOP-30 provide IEMA functional instructions for establishing and operating an evacuee and emergency worker monitoring and decontamination center and for dealing with potentially contaminated vehicles and other equipment.

Based upon the additional information provided in the applicant's responses to RAIs 13.3-13(i) through (k), that are related to how the State will acquire and distribute dosimeters (both direct-reading and permanent record devices); the State and local organization-specific action levels for determining the need for decontamination of emergency workers, equipment and vehicles, and the general public and their possessions, as well as State and local organizations' means for radiological decontamination of emergency personnel wounds, supplies, instruments, and equipment, the staff considers Open Item 13.3-6 to be resolved.

13.3.3.12.4 Conclusions

As discussed above, the applicant described the means for controlling radiological exposures to emergency workers in an emergency. Based on its review, the staff concludes that the proposed major feature K is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, and IV.E of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for radiological exposure control, as set forth above. The applicant provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.13 Medical and Public Health Support (Major Feature L)

13.3.3.13.1 Technical Information in the Application

Section 12.1 of the EGC ESP Emergency Plan states that arrangements, confirmed by letter of agreement every two or more calendar years, will also be maintained by the corporate office of a qualified major medical facility that is well equipped and staffed for dealing with persons having radiation injuries. John Warner Hospital in Clinton, Illinois, will be the primary supporting medical facility for injured persons who are contaminated with radioactivity. Whenever necessary, such persons will be transferred to this major hospital facility for extended specialized treatment. Section 12.1 also states that the applicant will have medical consultants available to the hospital staff who will provide the direction of the special care necessary for the treatment of persons having radiation injuries, as described in Section 3.4.5 of the EGC ESP Emergency Plan.

Section 12.3, "Medical Services Facilities," of the EGC ESP Emergency Plan states that, since radiation injuries involve specialized diagnosis and treatment, EGC corporate emergency preparedness personnel maintain an agreement with the REAC/TS. Section 3.4.5 of the EGC ESP Emergency Plan provides additional information related to REAC/TS. REAC/TS is a radiological emergency response team of physicians, nurses, health physicists, and necessary support personnel on 24-hour call to provide consultative or direct medical or radiological assistance at the REAC/TS facility or at the accident site. Specifically, the team has expertise in and is equipped to conduct medical and radiological triage; decontamination procedures and therapies for external contamination and internally deposited radionuclides, including chelation therapy; diagnostic and prognostic assessments of radiation-induced injuries; and radiation dose estimates by methods that include cytogenetic analysis, bioassay, and in vivo counting.

Sections 1H, "Overview, Medical Services," and 1E(5)(e), "Basic Functions, Parallel Actions, Emergency Medical Services," of IPRA Volume I explain that hospitals statewide are provided with a telephone number, maintained on a 24-hour basis by IDNS, that medical personnel can use to obtain advice or technical assistance. In accordance with the Illinois Emergency Medical Services Act, an individual who may be contaminated as a result of a reactor accident will be transported to an assigned medical treatment facility.

Section 2A of IPRA Volume VIII states that IEMA and IDNS maintain a listing of hospitals with specific capabilities to treat radiologically contaminated and injured individuals. The IDNS maintains a listing of all medical facilities within the State with capabilities related to the evaluation of radioactive exposure and uptake, including those hospitals under contract to the nuclear utilities for the treatment of onsite injured and exposed or contaminated personnel.

13.3.3.13.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.C, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those that apply to major feature L, "Medical and Public Health Support."

Major feature L calls for the applicant to describe contacts and arrangements made for medical services for contaminated, injured individuals, as well as to develop lists indicating the locations and capabilities of emergency medical services facilities.

13.3.3.13.3 Technical Evaluation

In the EGC ESP Emergency Plan and State and local plans, the applicant described the contacts and arrangements made for local and backup hospital and medical services having the capability to evaluate radiation exposure and uptake.

The State plan notes that lists exist to indicate the location of public, private, and military hospitals and other emergency medical services facilities within the State, or contiguous States, that are considered capable of providing medical support for any contaminated, injured individual. The listing includes the name, location, type of facility and capacity, and any special radiological capabilities. Contacts and arrangements made in developing these lists are described.

13.3.3.13.4 Conclusions

As discussed above, the applicant described the contacts and arrangements for medical services for contaminated, injured individuals, including local and backup hospital and medical services having the capability for evaluating radiation exposure and uptake. Based on its review, the staff concludes that the proposed major feature L is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.C, and IV.E of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for medical and public health support, as set forth above. The applicant provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.14 Radiological Emergency Response Training (Major Feature O)

13.3.3.14.1 Technical Information in the Application

Section 15.1, "Assurance of Training," of the EGC ESP Emergency Plan states that the emergency plan training program will assure the training, qualification, and requalification of individuals who may be called upon for assistance during an emergency. In addition, lesson plans and study guides will describe specific emergency response task training, prepared for each emergency plan position. The ERO training program will contain the lesson plans, study guides, and written tests. Responsibilities for implementing the training program will be contained in the EGC ESP facility procedures. Section 15.5, "General, Initial, and Annual Training Program Maintenance," of the EGC ESP Emergency Plan describes the responsibilities for the training and retraining of the ERO personnel, as well as their initial qualification and requalification. Section 15.1 outlines the training to be provided to support organizations that may be called upon to provide assistance in the event of an emergency. Section 15.4, "Emergency Response Organization Training Program," of the EGC ESP Emergency Plan states that the applicant's ERO personnel who will be responsible for implementing this plan will receive specialized training. Section 15.2, "Functional Training of the Emergency Response Organization," of the EGC ESP Emergency Plan states that, in addition to general and specialized classroom training, members of the applicant's ERO will receive periodic performance-based emergency response training.

Section 15.4.1, "Directors, Managers, and Coordinators within the Facility and Corporate Emergency Response Organization," of the EGC ESP Emergency Plan describes the specialized internal training that will be provided for directors, managers, and coordinators within the facility and corporate ERO.

Section 6B, "Preparedness Functions," of IPRA Volume I and Section 2L, "DeWitt County Training," of IPRA Volume VIII explain that all State and local emergency personnel receive annual initial and refresher training provided jointly by IEMA and IDNS. The training is comprehensive and covers the operational and technical aspects of IPRA, basics of radiological response, and the specific duties that each organization and individual are responsible for. The training program includes command and coordination, protective actions, and parallel actions.

Section 15.4.2, "Personnel Responsible for Accident Assessment," of the EGC ESP Emergency Plan describes the specialized internal training that will be provided for personnel responsible for accident assessment.

Section 6B of IPRA Volume I and Section 2L of IPRA Volume VIII explain that, at the State level, IDNS performs accident assessments and is responsible for conducting a confirmatory, independent assessment of the accident. State accident assessment personnel work out of the IDNS Radiological Emergency Assessment Center located in Springfield, Illinois. Annual initial and refresher training to all staff is provided on basic radiation principles, detection, and the IPRA concept of operations.

Section 15.4.3, "Radiological Monitoring Teams and Radiological Analysis Personnel," of the EGC ESP Emergency Plan describes the specialized internal training that will be provided for radiological monitoring teams and radiological analysis personnel.

Section 6B of IPRA Volume I and Section 2L of IPRA Volume VIII state that the RAFT performs the field radiological functions of confirmatory accident assessment, monitoring, and decontamination. Upon request, ISP District 6 and 8 will monitor for possible radioactive release during an incident at CPS before the arrival of the RAFT. In a joint effort, IEMA and IDNS provide annual initial and refresher training to all State and local personnel.

Section 15.4.4, "Police, Security, and Fire Fighting Personnel," of the EGC ESP Emergency Plan describes the specialized internal training that will be provided for security and firefighting personnel. Section 15.4.4.1, "Local Police and Fire Fighting Personnel," of the EGC ESP Emergency Plan states that local police and fire departments will be invited to receive training, as outlined in Section 15.1.

Section 6B of IPRA Volume I and Section 2L of IPRA Volume VIII state that all State, local police, security, and firefighting personnel receive the Annual Emergency Response Training Program provided by IEMA. The training focuses on the operational aspects of the plan and addresses the unique radiological emergency response skills that workers would not normally acquire as part of their usual job. The training also addresses subjects of a technical nature such as KI, contamination/decontamination, and a hands-on practical application phase covering the operation and maintenance of dosimetry equipment.

Section 15.3, "First Aid Response," of the EGC ESP Emergency Plan describes the specialized internal training that will be provided for first aid and rescue personnel.

Section 6B of IPRA Volume I and Section 2L of IPRA Volume VIII state that all first aid and rescue team personnel receive the Annual Emergency Response Training Program provided by IEMA. The training focuses on the operational aspects of the plan and addresses the unique radiological emergency response skills that workers would not normally acquire as part of their usual job. The training also addresses subjects of a technical nature such as KI, contamination/decontamination, and a hands-on practical application phase covering operation and maintenance of dosimetry equipment.

Section 15.4.7, "Local Support Service Personnel," of the EGC ESP Emergency Plan states that local support service personnel providing assistance during an emergency will be invited to receive the training, as outlined in Section 15.1 of the EGC ESP Emergency Plan.

Section 6B of IPRA Volume I and Section 2L in IPRA Volume VIII state that all local support services personnel receive the Annual Emergency Response Training Program provided by IEMA. The training focuses on the operational aspects of the plan and addresses the unique radiological emergency response skills that workers would not normally acquire as part of their usual job. The training also addresses subjects of a technical nature such as KI, contamination/decontamination, and a hands-on practical application phase covering operation and maintenance of dosimetry equipment.

Section 15.4.8, "Medical Support Personnel," of the EGC ESP Emergency Plan states that onsite medical service personnel will receive specialized training in the handling of contaminated victims and hospital interface. In addition, offsite ambulance and hospital personnel will be offered annual training in accordance with the program described in Section 15.1 of the EGC ESP Emergency Plan.

Section 6B of IPRA Volume I and Section 2L of IPRA Volume VIII state that, in accordance with the guidance of Revision 1 of NUREG-0654/FEMA-REP-1, IDNS maintains a listing of all medical facilities within the State with capabilities related to the evaluation of radioactive exposure and uptake, including those hospitals under contract to the nuclear utilities for the evaluation and treatment of onsite injured and exposed or contaminated personnel. The IDNS provides a guide for handling, transporting, evaluating, and treating patients accidentally exposed to radiation or contaminated with radioactive materials. Offsite ambulance and hospital personnel will be offered annual training based on this guidance.

Section 15.4.10, "Communication Personnel," of the EGC ESP Emergency Plan describes the specialized internal training that will be provided for communications personnel.

Section 6B of IPRA Volume I and Section 2L of IPRA Volume VIII state that, at the State and county level, public information personnel receive the Annual Emergency Response Training Program provided by IEMA. The training covers all operational and technical aspects of IPRA. State and county plans do not include the major features of specific training for personnel responsible for disseminating emergency information. Information is also provided annually to the media in the vicinity of the powerplant.

13.3.3.14.2 Regulatory Evaluation

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50. The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, and IV.F of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for a ESP may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those that apply to major feature O, "Radiological Emergency Response Training."

Major feature O calls for the applicant to describe a radiological emergency response training program for personnel who would implement the radiological emergency response plans.

13.3.3.14.3 Technical Evaluation

The EGC ESP Emergency Plan and IPRA Volumes I and VIII adequately describe a training program for instructing and qualifying personnel who will implement radiological emergency response plans. Specialized initial training and periodic retraining is provided for the following categories of personnel:

- directors or coordinators of the response organizations
- personnel responsible for accident assessment
- radiological monitoring teams and radiological analysis personnel
- police, security, and firefighting personnel
- first aid and rescue personnel
- local support services personnel, including civil defense/emergency services personnel
- medical support personnel
- personnel responsible for transmission of emergency information and instructions

13.3.3.14.4 Conclusions

As discussed above, the applicant described a radiological emergency response training program for those who may be called on to assist in an emergency, including a training program for instructing and qualifying personnel who would implement the radiological emergency response plans. In addition, the applicant described specialized initial training and periodic retraining. Based on its review, the staff concludes that the proposed major feature O is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, and IV.F of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for radiological emergency response training, as set forth above. The applicant provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

13.3.3.15 Responsibility for the Planning Effort: Development, Periodic Review, and Distribution of Emergency Plans (Major Feature P)

13.3.3.15.1 Technical Information in the Application

Section 16.1, "Emergency Preparedness Staff Training" of the EGC ESP Emergency Plan describes the training of each member of the emergency preparedness staff as involving at least one of the following activities at least once a calendar year:

- training courses specific or related to emergency preparedness
- observation of, or participation in, drills and/or exercises at other facilities
- participation in industry review and evaluation programs
- participation in regional or national emergency preparedness seminars, committees, workshops, or forums
- specific training courses in related areas, such as systems, equipment, operations, radiological protection, or problem identification and resolution

Section 6B of IPRA Volume I and Section 2L of IPRA Volume VIII state that State and county personnel responsible for the IPRA planning functions receive annual initial and refresher training provided jointly by IEMA and IDNS. This comprehensive training covers the operational and technical aspects of IPRA, the basics of radiological response, and the specific duties that each organization and individual are responsible for.

Section 16.2, "Authority for the Emergency Preparedness Effort," of the EGC ESP Emergency Plan states that the applicant's officers will be responsible for the safe and reliable operation of the EGC ESP facility. The issuance and control of this plan and the activities associated with emergency preparedness at EGC will be the overall responsibility of the Vice President of Licensing and Regulatory Affairs. In RAI 13.3-10, the staff asked the applicant to identify by title the individual who will have overall authority and responsibility for radiological emergency response planning. In addition, the staff asked the applicant to identify an emergency planning coordinator with responsibility for developing and updating of emergency plans and for coordinating these plans with other response organizations.

In response to RAI 13.3-10, the applicant stated that the Vice President of Licensing and Regulatory Affairs will have overall authority and responsibility for radiological response planning, as indicated in Section 16.2 of the EGC ESP Emergency Plan. However, Section 16.3, "Responsibility for Development and Maintenance of the Plan," identifies the emergency planning coordinator as the emergency preparedness manager, who has certain authority and responsibilities, as discussed in Section 16.3.1.1, "Program Administration," of the EGC ESP Emergency Plan. Section 16.3.1.1 states that the MWROG emergency preparedness manager is responsible for developing and maintaining the emergency plan.

Section 6C, "Preparedness Functions, Plan Maintenance and Updating," of IPRA Volume I indicates that IEMA and IDNS are responsible for overseeing the updating of the IPRA, including the plans, SOPs, and training modules. In RAI 13.3-13(l), the staff requested the title of the individual(s) at the State level with the overall authority and responsibility for radiological emergency response planning. In response to RAI 13.3-13(l), the applicant stated that, ultimately, the Governor has the overall authority and responsibility. However, within IEMA, Section 3A(3) of IPRA Volume I provides the requested information and identifies that IEMA is responsible for emergency planning, and the director of IEMA is responsible for the direction and control of IEMA operations.

Section 2N, "DeWitt County, Emergency Plan Maintenance," of IPRA Volume VIII states that DeWitt County defers responsibility for maintenance and updating IPRA to IEMA. The DeWitt County/Clinton ESDA coordinator is responsible for coordinating the planning, updating, and maintenance of the DeWitt County section of IRPA Volume VIII. Furthermore, each agency head is responsible for updating its agency's sections.

Section 16.3 of the EGC ESP Emergency Plan states that the MWROG emergency preparedness manager will be responsible for the overall Radiological Emergency Preparedness Program associated with the EGC ESP site. Section 16.3.1.1 of the EGC ESP Emergency Plan states that the emergency preparedness manager is responsible for developing and maintaining the emergency plan, developing and maintaining 10 CFR 50.54(q) evaluations of changes to emergency planning documents, and ensuring integration of plans between the applicant and offsite agencies.

In RAI 13.3-13(m), the staff requested the title of the individual(s) at the State level who is designated as the emergency planning coordinator with responsibility for developing and updating emergency plans and coordinating these plans with other response organizations. In response to RAI 13.3-13(m), the applicant stated that, although no title is provided in Section 6C of IPRA Volume I, this section identifies that IEMA and IDNS are responsible for these activities. Appropriate IEMA and IDNS documents (e.g., procedures and position descriptions) provide the specific titles. The respective directors of IEMA and IDNS are the positions with the identified responsibility.

Section 2N of IPRA Volume VIII states that, in DeWitt County, the Dewitt County/Clinton ESDA coordinator is assigned this responsibility.

Section 16.4, "Emergency Plan and Agreement Revisions," of the EGC ESP Emergency Plan states that the Exelon Nuclear Standardized Radiological Emergency Plan and supporting agreements will be reviewed on an annual basis. The annual plan review/update will include required changes identified during audits, assessments, training, drills, and exercises. The MWROG emergency preparedness manager will be responsible for determining which recommended changes are incorporated into a plan or emergency procedure revision. In those years when the review does not warrant a revision, a letter to that effect will be issued. In RAI 13.3-11, the staff requested that the applicant submit a description of the process for updating the agreements that support the Exelon Nuclear Standardized Radiological Emergency Plan. In response to RAI 13.3-11, the applicant stated that agreements supporting the Exelon Nuclear Standardized Radiological Emergency Plan are reviewed on an annual basis, as identified in the first sentence of Section 16.4 of the EGC ESP Emergency Plan (i.e., the phrase "and supporting agreements" is included specifically to identify that annual reviews are also applicable to the agreements). As indicated in the second sentence, this review includes updating as necessary. The process for updating an agreement is the same as the process for obtaining the original agreement.

Section 6C of IPRA Volume I states that, at the State level, IEMA ensures that each State agency reviews its portion of the plan annually, and any changes deemed necessary by lessons learned during the drills and exercises and from actual emergency response, as well as those resulting from agency reorganization, address, and telephone changes, will be made during the IPRA update process. The IEMA is also responsible for ensuring that the same requirement is met at the local level.

Section 2N of IPRA Volume VIII states that changes at the local level are reported to the DeWitt County ESDA coordinator, who keeps a record of changes and forwards them to IEMA.

Section 16.5, "Emergency Plan Distribution," of the EGC ESP Emergency Plan states that the emergency plan for the EGC ESP facility will not be distributed for implementation. The final emergency plan and future EGC ESP facility implementing procedures will be distributed on a controlled basis, before initial fuel loading, to the ERFs, selected Federal, State, and local agencies, and other appropriate locations. Controlled document holders will be issued revision changes upon approval. Procedures that control the revision of the emergency plan will require the use of revision bars and individual page identifications (i.e., section of plan and revision number).

Sections 6C of IPRA Volume I and Section 2N of IPRA Volume VIII state that all State, local, and private organizations, upon review and update of their sections of the plan, are required to forward to IEMA either a statement saying that no changes are necessary or a copy of their portions with all revisions clearly marked and dated.

The table of contents for the EGC ESP Emergency Plan is provided on pages iii–xi. Appendix B, "Requirements Matrix," to the EGC ESP Emergency Plan contains a cross-reference of the planning standards and evaluation criteria in Supplement 2. In RAI 13.3-19, the staff asked the applicant to provide an updated version of Table B-1, "Requirements Matrix," of Appendix B to the EGC ESP Emergency Plan. In response to RAI 13.3-19, the applicant stated that it updated Table B-1 of Appendix B to the EGC ESP Emergency Plan to include the revisions that the NRC identified in this RAI.

There are tables of contents at the beginning of each section for the State and local plans. The State and local plans also contain a "Planning Standards and Evaluation Criteria Correlation Document," that includes a cross-reference to Revision 1 of NUREG-0654/FEMA-REP-1.

13.3.3.15.2 *Regulatory Evaluation*

In Section 1.1 of the EGC ESP Emergency Plan, the applicant stated that it developed the plan to comply with the requirements of 10 CFR 52.17, using the guidance in Supplement 2. In Section 1.2 of the EGC ESP Emergency Plan, the applicant stated that the EGC ESP Emergency Plan, in conjunction with future implementing and administrative procedures, documents the methods by which the applicant's emergency preparedness program meets the planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50.

The staff finds that the applicant identified the regulatory requirements and guidance applicable to the proposed major features of emergency plans for an ESP application.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.F, and IV.G of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose major features of emergency plans for NRC review and approval, in consultation with FEMA, in the absence of a complete and integrated emergency plan. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. RS-002 and Supplement 2 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those that apply to major feature P, "Responsibility for the Planning Effort: Development, Periodic Review, and Distribution of Emergency Plans."

Major feature P calls for the applicant to describe the development, review, distribution, and update of emergency plans. The ESP application should also designate an emergency planning coordinator for each organization and identify (by title) individuals with emergency planning responsibility. In addition, the application should describe training for those responsible for the planning effort.

13.3.3.15.3 Technical Evaluation

The staff finds the applicant's clarification of the authority and responsibility for radiological response planning in response to RAIs 13.3-10 and 13.3-13(l) and (m) consistent with the guidance in Supplement 2 and, therefore, acceptable. The staff finds the additional information related to the process for updating agreements in the response to RAI 13.3-11 and the updates to the cross-reference matrix in response to RAI 13.3-19 to be acceptable.

The EGC ESP Emergency Plan and IPRA Volumes I and VIII adequately describe (1) the training of individuals responsible for the planning effort, (2) the individual with the overall authority and responsibility for radiological emergency response planning, (3) the designation of an emergency planning coordinator with responsibility for the development and updating of emergency plans, (4) the coordination of these plans with other response organizations, (5) the update of emergency plans and agreements, as needed, (6) the process for approved changes to the emergency response plans to be forwarded to all organizations and appropriate individuals with responsibility for the implementation of the plans, (7) the dating and marking of revised pages to show where changes have been made, and (8) a specific table of contents.

The EGC ESP Emergency Plan contains a matrix that adequately cross-references the criteria in Supplement 2. Volumes I and VIII of IPRA contain a matrix that appropriately cross-references the criteria in Revision 1 of NUREG-0654/FEMA-REP-1, rather than the criteria in Supplement 2.

13.3.3.15.4 Conclusions

As discussed above, the applicant described the responsibilities for plan development and review, as well as for distribution and update of emergency plans. In addition, the applicant identified those responsible for the planning effort and described the training they receive. Based on its review, the staff concludes that the proposed major feature P is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.F, and IV.G of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that the applicant considered for assigning responsibility for the planning effort, including development, periodic review, and distribution of emergency plans, as set forth above. The applicant provided other information in the application that is outside the scope of the staff's review of this feature and is not discussed in this SER. Therefore, the staff did not make findings regarding its acceptability.

The EGC ESP Emergency Plan contains a matrix that adequately cross-references the criteria in Supplement 2. Volumes I and VIII of IPRA contain a matrix that appropriately cross-references the criteria in Revision 1 of NUREG-0654/FEMA-REP-1, rather than the criteria in Supplement 2.

13.6 Industrial Security

The NRC staff reviewed the physical security aspects of the ESP application to determine whether the site characteristics are such that adequate security plans and measures can be developed.

13.6.1 *Technical Information in the Application*

SSAR Section 3.4.1.6 states that, to accommodate the recommended 360 feet of distance from vital equipment to the protected area (PA) fence, as specified in Regulatory Guide (RG) 4.7, Revision 2, "General Site Suitability Criteria for Nuclear Power Stations," issued April 1998, the actual ESP facility footprint may extend beyond the depicted ESP footprint. The application indicates that the site characteristics are such that applicable NRC regulations, guidance documents, and orders can be met. This conclusion is based on the fact that the Clinton owner-controlled area (OCA) is sufficiently large to provide adequate distances between vital areas and the probable location of a security boundary.

In RAI 3.4.1.6-1, the staff asked the applicant to provide a scale drawing of the ESP site in relation to the PA boundary, the OCA boundary, the shore of Clinton Lake, and other features such as roads and railroad lines. In response, the applicant provided a figure indicating that the OCA is large enough to meet the 360-foot distance criterion.

SSAR Section 3.4.1.6 also states that EGC has a security program in place for the existing unit and that there are no identified impediments to the eventual development of an adequate security plan for EGC's ESP facility. In addition, Section 3.4.1.6 states that sufficient distance is available to satisfy the criteria of 10 CFR 73.55 and the revised design-basis threat.

Sections 2.2 and 3.5.1.6 of the SSAR discuss the potential hazards (e.g., fluids, explosives, munitions, and chemicals stored or transported near the site).

13.6.2 Regulatory Evaluation

According to NRC regulations, applicants for an ESP must address characteristics of the proposed site that could affect the establishment of an effective security program. Specifically, 10 CFR 52.17 requires that site characteristics comply with 10 CFR Part 100. Pursuant to 10 CFR 100.21(f), site characteristics must allow the development of adequate security plans and measures. Revision 2 of RG 4.7 provides amplifying guidance and notes that 10 CFR 73.55 describes physical protection requirements for nuclear power plants.

SSAR Section 3.4.1.6 states that RG 4.7 provides applicable guidance and, in response to RAI 1.5-1, the applicant stated that RS-002 identifies the NRC regulations applicable to its ESP SSAR. RS-002 identifies 10 CFR 100.21(f) and 10 CFR 73.55 as the applicable regulations. The staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance.

13.6.3 Technical Evaluation

The staff reviewed the application and the responses to the RAIs and examined aspects of the application during a site visit. The proposed ESP site is located on the shore of Clinton Lake in DeWitt County, Illinois, near a licensed nuclear power reactor (Clinton Power Station) owned by AmerGen Energy, LLC, an affiliate of the applicant. Using the criteria set forth in 10 CFR 100.21(f), the staff identified and considered various characteristics of the site that could affect the establishment of adequate security plans and measures. Specifically, the staff considered pedestrian land approaches, vehicular land approaches, railroad approaches, water approaches, potential high-ground adversary advantage areas, nearby road transportation routes, nearby hazardous materials facilities, nearby pipelines, and culverts that could provide a pathway into the PA.

With respect to pedestrian and water approaches, the staff found that various figures in the application (e.g., Figure 1.2-4) identify the ESP site footprint within which all safety-related structures would be located if one or more reactors were constructed. In RAI 3.4.1.6-1, the staff asked the applicant to provide a scale drawing to allow the NRC staff to assess conformance with RG 4.7, which specifies that there should be a minimum of 360 feet for appropriate barriers, detection equipment, and isolation zones to protect vital equipment. In response, the applicant provided Figure 3.4-1, which shows that the distances between the planned locations of vital equipment and structures and the OCA boundary would permit the development of adequate security plans and measures. The staff concluded that the distance from possible locations of vital equipment and structures (which might be located anywhere in the site footprint identified by the applicant because the ESP application does not describe a specific design) to the OCA boundary is sufficiently large to locate barriers, detection equipment, and isolation zones consistent with RG 4.7.

With respect to vehicular land and railroad approaches, the staff identified and evaluated existing roads, rail spurs, and site terrain features. The staff concluded that the location of existing roads and site terrain features does not preclude the establishment of adequate vehicle control measures to prevent potential adversaries from getting close to vital equipment or protect against a vehicle bomb. This conclusion is based on the fact that the OCA is sufficiently large to enable the establishment of a vehicle checkpoint that has adequate standoff distance from the possible location of vital equipment to mitigate vehicle bomb overpressure effects. The ESP facility would not use the same vehicle checkpoint that was used during the May 2004 site visit for the existing operating facility. The staff identified railroad lines and spurs and found no features that would preclude the development of adequate security plans or measures. The staff also confirmed during the site visit that it is feasible to implement a vehicle barrier system over the terrain on all borders of the site.

With respect to deliberate vehicle explosions on nearby transportation routes, the staff analyzed a gasoline tanker explosion of 8500 gallons of gasoline on Illinois Highway 54 at a point three-fourths of a mile from the proposed site, which is the nearest approach to the site from a highway. The analysis demonstrated that such an event would not result in an overpressure greater than 1 psi at the site boundary (the pressure threshold for human eardrum rupture is 5 psi, which is also the first point of human incapacitation per U.S. Army Technical Manual 5-1300, "Structures to Resist the Effects of Accidental Explosions," issued November 1990). According to RG 1.91, Revision 1, "Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants," issued February 1978, 1 psi of peak positive overpressure is a conservative threshold. Below 1 psi, no significant damage would be expected for structures, components, and systems of concern.

With respect to nearby hazardous materials facilities and nearby pipelines, the staff found that the distances to those facilities and pipelines and the hazardous materials identified associated with them were of such a nature that they did not pose an impediment to the development of adequate security plans or measures.

The staff examined the overall site terrain with respect to natural features and existing manmade features such as culverts that potential adversaries could use to their advantage; no features that would preclude establishment of adequate security plans and measures were found on the site.

The COL applicant will need to provide specific designs for protected area barriers, since such design information is not available at the ESP stage. This is **COL Action Item 13.6-1.**

13.6.4 Conclusions

As described above, the staff examined the proposed ESP site characteristics to determine whether they might affect the establishment of adequate security plans and measures. The staff examined pedestrian, vehicle, and water approaches, including existing culverts, nearby railroad lines, nearby hazardous materials facilities, nearby pipelines, and other transportation routes and terrain features. Based on this evaluation, the staff concludes that the ESP site characteristics would allow an applicant for a combined license or construction permit to develop adequate security plans and measures for a reactor or reactors that the applicant might construct and operate on the ESP site.

15. ACCIDENT ANALYSES

15.1 Technical Information in the Application

In Section 3.3 of the site safety analysis report (SSAR), Exelon Generation Company (EGC or the applicant) analyzed and provided the radiological consequences of design-basis accidents (DBAs) to demonstrate that a new nuclear unit(s) could be sited at the proposed early site permit (ESP) site without undue risk to the health and safety of the public, in compliance with the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR), Section 52.17, "Contents of Applications," and 10 CFR Part 100, "Reactor Site Criteria." The applicant did not identify a particular reactor design to be considered for the proposed ESP site. Instead, the applicant developed a set of reactor DBA source term parameters using surrogate reactor characteristics. The applicant used these parameters, in conjunction with specific site characteristics, to conduct the radiological consequences of DBAs for the purpose of assessing the suitability of the proposed ESP site. These plant parameters collectively constitute a plant parameter envelope (PPE).

The applicant developed a PPE using seven reactor designs, five water-cooled reactors and two gas-cooled reactors, though it used source terms for only two of these designs as inputs to the DBA analyses. The water-cooled reactors included in the PPE are (1) a version of the Westinghouse Advanced Plant 1000 (AP1000), (2) the certified General Electric Advanced Boiling-Water Reactor (ABWR), (3) the Atomic Energy of Canada Advanced CANDU Reactor (ACR-700), (4) the General Electric Economic and Simple Boiling-Water Reactor (ESBWR), and (5) the Westinghouse-led International Reactor Innovative and Secure (IRIS) Reactor. The ACR-700 is light-water cooled, but heavy-water moderated. The two gas-cooled reactors are (1) the General Atomics Gas Turbine Modular Helium Reactor, and (2) the Pebble Bed Modular Reactor. The applicant stated that the PPE values were not intended to be limited to these reactor designs, but rather to provide a broad overall outline of a design concept, which could include other potential reactor designs if they fall within the parameter values provided in the PPE.

In selecting DBAs for radiological consequence analyses, the applicant focused predominantly on two light-water reactors, the certified ABWR and a version of the AP1000,[1] to serve as surrogates. The applicant stated that it selected these two reactor designs because they are (or are based on) previously certified standard designs and have recognized bases for postulated accident analyses. Using source terms developed from these two designs, the applicant performed and provided radiological consequence analyses for the following DBAs:

- main steamline breaks (AP1000 and ABWR)
- reactor coolant pump locked rotor (AP1000)
- control rod ejection (AP1000)
- control rod drop (ABWR)
- small line break outside containment (AP1000 and ABWR)
- steam generator tube rupture (AP1000)

[1] As discussed later in this section, EGC originally referenced the version of the AP1000 design available at the time its ESP application was submitted. Subsequently, EGC referenced the latest version of the AP1000 design (Revision 14 of the AP1000 Design Control Document) provided by Westinghouse in support of the final AP1000 design certification.

- loss-of-coolant accidents (LOCAs) (AP1000, ABWR, ESBWR, and ACR-700)
- fuel handling accident (AP1000 and ABWR)

The applicant presented the radiological consequence assessment results in SSAR Table 3.3-2. This table provides a summary of the postulated radiological consequences of the DBAs identified above at the proposed exclusion area boundary (EAB) and the low population zone (LPZ). The table also demonstrates that any potential doses would be within the radiological dose consequence evaluation factors set forth in 10 CFR 50.34(a)(1). The applicant provided the accident-specific source terms (i.e., release rates of radioactive materials from the ESP footprint (PPE values) to the environment) and resulting site-specific dose consequences for each DBA in the tables included in Chapter 3 of the SSAR.

In Request for Additional Information (RAI) 3.3.1-1, the staff noted that Westinghouse had revised its χ/Q values in the AP1000 Design Control Document (DCD) since the applicant had submitted its ESP application. The staff asked whether the applicant planned to use the updated values in revising its application. The applicant responded in its submission to the U.S. Nuclear Regulatory Commission (NRC) dated October 7, 2004, that it had elected not to update the ESP application to incorporate the latest χ/Q values in the AP1000 design certification because it had assessed the specific impact of the changes in χ/Q values and found them to have only a minor affect on the EAB and LPZ doses for the DBAs presented in the SSAR. The applicant also stated that the ESP application used the χ/Q values from Revision 2 of the Westinghouse AP1000 DCD, which was the most recently completed revision of the DCD at the time the applicant submitted its ESP application.

In its submission to the NRC dated April 4, 2005, responding to Open Item 3.3-1, the applicant changed its position and elected to update the ESP application to incorporate the latest χ/Q values in the AP1000 design certification for the postulated LOCA only. SSAR Table 3.3-2 B provides the latest χ/Q values the applicant used for the postulated LOCA. Subsequent to its April 4, 2005, submission responding to Open Item 3.3-1, the applicant changed its position again in its submission to the NRC dated July 14, 2005, and elected to further update the ESP application to apply the latest χ/Q values in the AP1000 DCD, Revision 14, which is the basis for the AP1000 design certification, to all DBAs, including the postulated LOCA. The staff verified that the latest χ/Q values the applicant used are the same as those in the AP1000 DCD and in the final safety evaluation report (SER) prepared by the staff for the AP1000 design certification.

In RAI 3.3.4-3, the staff noted that SSAR Section 3.3 provides total effective dose equivalent (TEDE) values for the ABWR design, while the ABWR design is certified with the thyroid and whole body doses specified in 10 CFR Part 100. The staff asked the applicant to explain how the doses compare. In its response, the applicant provided revised tables in SSAR Chapter 3 that included the calculated thyroid and whole body doses, in addition to the estimated TEDE values for the dose comparison. The staff finds the applicant's response acceptable.

In RAI 3.3.4-1, the staff asked the applicant to provide references and explain the methodology it used to determine time-dependent activity releases for each DBA. The applicant provided the requested references. In its response, the applicant stated that the respective DCDs present the methodologies used for calculating time-dependent releases for the ABWR and AP1000. The staff finds the methodologies used in the respective DCDs to be acceptable. The applicant further stated that for noncertified reactors the vendors have not provided the specific details of the methodology, but have provided time-dependent activity releases, which they consider to be the best estimate of the limiting DBA activity releases. The staff finds the response acceptable.

In RAI 3.3.4-2, the staff asked the applicant to provide, for each DBA, the doses it used for the EAB and the LPZ for the AP1000, the ABWR, and the ACR-700 designs, as well as the ratios of site-specific χ/Q values to design certification χ/Qs used. In its response, dated September 30, 2005, the applicant provided the requested information in a supplementary table, "Tabulation of the Bases for the AP1000 Design Basis Accident Offsite Doses at the EGC ESP Site," as an attachment to the response to RAI 3.3.4-2. The table provided, for each DBA, the doses the applicant used for the EAB and the LPZ for the AP1000. For the ABWR design, the applicant stated that it did not base the doses provided on the ratios of the χ/Q values, but calculated them using the activity releases, the EGC ESP site-specific χ/Q values, and the dose conversion factors in Federal Guidance Reports 11 and 12. The applicant further stated that it projected the offsite doses associated with the ESBWR and ACR-700 designs based on the estimated activity releases to the environment provided by the vendors and the site-specific χ/Q values. The staff finds the applicant's response acceptable.

In RAI 3.3.2-1, the staff asked the applicant to clarify whether the 0- to 2-hour EAB doses presented in the SSAR are for the 2-hour period with the greatest EAB doses. In its response, the applicant stated that the greatest EAB dose occurs during the first 2 hours of the accident for the ABWR, AP1000, and ACR-700 designs; however, the period from 1 to 3 hours yields the greatest EAB dose from a LOCA for the AP1000 design. The applicant clarified this information in the application. The staff finds the applicant's response acceptable.

15.2 Regulatory Evaluation

In RAI 1.5-1, the staff asked the applicant to provide a comprehensive listing of NRC regulations applicable to its ESP SSAR. In its response to RAI 1.5-1, the applicant stated that NRC Review Standard (RS)-002, "Processing Applications for Early Site Permits," Attachment 2, identifies the NRC regulations applicable to its ESP SSAR. In response to RAI 1.5-1, and in SSAR Table 1.5-1, the applicant identified the following applicable NRC regulations and guidance cited in Chapter 15 of RS-002, Attachment 2, regarding reactor accident radiological consequence analyses:

- 10 CFR 52.17
- 10 CFR Part 100
- 10 CFR 50.34, "Contents of Applications; Technical Information"
- Regulatory Guide (RG) 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Boiling Water Reactors," issued June 1974
- RG 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors," issued March 1972

- RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," issued November 1982

- RG 1.183, "Alternative Radiological Source Terms for Evaluating Design-Basis Accidents at Nuclear Power Reactors," issued July 2000

- NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," issued July 1981

- Technical Information Document (TID)-14844, "Calculation of Distance Factors for Power and Test Reactor Sites," issued March 1962

The staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance. In its evaluation, the staff used the relevant dose consequence evaluation factors found in 10 CFR 50.34(a)(1) to determine the acceptability of the site, in accordance with 10 CFR 52.17(a)(1).

The regulations in 10 CFR 52.17(a)(1) require that ESP applications contain an analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site under the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1). In addition, the ESP site characteristics must comply with the requirements of 10 CFR Part 100. The regulations in 10 CFR 50.34(a)(1)(ii)(D) require the following for a postulated fission product release based on a major accident:

- An individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the postulated fission product release would not receive a radiation dose in excess of 25 rem TEDE.

- An individual located at any point on the outer boundary of the LPZ, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage), would not receive a radiation dose in excess of 25 rem TEDE.

Because EGC has not selected a reactor design to be constructed on the proposed ESP site, the applicant used a PPE approach to demonstrate that it meets these requirements. A PPE is a set of plant design parameters that are expected to bound the characteristics of a reactor(s) that may be constructed at a site, and it serves as a surrogate for actual reactor design information. As discussed in RS-002 and Chapter 1 of this SER, the staff considers the PPE approach an acceptable method for assessing site suitability. For the purposes of this analysis, the applicant proposed fission product release rates from the ESP footprint (PPE values) to the environment, and the staff reviewed the applicant's dose evaluation based on these release rates.

15.3 Technical Evaluation

The applicant evaluated the suitability of the site under the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1) using bounding reactor accident source terms and dose consequences as a set of PPE values based predominantly on two surrogate designs, as well as site-specific χ/Q values based on the ESP footprint. The following paragraphs describe the staff's review of each aspect of this evaluation.

15.3.1 Selection of DBAs

The applicant selected the DBAs listed in Section 15.1 of this SER based on the proposed AP1000 design and the certified ABWR design, indicating that it chose these two reactor designs because they have (or are based on) previously certified standard designs and have recognized bases for postulated accident analyses. The staff finds that the applicant selected DBAs that are consistent with those analyzed in NUREG-0800 and RG 1.183. Therefore, the staff finds that the applicant provided an acceptable DBA selection for evaluating the compliance of the proposed ESP site with the dose consequence evaluation factors specified at 10 CFR 50.34(a)(1). The applicant stated that the DBAs analyzed in the proposed AP1000 and certified ABWR DCDs are expected to bound the DBAs of the other reactors being considered for the proposed ESP site. While it has not reviewed the designs other than the ABWR and AP1000 in detail, the staff believes that any conclusions drawn regarding the site's acceptability based on the AP1000 and ABWR designs are likely to be valid for the other reactor designs the applicant is considering. Whether or not such designs are in fact bounded by these DBA analyses would be subject to the staff's review during its consideration of any combined license (COL) or construction permit (CP) application that might be filed with respect to construction and operation of a reactor design at the EGC ESP site.

15.3.2 Design-Specific (Postulated) χ/Q Values

In evaluating the AP1000 design, the applicant originally used those χ/Q values in the proposed AP1000 DCD, Revision 2, that were being reviewed by the staff at the time EGC submitted its ESP application. Westinghouse subsequently revised the χ/Q values in the AP1000 DCD. In its submission to the NRC dated April 4, 2005, responding to Open Item 3.3-1, the applicant updated the ESP application to incorporate the more conservative and latest χ/Q values in the AP1000 DCD, Revision 14, for the postulated LOCA only. For all other DBA radiological consequence analyses, the applicant used χ/Q values in the AP1000 DCD, Revision 2.

Subsequent to the April 4, 2005, submission responding to Open Item 3.3-1, the applicant changed its position again in its submission to the NRC dated July 14, 2005, and elected to further update the ESP application to apply the latest χ/Q values in the AP1000 DCD, Revision 14, which is the basis for the AP1000 design certification, to all DBAs, including the postulated LOCA. The staff verified the latest χ/Q values used by the applicant with those in the AP1000 DCD and in the final SER prepared by the staff for the AP1000 design certification. The latest χ/Q values used by the applicant are shown in Table 15.3-1. The staff verified that these χ/Q values used by the applicant are the same as those in the AP1000 design certification document.

Table 15.3-1 AP1000 χ/Q Values (s/m^3)

Location and Time Interval	χ/Q Values
0 to 2 hour EAB	5.10×10^{-4}
0 to 8 hour LPZ	2.20×10^{-4}
8 to 24 hour LPZ	1.60×10^{-4}
1 to 4 day LPZ	1.00×10^{-4}
4 to 30 day LPZ	8.00×10^{-5}

In evaluating the ABWR, the applicant did not use the postulated χ/Q values in the ABWR certified DCD. Instead, the applicant calculated the radiological consequence doses using the postulated activity releases in the ABWR DCD, the EGC ESP site-specific χ/Q values, and the dose conversion factors in Federal Guidance Reports 11 and 12.

15.3.3 Site-Specific χ/Qs

In Section 2.3.4 of this SER, the staff reviewed the site-specific χ/Q values calculated and provided by the applicant and performed an independent evaluation of atmospheric dispersion, in accordance with the guidance provided in Section 2.3.4 of RS-002. In its review, the staff concluded, as described in Section 2.3.4 of the draft SER, that the applicant needed to provide appropriate meteorological data and appropriate distances from the postulated accident source term release points within the proposed ESP site to the proposed EAB and LPZ outer boundary for use in estimating the site-specific χ/Q values. Section 2.3.4 of the draft SER identified this issue as Open Item 2.3-3. The site-specific χ/Q values are used in the radiological consequence evaluations for the proposed ESP site, and therefore, Section 3.3.3.4 of the draft SER identified this open item, in part, as Open Item 3.3-1.

In its submission to the NRC dated April 4, 2005, the applicant responded to Open Item 2.3-3 and the related part of Open Item 3.3-1. In this submission, the applicant recalculated the short-term accident χ/Q values using three complete years of meteorological data from January 2000 to December 2002 (instead of January 2000 to August 2002 data previously used) and using a minimum distance of 805 meters to the EAB (instead of 1025 meters previously used). The applicant stated that the 805-meter distance is the minimum distance to the proposed EAB from any point on the PPE of the ESP facility footprint. The applicant provided recalculated site specific χ/Q values in Table 1.4-1 of the SSAR. Based on the recalculated site-specific χ/Q values submitted by the applicant, the staff considers Open Item 2.3-3 resolved (see Section 2.3.4 of this final SER).

15.3.4 Source Terms and Radiological Consequence Evaluations

To evaluate the suitability of the site using the radiological consequence evaluation factors in 10 CFR 50.34(a)(1), the applicant provided the bounding reactor accident source terms as a set of PPE values based on (1) the surrogate AP1000 and certified ABWR designs (as explained below), and (2) the site-specific χ/Qs based on the ESP footprint. The source terms are expressed as the timing and release rate of fission products to the environment from the proposed ESP site. The dose consequences are then derived from the source terms using established methods.

The AP1000 source terms are based on the guidance provided in RG 1.183. The methodologies and assumptions used by Westinghouse, the AP1000 vendor, in its radiological consequence analyses are consistent with the guidance provided in RG 1.183. The resulting doses calculated by the applicant for the proposed ESP site using the AP1000 source terms, postulated site parameters assumed in the AP1000 DCD, and EGC ESP site-specific χ/Qs calculated by the applicant meet the dose consequence evaluation factors specified in 10 CFR 50.34(a)(1) (i.e., 25 rem TEDE).

The methodologies and assumptions used by General Electric, the ABWR vendor, in its radiological consequence analyses for the ABWR design are consistent with the guidance provided in RGs 1.3 and 1.25. The ABWR source terms are based on the guidance in TID-14844. The resulting doses for the proposed ESP site using the ABWR source terms and the EGC ESP site-specific χ/Qs calculated by the applicant meet the dose consequence evaluation factors in 10 CFR 100.11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance" (i.e., 300 rem to the thyroid and 25 rem to the whole body). While the requirements of 10 CFR 100.11 are not applicable to ESPs, the staff notes that the final rule at Appendix A, "Design Certification Rule for the U.S. Advanced Boiling Water Reactor," to 10 CFR Part 52, "Early Site Permits, Design Certifications, and Combined Licenses for Nuclear Power Plants," states the following:

> The Commission has determined that with regard to the revised design-basis accident radiation dose acceptance criteria in 10 CFR 50.34, the ABWR design meets the new dose criteria, based on the NRC staff's radiological consequence analyses, provided that the site parameters are not revised.

Therefore, the staff concludes that the certified ABWR design, in conjunction with the assumed site parameters, meets the dose consequence evaluation factors specified in 10 CFR 100.21, "Non-Seismic Site Criteria," and 10 CFR 50.34(a)(1).

In the draft SER, the staff stated that the applicant did not use appropriate meteorological data or appropriate distances from postulated release points to the EAB and the LPZ outer boundary to estimate the site-specific χ/Q values used in the radiological consequence evaluations. Therefore, the radiological consequence evaluation for the proposed ESP site was unresolved. The staff identified this as Open Item 3.3-1.

In its submission to the NRC dated April 4, 2005, the applicant responded to Open Item 3.3-1. The applicant stated that it had recalculated the site-specific χ/Q values and site-specific dose consequences; the tables in Chapter 3 of the SSAR provided the recalculated values. Based on the recalculated site-specific χ/Q values and the resulting recalculated site-specific dose consequences, the staff considers Open Item 3.3-1 resolved.

In determining the potential radiological consequence doses resulting from DBAs at the proposed site, the applicant used the site-specific χ/Q values, in conjunction with the DBA radiological consequence doses and the postulated χ/Q values provided in the proposed AP1000 DCD, Revision 14. The proposed AP1000 design used the postulated χ/Q values to meet the radiological consequence evaluation factors identified in 10 CFR 50.34 (a)(1).

The χ/Q values indicate the atmospheric dilution capability. Smaller χ/Q values are associated with greater dilution capability, resulting in lower radiological doses. The radiological consequence doses are directly proportional to the χ/Q values. The applicant provided the site-specific χ/Q values used in its radiological consequence analyses in Table 1.4-1 of the SSAR, and the staff discussed and evaluated the site-specific χ/Q values in Section 2.3.4 of the final SER.

The applicant used the atmospheric dispersion computer code (PAVAN) to derive its site-specific χ/Q values at the EAB and LPZ for evaluating the radiological consequences. The staff describes the PAVAN code calculations for the proposed EGC ESP site in more detail in Section 2.3.4 of the final SER.

The applicant compared the ratios of the site-specific χ/Q values to the values postulated in the AP1000 DCD, Revision 14, to demonstrate that the radiological consequence doses at the proposed site meet the requirements of 10 CFR 50.34. The estimated site-specific χ/Q values for the proposed site are lower than the values postulated in the AP1000 DCD. The proposed AP1000 designs met the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1) with the postulated χ/Q values. Accordingly, the resulting DBA radiological consequence doses at the proposed site are lower than the doses provided in the AP1000 DCD, Revision 14, and therefore, meet the requirements of10 CFR 50.34.

In evaluating the ABWR, the applicant did not use postulated χ/Q values in its certified ABWR DCD. Instead, the applicant calculated the radiological consequence doses using the postulated activity releases in the ABWR DCD, the EGC ESP site-specific χ/Q values, and the dose conversion factors in Federal Guidance Reports 11 and 12 to meet the dose consequence evaluation factors specified in 10 CFR 100.11.

The staff believes that the radiological consequences of the DBAs at the proposed site based on the AP1000 and ABWR designs are likely to be acceptable for the other reactor designs the applicant is considering. Whether the final reactor design the applicant selects at the EGC ESP site is, in fact, bounded by the acceptance here would be subject to review during the staff's consideration of a COL or CP application. In accordance with 10 CFR 52.79(a)(1), the staff will evaluate, at the COL stage, whether the design of the facility falls within the parameters specified in the ESP, should the NRC issue one for the EGC ESP site.

The staff has verified the design-specific radiological dose consequences used by the applicant and finds them to be consistent with those evaluated by the staff as part of the design certification reviews. Furthermore, the staff finds that the references provided by the applicant and the methodology used to determine timing and release rate of fission product source terms to the environment (and resulting dose consequences) from the proposed ESP site are acceptable. Therefore, the staff finds the source terms from the ESP (PPE values) to be reasonable and acceptable. The staff intends to include the site-specific χ/Q values as site characteristics listed in Appendix A to any ESP that the NRC might issue for the EGC ESP site.

Based on its evaluation of the applicant's analysis methodology and inputs to that analysis, the staff finds that the applicant's conclusion that the dose consequences for the chosen surrogate designs comply with the dose consequence evaluation factors of 10 CFR 50.34(a)(1) to be correct.

The staff identified the following site χ/Q values as appropriate for inclusion in any ESP that the staff might issue for the EGC ESP site:

Table 15.3-2 Site-Specific χ/Q Values

Location and Time Interval	χ/Q Value
0 to 2 hour EAB	2.52×10^{-4} s/m^3
0 to 8 hour LPZ	3.00×10^{-5} s/m^3
8 to 24 hour LPZ	2.02×10^{-5} s/m^3
1 to 4 day LPZ	8.53×10^{-6} s/m^3
4 to 30 day LPZ	2.48×10^{-6} s/m^3

RS-002 calls for the staff to perform a confirmatory radiological consequence calculation. However, the design-related inputs to the applicant's dose calculation were directly extracted from design documentation previously submitted to, and reviewed by, the NRC in connection with design certification applications. Because the applicant simply used the ratio of the site-specific χ/Q values to the postulated design χ/Q values, the staff did not consider an independent calculation to be useful or necessary, and therefore, did not perform one.

At the COL stage, in accordance with 10 CFR 52.79(a)(1), the staff will evaluate whether the design of the facility falls within the parameters specified in an ESP, should one be issued for the EGC ESP site. Should the COL applicant reference a certified design as well as the ESP, and should the site characteristic χ/Q values specified in the ESP fall within the postulated χ/Qs for the chosen certified design, the staff will likely conclude that the COL applicant has satisfied this requirement. Should the COL applicant reference the ESP but not a certified design, the staff will evaluate the source term for the chosen design and will use that source term and the site χ/Qs determined at the ESP stage to determine whether the applicable regulations at 10 CFR 50.34 regarding dose consequence evaluation factors have been met. In the event of the filing of a CP referencing the ESP, the staff will evaluate the design's source terms and use the site χ/Qs from the ESP to determine compliance with the requirements of 10 CFR 50.34.

15.4 Conclusions

As set forth above, the applicant submitted its radiological consequence analyses using the site-specific χ/Q values and PPE source term values and concluded that the proposed ESP site meets the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1).

Based on the reasons set forth above, the staff finds that the applicant's PPE values for source terms included as inputs to the radiological consequence analyses are reasonable. Furthermore, the staff finds that the applicant's site-specific χ/Q values and dose consequence evaluation methodology are acceptable.

Therefore, the staff concludes that the proposed distances to the EAB and the LPZ outer boundary of the proposed ESP site, in conjunction with the fission product release rates to the environment provided by the applicant as PPE values, are adequate to provide reasonable assurance that the radiological consequences of the DBAs will be within the dose consequence evaluation factors set forth in 10 CFR 50.34(a)(1) for the proposed ESP site. This conclusion is subject to confirmation at the COL or CP stage that the design of the facility specified by the COL or CP applicant falls within the ESP PPE values.

The staff further concludes that (1) the applicant demonstrated that the proposed ESP site is suitable for power reactors with source term characteristics bounded by those of the ABWR and AP1000 without undue risk to the health and safety of the public, and (2) the applicant complied with the requirements of 10 CFR 52.17 and 10 CFR Part 100.

17. EARLY SITE PERMIT QUALITY ASSURANCE MEASURES

17.1 Introduction

The applicant (Exelon Generation Company (EGC)) chose not to supply information on the quality assurance (QA) measures it applied to the early site permit (ESP) activities described in its application. The applicant, responding to a request for additional information (RAI) from the U.S. Nuclear Regulatory Commission (NRC), subsequently submitted information on the QA measures EGC and its principal contractors applied to ESP activities. The NRC staff inspected the applicant's QA measures between January 12 and 16, 2004. Subsequently, the staff performed an in-office technical review to evaluate whether the applicant and its principal contractors had applied adequate QA measures. The staff also conducted a review to determine whether the applicant had adequately applied the guidance in Section 17.1.1 of Review Standard (RS)-002, "Processing Applications for Early Site Permits," Attachment 2, issued in 2004, to demonstrate the integrity and reliability of the data obtained during ESP activities.

Under Title 10, Section 52.18, "Standard for Review of Applications," of the *Code of Federal Regulations* (10 CFR 52.18), the staff must review ESP applications in accordance with the applicable regulations of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," and its appendices, as well as 10 CFR Part 100, "Reactor Site Criteria," as they apply to construction permits. The current regulations do not require ESP holders or applicants to implement a QA program compliant with the requirements of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50. However, the applicant is expected to implement QA measures equivalent in substance to the measures described in Appendix B to 10 CFR Part 50. This will provide reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of structures, systems, and components (SSCs) important to safety will support satisfactory performance of such SSCs once they are in service. Therefore, the staff evaluated quality measures for those activities associated with the applicant's generation of site-related information that could be used as input to the design of future SSCs to ensure that these measures can provide reasonable assurance of the integrity and reliability of the information, assuming that the applicant's QA measures are equivalent in substance to the criteria of Appendix B to 10 CFR Part 50.

In accordance with 10 CFR 52.79(a)(1), if an application for a combined license (COL) references an ESP, it must contain information sufficient to demonstrate that the design of the facility falls within the parameters specified in the ESP. Therefore, the ESP applicant must provide reasonable assurance of the reliability and integrity of the data contained in or supporting the ESP application, which in turn supports the COL application.

Conformance with the QA measures described in Section 17.1.1 of RS-002, Attachment 2, provides reasonable assurance that the applicant used adequate QA measures to support its ESP application. The staff focused its review on whether the applicant's QA measures adequately addressed the guidance in Section 17.1.1 of RS-002, Attachment 2, for each applicable element (as determined by the applicant). The staff performed much of its evaluation in an inspection conducted in January 2004 and documented in Inspection Report 05200007/2004001, "Exelon Generation Company, LLC—NRC Inspection of Applicant and Contractor Quality Assurance Activities Involved with Preparation of the Application for an Early Site Permit" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML040540622), in February 2004. For any element the applicant determined was not applicable, the staff verified that the ESP activities did not rely on QA measures associated with that element. The review focused on the applicant and its primary contractor, CH2M HILL. Inspection Report 0520007/2004001 includes details on additional subcontractors involved in the EGC ESP activities. Section 17.7 of this SER discusses the adequacy of the QA measures used by these additional subcontractors.

In response to an RAI, the applicant submitted the description of the QA measures it applied to the ESP activities. The staff reviewed the EGC general guidance to its subcontractors for the quality measures applied to ESP activities. EGC Instruction AP-AA-1000, "Early Site Permit Project Quality Assurance Instructions," Revision 0, issued in 2004 (hereafter referred to as the instruction), states that activities related to the development of the application will be conducted in accordance with 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants." The applicant's subcontractors conducted their ESP activities in accordance with their own QA measures, by direction provided in procurement documents, or in accordance with the primary contractor's required QA measures.

17.1.1 Technical Information in the Application (Organization)

The EGC application did not initially supply information about its QA organization, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant will apply elements from these criteria or verify that the controls applied to the ESP activities reflect these elements. The applicant considered organization to be a criterion having elements associated with the control of ESP activities.

The instruction states that EGC is responsible for the establishment and execution of an ESP project QA plan. The applicant typically delegates to others, such as contractors or consultants, the work of establishing and executing the QA plan, or part thereof, but retains overall responsibility.

The instruction further states that an appropriate level of EGC management will have overall responsibility for the ESP project. EGC management will have authority and responsibility to establish a program such that the persons and organizations performing QA functions have sufficient authority and organizational freedom to identify quality problems; to initiate, recommend, or provide solutions; to verify implementation of solutions; and to have direct access to such levels of management as may be necessary to perform these functions. The instruction also states that individuals performing audits should possess experience, training, or background at least sufficient to assess the quality of the product provided by the contractor.

The CH2M HILL "Project Quality Plan for Exelon Early Site Permit" (hereafter referred to as the Project Quality Plan (PQP)) describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50.

The PQP states that, while EGC retains the overall responsibility for the completeness and accuracy of the information to be provided in support of obtaining an ESP, it delegated the initial gathering and analysis of that information to CH2M HILL. The PQP also establishes and communicates the authority and duties of persons and organizations performing quality management and provides an organization chart.

17.1.2 Regulatory Evaluation (Organization)

While the applicant is not required to develop an organization to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's organization. The applicant's instruction outlines the elements of an organization that the applicant applied to its ESP activities.

Paragraph 17.1.1.1 in RS-002, Attachment 2, Section 17.1.1, provides the QA measures that constitute an acceptable organization. An acceptable organization should include (1) an organization description and charts of the lines, interrelationships, and areas of responsibility and authority for all organizations performing quality-related activities, including the applicant's organization and principal contractors, (2) the relative location of the QA organization, degree of independence from the organization performing ESP activities, and authority of the individuals assigned the responsibility for performing QA functions, and (3) the organizational provisions that exist for ensuring the proper implementation of QA controls.

17.1.3 Technical Evaluation (Organization)

17.1.3.1 Exelon Generation Company

The PQP identifies the authority and responsibilities of persons and organizations performing quality management functions. The EGC project manager is primarily responsible for directing the project staff to complete the ESP application.

The site safety analysis report (SSAR) lead had overall responsibility for the technical content and completion of the report. The NRC staff interviewed individuals carrying out these responsibilities. Based on these interviews and the review of project documentation, the staff determined that the applicant's staffing for these positions is consistent with the descriptions in the PQP. The PQP also describes the assignment of responsibilities to lead technical positions for key project areas. Based on its review of the overall project documentation, the staff determined that the PQP accurately describes these positions.

The applicant developed procedures specific to ESP activities, as detailed in Inspection Report 0520007/2004001. The staff reviewed the program procedures and noted that the procedures meet the guidance in Section 17.1.1 of RS-002, Attachment 2. The applicant adequately described the ESP organization and personnel responsibilities.

The instruction indicates that EGC is responsible for the establishment and execution of a project QA plan for an ESP project, but that EGC typically delegates to others, such as contractors, the work of establishing and executing the QA plan. The instruction further indicates that EGC management will ensure that persons and organizations performing QA functions have sufficient authority and organizational freedom to (1) identify problems in quality,

(2) initiate, recommend, or provide solutions, and (3) verify implementation of solutions. The instruction also indicates that EGC management will ensure that persons and organizations performing QA functions have direct access to any level of management necessary to perform these functions.

The staff interviewed the EGC QA audit personnel who conducted the audits of ESP activities and reviewed their personnel training records. The applicant indicated that its project staff received on-the-job training related to ESP activities. However, the applicant did not develop formal training plans or maintain training records. The applicant stated that it had assembled personnel for the project whose experience precluded the need for formal training. The staff reviewed the resumes of several EGC ESP project personnel and found that the resumes demonstrate satisfactory experience and education for each of the individuals reviewed.

17.1.3.2 CH2M HILL

The staff reviewed the CH2M HILL PQP. The applicant indicated that the PQP, prepared by CH2M HILL and reviewed by EGC, provides quality controls to ensure that the preparation of the EGC ESP application followed quality practices commensurate with the intended use of the application and its content. CH2M HILL prepared procedures for those quality functions the PQP described. The staff reviewed several CH2M HILL procedures in detail, as described in Inspection Report 0520007/2004001, to ensure the adequacy of the procedures to perform their stated purpose. The staff also determined that the procedures adequately identified the organizational roles and responsibilities regarding managerial and administrative controls for the project.

The staff reviewed training and qualification records for CH2M HILL personnel and other contractors involved in ESP-related activities. The staff also reviewed the CH2M HILL organizational structure and personnel responsibilities. The staff did not identify any issues.

17.1.4 Conclusion (Organization)

As set forth above, the staff reviewed the applicant's QA measures and those of its primary contractor and concluded that both EGC and CH2M HILL have implemented an acceptable organization which meets the guidance in Section 17.1.1 of RS-002, Attachment 2, and helps provide reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.2 Quality Assurance Program

17.2.1 Technical Information in the Application (QA Program)

The EGC application did not initially supply information about the QA program, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant would apply elements from these criteria or verify that the controls applied to the ESP activities reflected these elements. The applicant considered the QA program to be a criterion having elements associated with the control of ESP activities.

The instruction states that EGC will establish, for each ESP project, a PQP that complies with the requirements of this procedure and includes relevant and instructive elements from the criteria in Appendix B to 10 CFR Part 50 identified herein. This PQP will also include other controls and criteria that the applicant's project management has determined to be necessary or desirable.

The instruction states that the primary contractor retained by EGC to prepare the ESP application will typically prepare the PQP and associated subtier documentation and EGC ESP project management will approve these documents. The primary contractor's PQP describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50.

The PQP details the quality processes that define the QA program. Attributes of the QA program include (1) creating the PQP to identify the applicable quality requirements, (2) establishing document and record control programs, (3) selecting personnel for the project based on knowledge, skills, and abilities, (4) conducting or directing audits, (5) reviewing reports, and (6) researching project contract requirements.

17.2.2 Regulatory Evaluation (QA Program)

While the NRC does not require a QA program to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's QA program. The applicant's instruction describes the elements of a project QA plan that the applicant applied to ESP activities.

Paragraph 17.1.1.2 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of control for ESP activities. The QA program should include (1) a scope of QA controls adequate to ensure that appropriate quality controls are applied to all site characterization data related to the design and analysis of SSCs important to safety that might be constructed on the proposed site, (2) provisions to ensure proper definition of QA controls, and (3) provisions to ensure the adequacy of personnel qualifications.

17.2.3 Technical Evaluation (QA Program)

This section of the safety evaluation report (SER) documents the staff's evaluation of the applicant's and its primary contractor's overall QA program description. The following sections of this SER provide a detailed review and evaluation of each applicable portion of the program.

17.2.3.1 Exelon Generation Company

The staff reviewed the applicant's instruction, which describes the elements of the ESP QA plan prepared by CH2M HILL. The instruction identifies the pertinent elements of the criteria stated in Appendix B to 10 CFR Part 50 that apply to controls for the ESP application. The instruction also identifies responsibilities for the establishment and execution of the PQP for the ESP by others, such as contractors or consultants. The instruction states that EGC management retains overall responsibility for the project, including the responsibility for attaining quality objectives, and that persons and organizations with QA functions have the organizational freedom to identify quality-related problems. Additionally, the instruction states that the individuals performing audits of the plan have the experience, training, or background necessary to assess the quality of the product provided by the contractor. The staff reviewed the resumes and training records of EGC individuals involved with QA plan oversight and audit and found their qualifications and training to be adequate.

The staff reviewed the applicant's procedures that provide general guidance to its subcontractors in applying the quality measures to ESP activities. The instruction states that EGC will conduct activities related to the development of the application in accordance with 10 CFR Part 52. The applicant determined that the Exelon Nuclear Quality Assurance Topical Report does not apply to ESP activities. However, the applicant did determine that elements of certain criteria of Appendix B to 10 CFR Part 50 are applicable. As detailed in Inspection Report 0520007/2004001, EGC delegated the ESP activities. The applicant's subcontractors conducted their ESP activities in accordance with their own QA measures, by direction provided in procurement documents, or in accordance with the lead contractor's required QA measures. The staff found the guidance provided by the instruction to be adequate as an overall guide for the conduct of ESP activities.

17.2.3.2 CH2M HILL

CH2M HILL led the compilation of information for the SSAR. CH2M HILL conducted such tasks as seismic analysis, QA audit activities, environmental report preparation, and contract preparation. The staff reviewed the PQP developed by CH2M HILL for the EGC ESP project. The PQP describes the quality program for the development of the ESP application. The PQP states that CH2M HILL will develop the application in accordance with the requirements of 10 CFR Part 52. The PQP describes the project organization, quality objectives and criteria, and project quality processes. The PQP organizes the project quality processes around the criteria found in Appendix B to 10 CFR Part 50 that were to be applied to the ESP activities conducted by CH2M HILL. In addition, CH2M HILL developed procedures that amplify EGC guidance on the conduct of ESP activities. Inspection Report 0520007/2004001 provides additional information on the staff's review of these procedures.

The PQP states that, while the applicant retained the overall responsibility for the completeness and accuracy of the information provided in support of obtaining an ESP application, it delegated the initial gathering and analysis of this information to CH2M HILL. The document further states that the PQP provides adequate controls to ensure that the EGC ESP application was prepared under quality practices commensurate with the intended use of the application and its content. To that end, the PQP applied, as necessary, only certain elements of the criteria set forth in Appendix B to 10 CFR Part 50, as well as other quality standards. As stated in RS-002, Attachment 2, Section 17.1.1, an applicant may determine the applicable quality measures. The staff reviewed the quality measures that CH2M HILL considered to be applicable and determined that these measures are adequate for the activities conducted in support of the EGC ESP activities.

17.2.4 Conclusion (QA Program)

As set forth above, the staff reviewed the applicant's QA measures and those of its primary contractor and concluded that these measures form an acceptable QA program which meets the guidance in Section 17.1.1 of RS-002, Attachment 2, and helps provide reasonable assurance that any information derived from ESP activities that is used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.3 Design Control

17.3.1 Technical Information in the Application (Design Control)

The EGC application did not initially supply information on design controls, but it subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain the elements associated with the control of ESP activities. The instruction states that the applicant would apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant did not consider design controls to be a criterion having elements associated with the control of ESP activities.

The instruction states that the PQP will include controls for the development of and/or changes to ESP project products. However, the instruction also states that, since no activities associated with SSCs are to be conducted under this project, no QA measures are necessary for the control of design processes.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50.

The PQP describes application development inputs, outputs, development review, and control of development changes. The PQP states that the applicant will plan and control development of the ESP application. Development planning will determine (1) stages of the development process, (2) required review and verification and validation (V&V) activities appropriate to each development state, and (3) responsibilities and authorities for development activities. The PQP states the controls for development of inputs and outputs.

According to the PQP, the applicant will manage interfaces among different groups involved in development to provide effective communication and clear assignment of responsibilities. The PQP also states that the applicant will review and approve documents prepared for the ESP application, identify development changes, and maintain records of the changes.

In RAI 17.1.1-2, the staff asked the applicant to describe the QA measures it used to authenticate and verify any data important to safety that it retrieved from Internet Web sites and that support information in the SSAR that could affect the design, construction, or operation of SSCs important to safety. In its response, the applicant stated that the measures it relied on to authenticate data retrieved from Internet Web sites include formal documentation of the Internet

Web site used, peer review of the resulting application information, and independent examination of the source.

17.3.2 Regulatory Evaluation (Design Control)

While the NRC does not require design controls to comply with the criteria in Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's design controls. The applicant's instruction details the design controls applied to ESP activities.

Paragraph 17.1.1.3 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of design control. Acceptable design controls should include (1) the scope of activities that could affect design and construction activities for SSCs important to safety that might be constructed on the site, (2) a definition of the organizational structure, activity, and responsibility of the positions or groups responsible for design activities important to safety (if any), (3) provisions to carry out design activities important to safety in a planned, controlled, and orderly manner, (4) provisions for interface control between functional units of the applicant's organization, (5) provisions to verify the technical adequacy of design documents applicable to ESP activities that could affect SSCs important to safety, and (6) provisions to control design changes applicable to ESP activities that could affect SSCs important to safety.

17.3.3 Technical Evaluation (Design Control)

17.3.3.1 Exelon Generation Company

The EGC ESP application identified CH2M HILL as the primary contractor providing personnel, systems, project management, and resources for the EGC ESP project. Further, CH2M HILL procured engineering services and support for specific design control activities from subcontractors, including Parsons Power Group, Inc. (Parsons), Geomatrix Consultants, and GRL Engineers, Inc. (GRL). The staff reviewed and verified the adequacy of design control activities for each of these companies. Section 17.7 of this SER provides additional details on this topic.

The staff evaluated the applicant's response to RAI 17.1.1-2 concerning the QA measures it used to authenticate and verify data that were retrieved from Internet Web sites and that support information in the SSAR affecting the design, construction, or operation of SSCs important to safety. In its response to the RAI, the applicant described the method used to authenticate or verify the data. The staff found this method of authenticating Internet Web site data to be acceptable. The staff stated that it would verify completion of the applicant's method of authentication as part of its inspection program before developing the final SER. The staff identified this item as Confirmatory Item 17.3-1.

The staff conducted a followup inspection of Confirmatory Item 17.3-1 on May 19, 2005, at the applicant's offices in Kennett Square, Pennsylvania. The staff determined, through review of supporting documentation, that the applicant had provided adequate QA measures to authenticate and verify data retrieved from Internet Web sites that support information in the SSAR that would affect the design, construction, or operation of SSCs important to safety.

Specifically, the applicant's primary contractor (CH2M HILL) had technically qualified personnel review data retrieved from Internet Web sites, using a documented process. Subject matter experts reviewed the data again during an independent review conducted after the SSAR was completed. Based on this inspection, the staff concludes that Confirmatory Item 17.3-1 is resolved.

17.3.3.2 CH2M HILL

The applicant delineated the ESP work scope and quality requirements for CH2M HILL in a contract, as detailed in Inspection Report 0520007/2004001. The work scope identifies specific sections of the ESP application for which CH2M HILL was responsible for performing design control activities supporting analyses, evaluations, and procurement, as well as for ensuring that personnel involved with the project were trained and knowledgeable about the QA design control requirements. The staff reviewed CH2M HILL procedures and interviewed the responsible project and QA managers.

The staff reviewed the PQP, which describes the quality program for the development of an ESP application and outlines the ESP organizational, programmatic, and procedural requirements. The PQP also defines responsibilities regarding the traceability and appropriateness of information before its use in any design document.

The staff reviewed the PQP, as it relates to design control for ESP activities. The PQP describes the project quality processes, including organizational authority, responsibilities for completeness and accuracy of information, and gathering and analysis of information to support ESP application development. The PQP describes ESP design control elements related to Appendix B to 10 CFR Part 50. The PQP also provides for quality processes in the communication of the quality requirements of the PQP to the project leads and training of personnel used to perform activities affecting quality. The PQP describes development planning to determine required review and V&V activities related to the ESP project. It also provides for determination of functional and performance requirements and applicable statutory and regulatory requirements. Additionally, it establishes criteria for the approval of development inputs and outputs and the review and control of development changes, including computer software control.

The staff also reviewed several CH2M HILL ESP design control procedures, as detailed in Inspection Report 0520007/2004001. The staff concluded that the design control measures described in the CH2M HILL PQP and other reviewed procedures and documents are adequate.

17.3.4 Conclusion (Design Control)

As set forth above, the staff reviewed the CH2M HILL QA control measures and concluded that the contractor implemented acceptable design controls which meet the guidance of Section 17.1.1 of RS-002, Attachment 2, and help provide reasonable assurance that any information derived from ESP activities that is used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.4 <u>Procurement Document Control</u>

17.4.1 Technical Information in the Application (Procurement Document Control)

The EGC application did not supply information about procurement document control, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain the elements associated with the control of ESP activities. The instruction states that the applicant will apply elements from these criteria or verify that the controls applied to the ESP activities reflected these elements. The applicant considered procurement document control to be a criterion having elements associated with the control of ESP activities.

The instruction states that the PQP will include controls for the procurement of ESP project products (including services). The instruction further states that the applicant will contract with vendors to provide services in connection with ESP activities in accordance with appropriate EGC nuclear supply management procedures for nonsafety-related services.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50.

The PQP states that measures will be established to assure that the documents for procurement of material, equipment, and services (whether purchased by CH2M HILL, its contractors, or its subcontractors) suitably include or reference the applicable regulatory, design bases, and other requirements necessary to assure adequate quality. The PQP further states that, to the extent necessary, procurement documents will require contractors or subcontractors to provide a QA program that is at least consistent with the pertinent provisions of the PQP.

17.4.2 Regulatory Evaluation (Procurement Document Control)

While the NRC does not require procurement document controls to comply with the criteria in Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's procurement document controls. The applicant's instruction details the procurement document controls it applied to ESP activities.

Paragraph 17.1.1.4 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of procurement document controls. Acceptable procurement document controls should include (1) provisions to ensure that procurement documents related to ESP activities that could affect SSCs important to safety include or reference applicable technical requirements and QA controls, and (2) provisions for review and approval of procurement documents for ESP activities that could affect SSCs important to safety.

17.4.3 Technical Evaluation (Procurement Document Control)

17.4.3.1 Exelon Generation Company

The EGC project manager served as the contract administrator in authorizing all services procured under the ESP application contract. During review of the contract file governing the

ESP application, the NRC staff interacted with the project manager and the contract specialist and found them knowledgeable about contract administration.

The staff reviewed the EGC agreement, which authorizes the primary contractor's scope of work. The contract defines the scope of work to be performed. Quality requirements incorporated as part of the contract stipulate that the scope of work should ensure that individual tasks are accomplished with the appropriate level of quality controls, such that the quality of the data would not be questioned during their subsequent use in the COL process, as set forth in 10 CFR Part 52. The contract requires a detailed written description of the quality control practices employed and the corresponding data or information to which these controls were applied.

17.4.3.2 CH2M HILL

EGC selected CH2M HILL as the primary contractor for preparing the ESP application. The CH2M HILL proposal specified that the existing CH2M HILL QA program, which implements its quality management system (QMS), would be used for the ESP task to the extent applicable. The proposal also specified that CH2M HILL would review and approve all reports and records required by the application before forwarding them to EGC.

The NRC staff interviewed the CH2M HILL project manager and QA manager regarding authorization of subcontract procurement. The CH2M HILL project manager authorizes CH2M HILL procurement in coordination with the CH2M HILL procurement officer located in the CH2M HILL Tucson, Arizona, office.

Based on its review of procurement purchase orders and interviews with authorizing contract personnel, the staff found the authorizing individuals knowledgeable about EGC QA requirements. Section 17.7 of this SER discusses specific details of the procurement controls applied to each subcontractor.

17.4.4 Conclusion (Procurement Document Control)

As set forth above, the staff reviewed the QA measures employed by the applicant and its primary contractor and concluded that they have implemented an acceptable level of procurement document control, which meets the guidance of Section 17.1.1 of RS-002, Attachment 2, and helps provide reasonable assurance that any information derived from ESP activities that is used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.5 Instructions, Procedures, and Drawings

17.5.1 Technical Information in the Application (Instructions, Procedures, and Drawings)

The EGC application did not initially supply information about the control of instructions, procedures, and drawings, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain the elements associated with the control of ESP activities. The instruction states that the applicant would apply elements from these criteria or verify that the controls applied to

ESP activities reflect these elements. The applicant considered control of instructions, procedures, and drawings to be a criterion having elements associated with the control of ESP activities.

The instruction states that the PQP will include controls for ESP project activities to be conducted in accordance with documented instructions, procedures, or drawings for which ESP project management deemed such written controls to be necessary. In addition, the instruction states that documented instructions, procedures, or drawings will control EGC activities required by the PQP. The primary contractor describes in its PQP the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50.

The PQP states that activities affecting quality will be prescribed by and accomplished in accordance with documented instructions, procedures, or drawings of a type appropriate to the circumstances. Instructions, procedures, or drawings will include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished. The applicant will document work processes to the level required to complete the work in a consistent manner that meets applicable guidance.

17.5.2 Regulatory Evaluation (Instructions, Procedures, and Drawings)

While the NRC does not require instructions, procedures, and drawings to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's instructions, procedures, and drawings. The applicant's instruction lists the controls for instructions, procedures, and drawings it applied to ESP activities.

Paragraph 17.1.1.5 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of control for instructions, procedures, and drawings. Acceptable controls for instructions, procedures, and drawings should include (1) provisions for ensuring that ESP activities that could affect SSCs important to safety are prescribed by and accomplished in accordance with instructions, procedures, or drawings, and (2) provisions for including quantitative and qualitative acceptance criteria in instructions, procedures, and drawings related to ESP activities that could affect SSCs important to safety.

17.5.3 Technical Evaluation (Instructions, Procedures, and Drawings)

17.5.3.1 Exelon Generation Company

The applicant developed program procedures specific to ESP activities, as detailed in Inspection Report 0520007/2004001. The staff reviewed the program procedures and noted that the procedures meet the guidance in Section 17.1.1 of RS-002, Attachment 2. Additionally, the staff discusses the adequacy of instructions, procedures, and drawings in other technical evaluation sections of this SER.

17.5.3.2 CH2M HILL

The staff reviewed the PQP. According to the applicant, CH2M HILL prepared the PQP, and EGC reviewed it, to provide quality controls to ensure that the EGC ESP application was prepared under quality practices commensurate with the intended use of the application and its content. CH2M HILL prepared procedures for those quality functions described in the PQP. The staff reviewed several procedures, as detailed in Inspection Report 0520007/2004001, to determine the adequacy of the procedures to perform their stated purpose. The staff found that the instructions, procedures, and drawings developed and used for ESP activities are adequate.

17.5.4 Conclusion (Instructions, Procedures, and Drawings)

As set forth above, the staff reviewed the QA measures employed by the applicant and its primary contractor and concluded that they have implemented an acceptable level of control for instructions, procedures, and drawings which meets the guidance of Section 17.1.1 of RS-002, Attachment 2, and helps provide reasonable assurance that any information derived from ESP activities that is used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.6 Document Control

17.6.1 Technical Information in the Application (Document Control)

The EGC application did not supply information on document control, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant will apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant considered document control to be a criterion having elements associated with the control of ESP activities.

The instruction states that the PQP will include controls for issuance of documents related to the ESP project. The instruction also states that the applicant will provide controls for review and acceptance of completed project documents and that the PQP will establish methods for the control of changes to project documents, including a means for notifying appropriate individuals of document changes.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50. The PQP states that measures will be established to control the issuance of documents, such as instructions, procedures, and drawings, including changes thereto, which prescribe all activities affecting quality. These measures will assure that authorized personnel review documents, including changes, for adequacy and approve them for release, and that these documents are distributed to and used at the location where the prescribed activity is performed. The same organization(s) that performed the original review and approval will review and approve changes to those documents, unless the applicant designates another responsible organization.

17.6.2 Regulatory Evaluation (Document Control)

While the NRC does not require document control to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's document controls. In the instruction, the applicant provided the document controls it applied to ESP activities.

Paragraph 17.1.1.6 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of document control. Acceptable document controls should include provisions to ensure that documents related to ESP activities that would affect SSCs important to safety, including changes, are reviewed for adequacy, approved for release by authorized personnel, and distributed and used at the location where the prescribed activity is performed.

17.6.3 Technical Evaluation (Document Control)

Section 17.5 of this SER gives a detailed discussion of the document controls applied by the applicant. In addition, each section of this SER details the specific documents reviewed and any relevant discussions of their adequacy. The staff considers the scope of the documents reviewed to be adequate for the ESP activities that were conducted. The staff reviewed documents that were reviewed and approved for issuance to ensure the document control process was followed. The staff confirmed that the applicant and its primary subcontractor had adequate controls in place to ensure the proper revision of a document.

17.6.3.1 Exelon Generation Company

Inspection Report 0520007/2004001 discusses the staff's review of the applicant's document controls. The staff noted that procedures required that the EGC ESP project management establish the necessary project documentation to control project activities consistent with regulatory requirements. The staff found that the procedures provide adequate guidance for document control and that the applicant had adequately implemented the procedural requirements.

17.6.3.2 CH2M HILL

The applicant selected CH2M HILL as its primary contractor for preparing the ESP application. In its proposal, CH2M HILL specified that it would apply the existing CH2M HILL QA program, which implements its QMS, for the ESP task to the extent applicable and would also review and approve all reports and records required by the application before sending them to EGC.

The CH2M HILL proposal specified that the company would develop and approve special procedures for controlling processes used in data collection and report generation in accordance with the CH2M HILL controlled document program. The ESP project team would use these special procedures, together with existing procedures from CH2M HILL. Documents pertaining to the quality systems and those used to direct work relating to contractual requirements would be controlled. CH2M HILL applied the document control program to internally generated documents, such as manuals, procedures, plans, work instructions, forms, drawings, and records, as well as to documents of external origin, to ensure control of document creation and management. CH2M HILL designed this document management system to ensure that only those procedures reviewed and approved by project management were available at the point of use. Inspection Report 0520007/2004001 details the staff's review of the adequacy of the primary contractor's procedures. The staff found the primary contractor's document controls to be adequate.

17.6.4 Conclusion (Document Control)

As set forth above, the staff reviewed the QA measures employed by the applicant and its primary contractor and concluded that they have implemented acceptable document controls, which meet the guidance of Section 17.1.1 of RS-002, Attachment 2, and help provide reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.7 Control of Purchased Material, Equipment, and Services

17.7.1 Technical Information in the Application (Control of Purchased Material, Equipment, and Services)

The EGC application did not initially supply information about control of purchased material, equipment, and services, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant will apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant considered control of purchased material, equipment, and services to be a criterion having elements associated with the control of ESP activities.

The instruction states that the PQP will include controls for products, equipment, and services purchased for the ESP project commensurate with the intended use of the products or services. The instruction also states that any material, equipment, or services purchased directly by the applicant in connection with the development of an ESP application will be in accordance with EGC procedures.

In its PQP, the primary contractor described the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application. Where appropriate, the contractor will use the pertinent elements of Appendix B to 10 CFR Part 50. The PQP states that the primary contractor will establish measures to assure that purchased material, equipment, and services (whether purchased directly or through contractors and subcontractors) conform to the procurement documents. These measures will include appropriate provisions for source evaluation and selection, objective evidence of quality furnished by the contractor or subcontractor, inspection at the contractor or subcontractor source, and examination of products upon delivery. CH2M HILL will assess the effectiveness of the contractor and subcontractor quality control at intervals consistent with the importance, complexity, and quantity of the product or services provided.

17.7.2 Regulatory Evaluation (Control of Purchased Material, Equipment, and Services)

While the NRC does not require the control of purchased material, equipment, and services to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's control of purchased material, equipment, and services. In the instruction, the applicant described the control of purchased material, equipment, and services it applied to ESP activities.

Paragraph 17.1.1.7 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of control of purchased material, equipment, and services. Acceptable controls of purchased material, equipment, and services should include (1) provisions for the control of purchased material, equipment, and services related to ESP activities that could affect SSCs important to safety that apply to selecting suppliers, as well as to assessing the adequacy of quality, and (2) provisions to ensure onsite availability of documented evidence of the conformance to procurement specifications of material and equipment related to ESP activities that could affect SSCs important to safety before their installation or use.

17.7.3 Technical Evaluation (Control of Purchased Material, Equipment, and Services)

Section 17.4 of this SER details the controls of purchased material, equipment, and services applied by the applicant to its primary subcontractor. This section of the SER focuses on the additional subcontractors that were engaged in ESP activities. The following discussion addresses the scope of activities and the QA measures applied to those activities.

17.7.3.1 Parsons Energy & Chemicals Group

The overall scope of work conducted by Parsons includes review and assessment of existing site data; review and assessment of plant parameter envelope (PPE) data; preparation of site plot plan and facility description sections of the SSAR; preparation of the SSAR text for mechanical, structural, and electrical sections; and documentation for the effluents and design-basis accident sections of the SSAR.

Inspection Report 0520007/2004001 details the staff's review of Parsons' preparation of the SSAR in support of the ESP application. The Parsons QA manual states that Parsons will meet the requirements of Appendix B to 10 CFR Part 50; American National Standards Institute (ANSI) N45.2, "Quality Assurance Program Requirements for Nuclear Facilities," issued in 1977; and American Society of Mechanical Engineers (ASME) NQA-1-2000, "Quality Assurance Requirements for Nuclear Facility Applications," issued in 2000. Parsons conducted its work under this document and supplementary procedures.

The staff reviewed the adequacy of the guidance for the accumulation, control, and maintenance of QA records relating to the project. The staff also reviewed the organizational responsibilities and lines of communication among the different engineering disciplines established in each of the reviewed procedures. This included designation of personnel who originated the initial design or input and the associated reviewers. A Parsons procedure delineates guidelines for the review of specifications to produce design criteria and documentation used for the design of the project. The staff evaluated procedures for the review of calculations, including spreadsheet/database utilities and computer analyses.

The staff noted that the QA manual provides administrative directives to project personnel and includes the quality plan implemented for the project. The manual identifies organizational structure and interfaces, outlines project personnel responsibilities, and defines design control, interface control, and client-specific requirements. The manual recognizes the need for controls and procedures for the work performed under this task based on the use of the data generated. The manual states that it should be used for those portions of the work, such as calculations, where the requirements of Appendix B to 10 CFR Part 50 apply. The manual also details the specific areas that are applicable.

The staff found the QA manual and procedures to be adequate to cover the areas of ESP activities that were the responsibility of Parsons.

17.7.3.2 Testing Services Corporation

Testing Services Corporation (TSC) provided engineering, technical, and laboratory services associated with geotechnical activities. Geotechnical activities include site borings, sample collection, testing, and inspection of soil and rock as used in engineering design and construction. The staff reviewed the QA manual prepared by TSC for ESP activities. The TSC manual includes a description of the TSC organization, the resumes of personnel who conducted geotechnical activities, data reports and records, calibration records and procedures, and procedures related to sample testing and onsite inspections. TSC performed site borings and sample collections in accordance with the TSC manual. CH2M HILL reviewed and approved the manual and found it to be prepared in accordance with the criteria required in the PQP and in American Society for Testing and Materials (ASTM) D3740, "Standard Practice for Minimum Requirement for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction," issued in 2001. Inspection Report 0520007/2004001 details the staff's review of additional procedures related to the work conducted by TSC.

TSC designated a licensed professional engineer as responsible for ensuring internal quality reviews of work activities. The TSC QA manual includes a copy of the internal quality review check sheet.

Other subcontractors, including Stratigraphics and GEOVision Geographical Services (GEOVision), were involved in similar work. These subcontractors were also required to follow the same ASTM standards and CH2M HILL procedures.

The staff's review of the procedures and the TSC QA manual found that the documents provide a thorough description of the work processes and adequate QA measures.

17.7.3.3 Geomatrix

Geomatrix performed seismic and geologic data collection, site response studies, and the determination of the safe-shutdown earthquake (SSE) for the ESP application. The staff reviewed documentation related to calculations and analyses, software validation, verification and control, and the Geomatrix purchase order. The staff also reviewed company personnel resumes and QA training records. Geomatrix personnel were trained and performed work under CH2M HILL PQP procedures regarding software verification controls and documentation and review of calculations and analyses.

Geomatrix used software developed or modified by the company to perform calculations related to the seismic analysis in the ESP application. The staff reviewed Geomatrix documentation, which provides additional information regarding the V&V performed on the modified software. The documentation explains procedures for software V&V performed by Geomatrix. The documentation also includes a summary description of the V&V presentation provided by Geomatrix personnel to the NRC staff. During the presentation, Geomatrix personnel described the V&V procedures for two of the software codes used to perform the seismic hazard analysis and explained the software modifications necessary to perform the ESP calculations.

As further described in Inspection Report 0520007/2004001, Geomatrix performed verification activities for its software before the start of the ESP project. In order to perform the ESP calculations, the Geomatrix computer codes needed modifications to accept ground motion models and seismic source parameters developed by the Electric Power Research Institute (EPRI). The EPRI probabilistic seismic hazard analysis for the Seismic Owners Group is acceptable for characterizing the seismic hazard for nuclear power plants, as stated in Regulatory Guide (RG) 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe-Shutdown Earthquake Ground Motion," issued in 1997. Appendix B, Section 3.2.1, to the ESP SSAR documents the results, which the staff reviewed.

The staff concluded that Geomatrix complied with the CH2M HILL PQP and that the design control measures used by Geomatrix for seismic studies incorporated into the ESP application are adequate.

CH2M HILL developed a procedure to outline the quality measures for Geomatrix to use in conducting ESP activities. The procedure details the specific work to be conducted, such as seismic hazard and geotechnical studies. The procedure states that Geomatrix will conduct the work in accordance with the PQP. Additionally, the scope of work covered by the procedure was intended to be consistent with the guidance provided in RGs 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants—LWR Edition," issued in 1978, and 1.165. The staff determined that the procedure provides adequate guidance for the scope of work conducted.

17.7.3.4 GRL Engineers, Inc.

The staff reviewed the GRL QA manual. GRL conducted standard penetration test (SPT) measurement work. The staff reviewed documentation that provides the extent of QA measures applied to ESP activities. GRL performed its measurements in accordance with ASTM D4945, "Standard Test Method for High-Strain Dynamic Testing of Piles," issued in 2000, concerning dynamic measurements. Measurement gauges and signal processing equipment complied with the standard for dynamic measurements. In addition, GRL prepared and reviewed engineering calculations in accordance with the GRL QA plan. The staff reviewed the GRL QA plan and found the plan to be adequate for the GRL ESP activities.

GRL performed SPTs in accordance with the GRL QA plan and Section 6.1 of ASTM D4945 for dynamic measurements. A CH2M HILL field supervisor monitored the work performed and verified that it was performed in accordance with the seismic field work plan. CH2M HILL reviewed the GRL quality manual following completion of the GRL work and found that the manual meets the requirements of the PQP. The staff found the primary contractor's controls adequate for the scope of work GRL conducted.

17.7.3.5 Stratigraphics

Stratigraphics performed cone penetrometer measurements and testing used for the geotechnical aspects of the ESP application. CH2M HILL monitored the work, which was performed in accordance with the CH2M HILL PQP and ESP project quality field work plans. The staff found the primary contractor's controls adequate for the scope of work conducted by Stratigraphics.

17.7.3.6 University of Texas

The University of Texas (UT) performed soil sample resonant column and torsional shear (RCTS) testing. The staff reviewed the UT testing report, which details procedures for preparing, reviewing, and calibrating system equipment, and for system performance checks. The procedures were designed to meet ASTM D3740. The UT engineering personnel were trained and were supervised during performance of the tests.

The UT QA program policies contained in the report are in accordance with those previously approved by the U.S. Department of Energy for the Yucca Mountain project soil and rock tests, also performed by UT. Documentation presented by UT describes technical and test procedures for the RCTS testing performed in its soil dynamics laboratory. The staff also reviewed an overview of the test program, theoretical background of RCTS tests, discussion of the dynamic test results and reports, and validation procedures. The staff found no deficiencies.

17.7.3.7 10 CFR Part 21 Applicability

NRC Inspection Report 520007/2004001 identified Open Item 520007/2004001-02, concerning the applicability of 10 CFR Part 21, "Reporting of Defects and Noncompliance," to ESP applicants. This issue was generated during an NRC workshop held on August 27, 2003. During that workshop, EGC representatives stated the company's position is that 10 CFR Part 21 does not apply to ESP applicants. The NRC staff attending the workshop disagreed with this position but indicated that it would further evaluate this issue and communicate a final NRC position on the matter at a later date. The draft safety evaluation report (DSER) identifies this as Open Item 17.1-1.

A June 22, 2004, letter to the Nuclear Energy Institute (NEI) (ADAMS Accession No. ML040430041) and summaries of two public meetings with NEI on generic ESP issues (September 9, 2004, ADAMS Accession No. ML042610277; November 10, 2004, ADAMS Accession No. ML043290195) document the NRC position regarding the applicability of 10 CFR Part 21 to ESP applicants and holders.

The NRC position is that safety-related design and analysis or consulting services must be procured and controlled, or dedicated, in a manner sufficient to allow the ESP holder and its contractors, as applicable, to comply with the reporting requirements of 10 CFR 50.55(e) and 10 CFR Part 21. If this were not done, the ESP holder would not be in compliance with 10 CFR 50.55(e) upon issuance of the ESP nor would its suppliers of such services be in compliance with 10 CFR Part 21 at that time.

The staff conducted a followup inspection of Open Item 17.1-1 on May 19, 2005, at the applicant's offices in Kennett Square, Pennsylvania. The staff determined through a review of supporting documentation that the applicant had adequately implemented the requirements of 10 CFR Part 21 for safety-related design and analysis or consulting services supplied by the primary contractor and subcontractors, that supported information in the SSAR that would affect the design, construction, or operation of SSCs important to safety. Specifically, the applicant revised its QA instructions to incorporate 10 CFR Part 21 requirements. The contracts were revised to invoke 10 CFR Part 21 requirements for outstanding work being conducted by subcontractors. Additionally, for closed contracts, the applicant sent letters to the respective subcontractors requesting notification from a responsible company representative that EGC had been informed of any outstanding defect or noncompliance with the services supplied (there were none). Based on this inspection, the staff concludes that Open Item 17.1-1 is resolved.

17.7.4 Conclusion (Control of Purchased Material, Equipment, and Services)

As set forth above, the staff reviewed the QA measures employed by the applicant and its contractors and concluded that they have implemented acceptable controls for purchased material, equipment, and services which meet the guidance of Section 17.1.1 of RS-002, Attachment 2, and help provide reasonable assurance that any information derived from ESP activities that is used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.8 Identification and Control of Materials, Parts, and Components

17.8.1 Technical Information in the Application (Identification and Control of Materials, Parts, and Components)

The EGC application did not initially supply information about the identification and control of materials, parts, and components, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction stated that the applicant will apply elements from these criteria or verify that the controls applied to the ESP activities reflect these elements. The applicant did not consider identification and control of materials, parts, and components to be a criterion having elements associated with the control of ESP activities.

The instruction states that identification and control of materials, parts, and components do not apply to ESP activities because these activities do not involve fabrication, erection, installation, and use of materials, parts, or components.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50. The PQP states that this quality criterion does not apply to ESP activities.

In RAI 17.1.1-3, the staff asked the applicant to explain why the identification and control of materials, parts, and components do not apply to the development of the ESP application. Alternatively, if this QA measure were to apply, the staff asked the applicant to describe the QA measures it and its primary contractor used for the ESP application. In its response, the applicant stated that the development of the ESP application does not involve the fabrication, erection, installation, and use of materials, parts, or components. Thus, no QA measures are necessary to prevent the use of incorrect or defective fabricated, erected, or installed materials, parts, or components.

17.8.2 Regulatory Evaluation (Identification and Control of Materials, Parts, and Components)

While the NRC does not require the identification and control of materials, parts, and components to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's identification and control of materials, parts, and components. The applicant's instruction states that the identification and control of materials, parts, or components do not apply to ESP activities.

Paragraph 17.1.1.8 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of identification and control of materials, parts, and components. Acceptable identification and control of materials, parts, and components should include (1) provisions to identify and control materials, parts, and components related to ESP activities that could affect SSCs important to safety, and (2) provisions to ensure that incorrect or defective items are not used in ESP activities that could affect SSCs important to safety.

17.8.3 Technical Evaluation (Identification and Control of Materials, Parts, and Components)

Neither the applicant nor its primary contractor invoked QA measures for the identification and control of materials, parts, and components. The staff concluded, based on its review of the applicant's response to RAI 17.1.1-3 and its observations during the inspection, that the applicant and CH2M HILL did not conduct activities important to safety requiring identification and control of materials, parts, and components.

17.8.4 Conclusion (Identification and Control of Materials, Parts, and Components)

As set forth above, the staff reviewed the need for QA measures by the applicant and its primary contractor and concluded that, based on the scope of work for the ESP project, the identification and control of materials, parts, and components are not required.

17.9 Control of Special Processes

17.9.1 Technical Information in the Application (Control of Special Processes)

The EGC application did not initially supply information about the control of special processes, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant will apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant did not consider control of special processes to be a criterion having elements associated with the control of ESP activities.

The instruction states that control of special processes does not apply to ESP activities. In accordance with the instruction, because no special processes such as welding, heat treating, and nondestructive testing are involved in ESP activities, no measures are necessary for the control of special processes.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50. The PQP states that this quality criterion does not apply to ESP activities.

In RAI 17.1.1-3, the staff asked the applicant to explain why control of special processes does not apply to the development of the ESP application. Alternatively, if this QA measure were to apply, the staff asked the applicant to describe the QA measures it and its primary contractor used for the ESP application. In its response, the applicant stated that the development of the ESP application does not involve special processes, such as welding, heat treating, and nondestructive testing. Thus, no QA measures are necessary for the control of special processes.

17.9.2 Regulatory Evaluation (Control of Special Processes)

While the NRC does not require the control of special processes to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's control of special processes. In Section 4.2.9 of the instruction, the applicant stated that the use of special processes does not apply to ESP activities.

Paragraph 17.1.1.9 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of control of special processes. Acceptable control of special processes should include (1) provisions to ensure the acceptability of special processes used for ESP activities that could affect SSCs important to safety, and (2) provisions to ensure that qualified personnel using qualified procedures and equipment perform special processes related to ESP activities that could affect SSCs important to safety.

17.9.3 Technical Evaluation (Control of Special Processes)

Neither the applicant nor its primary contractor invoked QA measures for the control of special processes. The staff concluded, based on its review of the applicant's response to RAI 17.1.1-3 and its observations during the inspection, that the applicant and CH2M HILL did not conduct activities important to safety that required control of special processes.

17.9.4 Conclusion (Control of Special Processes)

As set forth above, the staff reviewed the need for QA measures by the applicant and its primary contractor and concluded that, based on the scope of work for the ESP project, control of special processes is not required.

17.10 Inspection

17.10.1 Technical Information in the Application (Inspection)

The EGC application did not initially supply information about the control of inspection, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant would apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant did not consider the control of inspection to be a criterion having elements associated with the control of ESP activities.

The instruction states that the control of inspection does not apply to ESP activities; therefore, since no safety-related material or product processing is involved in the ESP activities, no inspection activities (by the applicant) are expected or planned.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the elements of Appendix B to 10 CFR Part 50. The PQP states that this quality criterion does not apply to ESP activities.

In RAI 17.1.1-3, the staff asked the applicant to explain why inspection does not apply to the development of the ESP application. Alternatively, if this QA measure were to apply, the staff asked the applicant to describe the QA measures it and its primary contractor used for the ESP application. In its response, the applicant stated that the development of the ESP application does not involve safety-related material or product processing. Thus, the applicant does not expect or plan to conduct any QA inspections.

17.10.2 Regulatory Evaluation (Inspection)

While the NRC does not require inspection controls to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's controls for inspection. In Section 4.2.10 of the instruction, the applicant stated that inspection did not apply to ESP activities.

Paragraph 17.1.1.10 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of inspection control. Acceptable inspection controls should include (1) provisions for the inspection of activities affecting the quality of ESP activities that could affect SSCs important to safety, including the items and activities to be covered, (2) organizational responsibilities and qualifications for individuals or groups performing inspection of ESP activities that could affect SSCs important to safety, and (3) provisions for inspection personnel to be independent of the performance of the activity being inspected.

17.10.3 Technical Evaluation (Inspection)

Neither the applicant nor its primary contractor invoked QA measures for inspection. The staff concluded, based on its review of the applicant's response to RAI 17.1.1-3 and its observations during the inspection, that the applicant and CH2M HILL did not conduct activities important to safety that required control of inspection.

17.10.4 Conclusion (Inspection)

As set forth above, the staff reviewed the need for QA measures by the applicant and its primary contractor and concluded that, based on the scope of work for the ESP project, inspection by the applicant is not required.

17.11 Test Control

17.11.1 Technical Information in the Application (Test Control)

The EGC application did not initially supply information on test control, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant will apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant considered test control to be a criterion having elements associated with the control of ESP activities.

The instruction states that the PQP will include controls for testing accomplished in connection with the development of an ESP application.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50. The PQP states that testing will be conducted in accordance with controlled procedures established after consideration of the applicable industry standards. Test procedures will include provisions for verifying that the prerequisites for a given test have been met, that adequate test instrumentation is available and used, and that the test is performed under suitable environmental conditions. Test results will be documented and evaluated to verify that the test requirements have been satisfied.

17.11.2 Regulatory Evaluation (Test Control)

While the NRC does not require test controls to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's test controls. The applicant's instruction details the test controls it applied to the ESP activities.

Paragraph 17.1.1.11 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of test control. Acceptable test controls should include (1) provisions to ensure that tests performed related to ESP activities that could affect SSCs important to safety are appropriately controlled to provide confidence that these SSCs will perform adequately once they are in service, and (2) provisions to ensure that prerequisites are provided in written test procedures and that test results are documented and evaluated for ESP activities that could affect SSCs important to safety.

17.11.3 Technical Evaluation (Test Control)

17.11.3.1 Exelon Generation Company

ESP quality project personnel observed activities performed at the proposed ESP site. The field activities included the following:

- TSC advanced three deep soil borings using mud rotary drilling methods and conducted soil sampling. TSC also advanced rock coring up to 30 feet (ft) into the bedrock in the deep boring.

- TSC installed three ground water piezometers.

- Stratigraphics advanced four cone penetrometer test (CPT) soundings. Two of these included seismic wave CPTs for the measurement of the shear wave velocity soil profile, in addition to the normal CPT side and end resistance measurements. The other two were piezocone CPT soundings, involving end, side, and pore pressure measurements.

- GEOVision conducted one suspension logging test to log the shear wave velocity of the subsurface profile.

- Chastain surveyed each of the boring and sounding locations for horizontal coordinates. Elevations of each location were measured by differential leveling.

The "ESP Project Activity Matrix," which EGC provided to the staff, identified the contractors performing ESP-related activities. Contractors on site during the field activities included (1) TSC, responsible for site borings, sample collection, and piezometer tests, (2) GRL, responsible for SPT measurements, (3) GEOVision, responsible for suspension logging tests to determine shear and compressional wave velocities, and (4) Homer Chastain and Associates, responsible for collection, review, and preparation of the data for inclusion in the ESP application.

The staff considered test control to be adequate based on its field observations and review of ESP quality project personnel logs.

17.11.3.2 CH2M HILL

The staff reviewed the CH2M HILL purchase orders for each of the contractors. With the exception of TSC and GRL, the contractors worked in accordance with the CH2M HILL PQP. TSC and GRL conducted activities in accordance with their own internal quality plans. The staff reviewed all quality plans.

In conjunction with the governing quality plans, a task-specific geotechnical field work plan, prepared by CH2M HILL, controlled site activities. The CH2M HILL auditor and the CH2M senior geotechnical engineer assigned to the ESP project reviewed and approved the work plan. The senior engineer's qualifications, as shown on his resume, include 30 years of geotechnical design and consulting experience and a Ph.D. in civil engineering.

During the period of field activities, the CH2M HILL auditor was on site full time and observed activities in progress on a daily basis. The staff reviewed his field log for each of the days on which the subsurface investigations were conducted. The log documented work by TSC from the time the drill rig arrived at the site through the time of its departure when the auditor secured the site.

In addition to the surveillance activities that occurred during the performance of subsurface investigations, CH2M HILL conducted an audit while boring was in progress. The CH2M HILL project QA manager conducted the audit, with the CH2M HILL senior geotechnical engineer providing technical assistance. The scope of the audit included contractor compliance with the geotechnical field workplan, in addition to applicable quality requirements.

The field notes documented a site visit by Geomatrix during field activities and a visit subsequent to field activities by a UT representative. This individual was responsible for the resonant column/cyclic testing performed; the ESP application documents the results of this testing. The staff documented its observations from this visit in a September 9, 2002, memorandum from R.N. Gardner, NRC, to J.E. Lyons, NRC (ADAMS Accession No. ML022530396).

17.11.4 Conclusion (Test Control)

As set forth above, the staff reviewed the QA measures employed by the applicant and its primary contractor. The staff concluded that these measures implement acceptable test controls which meet the guidance of Section 17.1.1 of RS-002, Attachment 2, and help provide reasonable assurance that any information derived from ESP activities that is used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.12 <u>Control of Measuring and Test Equipment</u>

17.12.1 Technical Information in the Application (Control of M&TE)

The EGC application did not initially supply information about the control of measuring and test equipment (M&TE), but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant would apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant considered control of M&TE to be a criterion having elements associated with the control of ESP activities.

The instruction states that the PQP will include controls for the accuracy of M&TE used in connection with the development of an ESP application, as well as guidance that addresses actions to be taken when said equipment is unacceptable for use.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50. The PQP states that measures will be established to assure that tools, gauges, instruments, and other measuring devices used in activities affecting quality are properly controlled, calibrated, and adjusted at specified periods to maintain accuracy within necessary limits.

17.12.2 Regulatory Evaluation (Control of M&TE)

While the NRC does not require the control of M&TE to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's control of M&TE. In its instruction, the applicant detailed the control of M&TE it applied to ESP activities.

Paragraph 17.1.1.12 in Section 17.1.1 of RS-002, Attachment 2, describes the QA measures that constitute an acceptable level of control of M&TE. Acceptable control of M&TE should include provisions to ensure that tools, gauges, instruments, and other measuring and testing devices are properly identified and controlled and are calibrated and adjusted at specified intervals.

17.12.3 Technical Evaluation (Control of M&TE)

The instruction states that the applicant is responsible for the establishment and execution of a project QA plan for the ESP project, but that EGC typically delegates to others, such as contractors, the work of establishing and executing the QA plan. For control of M&TE, most of the subcontractors implemented their own controls. The following sections detail these controls.

17.12.3.1 GRL Engineers, Inc.

GRL conducted SPT measurement work. The staff reviewed the controls that GRL applied to M&TE. GRL performed its measurements in accordance with ASTM D4945 for dynamic measurements. Measurement gauges and signal processing equipment were in compliance with the standard for dynamic measurements. The staff found that GRL complied with the ASTM standard.

17.12.3.2 Testing Services Corporation

CH2M HILL subcontracted to TSC to obtain geological testing support, such as site borings, sample collection, and piezometer installation. The staff reviewed the adequacy of the TSC work plan and QA manual for control of M&TE. The manual indicates that reviews of test results were conducted. Furthermore, the staff noted that the QA manual states that TSC performs calibration and verification of required equipment at specified intervals. Additionally, TSC keeps a calibration and verification file for each piece of equipment. The staff found the TSC control of M&TE to be adequate for the scope of work conducted.

17.12.3.3 University of Texas

The UT team performed soil sample RCTS. The staff reviewed the testing report, which detailed procedures for the control of M&TE. The procedures were designed to meet ASTM D3740. The staff considered the procedures adequate for the control of M&TE for the scope of work conducted by UT.

17.12.4 Conclusion (Control of M&TE)

As set forth above, the staff reviewed the QA measures employed by the applicant and its contractors. The staff concluded that control of M&TE that meets the guidance of Section 17.1.1 of RS-002, Attachment 2, and helps provide reasonable assurance that any information derived from ESP activities that is used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.13 <u>Handling, Storage, and Shipping</u>

17.13.1 Technical Information in the Application (Handling, Storage, and Shipping)

The EGC application did not initially supply information about handling, storage, and shipping, but the applicant subsequently provided information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant would apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant considered handling, storage, and shipping to be a criterion having elements associated with the control of ESP activities.

The instruction states that the PQP will include controls for the handling, storage, and shipping of ESP project material and equipment.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50.

The PQP states that measures will be established to control the handling, storage, shipping, cleaning, and preservation of material and equipment, in accordance with work and inspection instructions as necessary, to prevent damage or deterioration. When necessary for particular products, the PQP will specify and provide, if appropriate, special protective environments such as inert gas atmosphere, specific moisture content levels, and temperature levels.

17.13.2 Regulatory Evaluation (Handling, Storage, and Shipping)

While the NRC does not require controls for handling, storage, and shipping to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's controls for handling, storage, and shipping. The applicant's instruction details the handling, storage, and shipping controls it applied to ESP activities.

Paragraph 17.1.1.13 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of handling, storage, and shipping control. Acceptable controls for handling, storage, and shipping should include provisions to control handling, storage, shipping, cleaning, and preservation of items related to ESP activities that could affect SSCs important to safety, in accordance with work and inspection instructions, to prevent damage, loss, and deterioration by environmental conditions, such as temperature or humidity.

17.13.3 Technical Evaluation (Handling, Storage, and Shipping)

17.13.3.1 CH2M HILL

With the exception of TSC and GRL, the contractors conducted their work in accordance with the CH2M HILL PQP. TSC and GRL conducted handling, storage, and shipping activities in accordance with their own internal quality plans. In conjunction with the governing quality plans, a task-specific geotechnical field work plan, prepared by CH2M HILL, controlled site activities. The staff reviewed all quality plans and the work plan and found them to be adequate for handling, storage, and shipping controls. The staff also reviewed field notes and logs and noted no deficiencies related to handling, storage, and shipping controls.

17.13.4 Conclusion (Handling, Storage, and Shipping)

As set forth above, the staff reviewed the QA measures the primary contractor and its subcontractors used. The staff concluded that there were acceptable controls for handling, storage, and shipping which meet the guidance of Section 17.1.1 of RS-002, Attachment 2, and help provide reasonable assurance that any information derived from ESP activities that is used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.14 Inspection, Test, and Operating Status

17.14.1 Technical Information in the Application (Inspection, Test, and Operating Status)

The EGC application did not initially supply information about the control of inspection, test, and operating status, but the applicant subsequently provided information in response to an RAI.

The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant would apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant did not consider the control of inspection, test, and operating status to be a criterion having elements associated with the control of ESP activities.

The instruction states that control of inspection, test, and operating status does not apply to ESP activities. Because ESP activities do not involve inspection, testing, or operation of SSCs of a nuclear power plant, the instruction does not require measures relating to the inspection, testing, or operation of such SSCs.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50. The PQP states that this quality criterion does not apply to ESP activities.

In RAI 17.1.1-3, the staff asked the applicant to explain why the control of inspection, test, and operating status does not apply to the development of the ESP application. Alternatively, if this QA measure were to apply, the staff asked the applicant to describe the QA measures it and its primary contractor used for the ESP application. In its response, the applicant stated that the development of the ESP application does not involve inspection, testing, or operation of SSCs of a nuclear power plant. Therefore, QA measures relating to the inspection, testing, or operation of such SSCs are not necessary.

17.14.2 Regulatory Evaluation (Inspection, Test, and Operating Status)

While the NRC does not require controls for inspection, test, and operating status to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's controls for inspection, test, and operating status. In Section 4.2.14 of the instruction, the applicant stated that controls for inspection, test, and operating status do not apply to ESP activities.

Paragraph 17.1.1.14 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of controls for inspection, test, and operating status. Acceptable controls for inspection, test, and operating status should include provisions to indicate the inspection, test, and operating status of items related to ESP activities that could affect SSCs important to safety. These provisions will prevent inadvertent use or bypassing of inspection and tests.

17.14.3 Technical Evaluation (Inspection, Test, and Operating Status)

Neither the applicant nor its primary contractor invoked QA measures for inspection, test, and operating status. The staff concluded, based on its review of the applicant's response to RAI 17.1.1-3 and its observations during the inspection, that the applicant and CH2M HILL did not conduct activities important to safety requiring inspection, test, and operating status.

17.14.4 Conclusion (Inspection, Test, and Operating Status)

As set forth above, the staff reviewed the need for QA measures by the applicant and its primary contractor and concluded that, based on the scope of work for the ESP project, inspection, test, and operating status measures are not required.

17.15 Nonconforming Materials, Parts, or Components

17.15.1 Technical Information in the Application (Nonconforming Materials, Parts, or Components)

The EGC application did not initially supply information about control of nonconforming materials, parts, or components, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant would apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant did not consider the control of nonconforming materials, parts, or components to be a criterion having elements associated with control of ESP activities.

The instruction states that control of nonconforming materials, parts, or components does not apply to ESP activities. Since ESP activities do not involve the fabrication, erection, installation, and use of materials, parts, or components, no measures are necessary to prevent the use or installation of nonconforming materials, parts, or components.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50. The PQP states that this criterion does not apply to ESP activities.

In RAI 17.1.1-3, the staff asked the applicant to explain why control of nonconforming materials, parts, and components does not apply to the development of the ESP application. Alternatively, if this QA measure were to apply, the staff asked the applicant to describe the QA measures it and its primary contractor used for the ESP application. In its response, the applicant stated that the development of the ESP application does not involve fabrication, erection, installation, and use of materials, parts, or components. Thus, no QA measures are necessary to prevent the use or installation of nonconforming materials, parts, or components.

17.15.2 Regulatory Evaluation (Nonconforming Materials, Parts, or Components)

While the NRC does not require control of nonconforming materials, parts, or components to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's control of nonconforming materials, parts, or components. The applicant's instruction states that the control of nonconforming materials, parts, or components does not apply to ESP activities.

Paragraph 17.1.1.15 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of control of nonconforming materials, parts, or components.

Acceptable controls for nonconforming materials, parts, or components should include provisions to control the use or disposition of nonconforming materials, parts, or components related to ESP activities that could affect SSCs important to safety.

17.15.3 Technical Evaluation (Nonconforming Materials, Parts, or Components)

Neither the applicant nor its primary contractor invoked QA measures for the control of nonconforming materials, parts, or components. The staff concluded, based on its review of the applicant's response to RAI 17.1.1-3 and its observations during the inspection, that the applicant and CH2M HILL did not conduct activities important to safety that required control of nonconforming materials, parts, or components.

17.15.4 Conclusion (Nonconforming Materials, Parts, or Components)

As set forth above, the staff reviewed the need for QA measures by the applicant and its contractors and concluded that, based on the scope of work for the ESP project, control of nonconforming materials, parts, or components is not required.

17.16 Corrective Action

17.16.1 Technical Information in the Application (Corrective Action)

The EGC application did not initially supply information about corrective action, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant would apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant considered corrective action to be a criterion having elements associated with control of ESP activities.

The instruction states that the PQP will include controls for the identification and correction of ESP project conditions adverse to quality. In addition, any conditions adverse to quality pertaining to the actions or functions of the EGC-specific segment of the ESP project will be addressed either in accordance with the corrective action program identified in the PQP, or in accordance with the applicant's corrective action program.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50. The PQP states that measures will be established to promptly identify and correct conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances. In the case of significant conditions adverse to quality, the measures will determine the cause of the conditions and result in corrective action being taken to correct the condition and to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken will be documented and reported to the appropriate level of management. The QA manager is responsible for the corrective action program and its implementing procedures, as well as for processing corrective actions. Project personnel may address quality issues directly to the QA manager or project manager when it is apparent that normal processes are not timely or capable of resolving the issue.

17.16.2 Regulatory Evaluation (Corrective Action)

While the NRC does not require a corrective action program to comply with Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's corrective action program. The applicant's instruction states that corrective action does apply to ESP activities.

Paragraph 17.1.1.16 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of control of corrective action. An acceptable corrective action program should include provisions to ensure that conditions adverse to quality are promptly identified and corrected. For significant conditions adverse to quality, those provisions should preclude recurrence.

17.16.3 Technical Evaluation (Corrective Action)

17.16.3.1 Exelon Generation Company

The instruction provides controls for the identification and correction of ESP project conditions adverse to quality. The instruction specifies that any conditions adverse to quality pertaining to the actions or functions specific to EGC would be addressed either in accordance with the corrective action program identified in the PQP or in accordance with the applicant's own corrective action program.

The PQP provides for the identification and correction of conditions adverse to quality. The PQP states that when a significant condition adverse to quality occurs, the cause of the condition and the corrective action taken will be documented and reported to the appropriate level of management. The CH2M HILL QA manager is responsible for the corrective action program and its implementing procedures and for processing corrective actions. The staff determined through interviews with the QA manager and review of relevant documentation that he possesses adequate training and qualification, including knowledge of the corrective action process and the resolution of condition reports.

17.16.3.2 CH2M HILL

The staff reviewed the CH2M HILL project procedure for the corrective action program, as detailed in Inspection Report 0520007/2004001. The procedure provides instructions for establishing and operating a corrective action program and establishes processes and methods to be used to resolve issues. The procedure requires documentation of the determination of the root cause of significant issues, the development and implementation of effective corrective action plans, and the performance of followup activities to determine whether the corrective action is effective in resolving the issue. The staff determined the guidance in the procedure to be adequate for the conduct of a corrective action program.

The staff reviewed all of the corrective action reports (CARs) that were generated during the applicant's ESP activities, including subsequent actions to resolve identified issues. Inspection

Report 0520007/2004001 provides further information. The staff also discussed some of its observations with the CH2M HILL QA manager. For the majority of the CARs, the staff found the proposed corrective action and subsequent resolution to be adequate in addressing the identified problem. The staff did note that the auditor performing the audit had generated all of the CARs. The personnel conducting the ESP activities did not generate any CARs. The staff also noted an instance in which CH2M HILL did not initially document the root cause of an adverse condition. The applicant identified this deficiency to CH2M HILL. CH2M HILL subsequently corrected it. Finally, an EGC audit identified many adverse findings related to procedural deficiencies revealed during the early stages of ESP activities. The applicant assured the staff that it had corrected the findings. The staff determined that the findings identified above do not have a significant impact on ESP activities and had been adequately resolved.

17.16.4 Conclusion (Corrective Action)

As set forth above, the staff reviewed the QA measures employed by the applicant and its primary contractor and concluded that they have implemented an acceptable corrective action program which meets the guidance of Section 17.1.1 of RS-002, Attachment 2, and helps provide reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.17 Quality Assurance Records

17.17.1 Technical Information in the Application (Quality Assurance Records)

The EGC application did not initially supply information about the control of QA records, but the applicant subsequently provided information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant would apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant considered QA records to be a criterion having elements associated with the control of ESP activities.

The instruction states that the PQP will include controls for the identification, retention, and maintenance of ESP project records. In addition, the applicant will retain records of audits and reviews in project files until the completion of the project. If the ESP application were to be used to obtain a COL, the project records would become records associated with the requirements of 10 CFR Part 52, Subpart C, for a licensed facility. The applicant will, at ESP project completion, take possession of and retain from the lead contractor all applicable ESP project documentation in accordance with its records retention and storage processes.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50. The PQP states that records required for the quality program will be controlled. Controls will be implemented to ensure that the records are legible, readily identifiable, and retrievable. Consistent with applicable regulatory requirements, specific requirements concerning record retention, such as duration, location, and assigned responsibility, will be determined. Records may be in any format consistent with these storage requirements, including hard copy, electronic, or other media. Sufficient records will be maintained to furnish evidence of activities affecting quality. The records will include, at a minimum, operating logs and the results of reviews, inspections, tests, audits, monitoring of work performance, and materials analyses. The records will also include closely related data, such as qualifications of personnel, procedures, and equipment. Inspection and test records will also identify the inspector or data recorder, the type of observation, the results, the acceptability, and the action taken in connection with any deficiencies noted.

17.17.2 Regulatory Evaluation (Quality Assurance Records)

While the NRC does not require control of QA records to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's QA records. In its instruction, the applicant stated that control of QA records applies to ESP activities.

Paragraph 17.1.1.17 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of QA records control. Acceptable control of QA records should include provisions for the identification, retention, retrieval, and maintenance of quality records.

17.17.3 Technical Evaluation (Quality Assurance Records)

17.17.3.1 Exelon Generation Company

The instruction states that the PQP will include controls for the identification, retention, and maintenance of ESP project records. The staff reviewed the applicant's procedures associated with records retention. Inspection Report 0520007/2004001 details this review. An EGC procedure provides general guidance on retention of records. Records are classified as "lifetime" or "nonpermanent" according to criteria in the procedure. The procedure requires review of nonpermanent records to determine an appropriate retention period; a documented review has not yet occurred for ESP records. The applicant stated that it intends to retain ESP-related QA records until it decides whether to use the ESP in support of a COL application. If EGC decides to reference the ESP in a COL application, the COL project will acquire the ESP records.

The staff reviewed the applicant's requirements imposed on contractors for turning over ESP quality records. The instruction requires that the applicant, at ESP project completion, take possession from the lead contractor of all applicable ESP project documentation, in accordance with EGC record retention and storage processes. The applicant stated that CH2M HILL does not have an explicit written internal requirement regarding turnover of records to EGC. However, the applicant, through a service agreement, required CH2M HILL to provide it with all information and documentation that are within the contractor's scope of services and that are required for the design, construction, licensing, QA, operation, or maintenance of the services or of the facility for which the services are intended.

17.17.3.2 CH2M HILL

The PQP states that records required for the quality program will be controlled and that sufficient records will be maintained to furnish evidence of activities affecting quality. The PQP also lists the types of records requiring control as quality records.

The staff reviewed several of the primary contractor's QA records procedures, which are discussed in Inspection Report 0520007/2004001. A CH2M HILL project procedure establishes instructions for identifying, storing, retrieving, protecting, retaining, and disposing of project QA records. This procedure outlines responsibility for QA records for project managers, the document control manager, and recordkeepers. It also lists categories of QA records and requirements for storage and protection, retrieval, and disposition. For example, the procedure requires that recordkeepers consider security, fire, and environment (heat and humidity) before storing records.

The staff also reviewed the CH2M HILL record retention requirements. The record retention procedure states that the retention time of all quality records will be defined. It referred to the CH2M HILL online records management retention schedule, which contains specific retention requirements for project files (records documenting substantive project documentation, including calculations, reference material, preliminary drawings and reports, project contracts, and documentation of any client requirements). The company maintains these records for the active length of a project plus 6 years. It retains work products and deliverables for periods of 6 to 15 years after the active period of a project, depending on the type of record. The staff also reviewed the CH2M HILL quality record log for ESP deliverables. This log showed specific CH2M HILL retention periods for ESP records that appeared to be consistent with those specified in the online records management retention schedule. CH2M HILL personnel interviewed stated that service agreements (contracts) with clients govern retention requirements for records developed by CH2M HILL that are associated with the clients' projects. Several line entries in the online retention schedule related to project records contain language consistent with these statements. As detailed in Inspection Report 0520007/2004001, the staff also reviewed procedures for document control and creation, as well as for peer and technical review.

Interviews with cognizant EGC and CH2M HILL staff indicated that responsibility for quality records had not been turned over to the applicant. At the time of the inspection, the records resided on a secure computer server in the CH2M HILL offices in Idaho Falls, Idaho. The CH2M HILL document control manager (DCM) stated that she controlled access to and storage of the records. She stated that the server containing the documents was housed in a secure room, which was locked at night, and that the room contained a fire suppression system. She stated that security, fire, and environmental considerations are factors in the storage of the records. She also stated that the electronic records were backed up nightly. Inspection Report 0520007/2004001 discusses these issues.

Finally, the staff reviewed the reports of the final review of the seismic sections of the SSAR, and supporting documents, as well as the CH2M HILL peer review, and found that the results of the reviews were documented. Inspection Report 0520007/2004001 provides further detail.

17.17.4 Conclusion (Quality Assurance Records)

As set forth above, the staff reviewed the QA measures the applicant and its primary contractor used and concluded that they have implemented an acceptable level of control for QA records which meets the guidance of Section 17.1.1 of RS-002, Attachment 2, and helps provide reasonable assurance that any information derived from ESP activities that is used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.18 Audits

17.18.1 Technical Information in the Application (Audits)

The EGC application did not initially supply information about the control of audits, but the applicant subsequently provided this information in response to an RAI. The applicant's instruction identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. The instruction states that the applicant would apply elements from these criteria or verify that the controls applied to ESP activities reflect these elements. The applicant considered control of audits to be a criterion having elements associated with the control of ESP activities.

The instruction states that the PQP will include controls for the verification of compliance with its requirements. In addition, the applicant may, from time to time, perform audits of the primary contractor's implementation of the PQP.

The PQP of the primary contractor describes the organizational, programmatic, and procedural requirements intended to result in a complete and accurate application and states that the contractor will use, where appropriate, the pertinent elements of Appendix B to 10 CFR Part 50.

The PQP states that planned audits will be carried out to verify compliance with the QA program and to determine the effectiveness of the program. Trained personnel who do not have direct responsibility for the area being audited will perform the audits in accordance with written procedures. The task lead with responsibility for the area being audited will review the audit results. Followup action, including reaudit of deficient areas, will be taken when indicated. The QA manager will coordinate the conduct of internal audits of project processes and procedures. Findings of nonconformance will be recorded in the corrective action/preventive action spreadsheet or other similar tracking mechanism.

17.18.2 Regulatory Evaluation (Audits)

While the NRC does not require the control of audits to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002, Attachment 2, contains guidance for the staff to use in evaluating an ESP applicant's control of audits. In its instruction, the applicant stated that audits did apply to ESP activities.

Paragraph 17.1.1.18 in Section 17.1.1 of RS-002, Attachment 2, provides the QA measures that constitute an acceptable level of control of audits. Acceptable audits should include (1) provisions for audits to verify compliance with all aspects of QA controls and to determine the effectiveness of these controls, and (2) responsibilities and procedures for conducting, documenting, and reviewing the results of audits (including designating management levels to review and assess audit results).

17.18.3 Technical Evaluation (Audits)

The staff reviewed all audits and the requisite audit reports that covered the applicant's ESP activities. Inspection Report 0520007/2004001 provides the details of the audit reports. The staff also addressed the adequacy of the audit process related to ESP activities.

17.18.3.1 Exelon Generation Company

The ESP project team consisted of representatives from EGC, CH2M HILL, Parsons, and Geomatrix. All of these organizations were audited during preparation of the ESP application.

Tasks performed by organizations not represented on the ESP project team were performed in conjunction with field investigations at the ESP site. During this period, CH2M HILL and EGC quality personnel provided full-surveillance coverage of subcontractor activities. Based on the audit and surveillance coverage identified above, the staff concluded that oversight of contract activities for the preparation of the ESP application was adequate.

The instruction states that the applicant may perform audits of the lead subcontractor's implementation of the PQP. The PQP included guidance for subcontractors to conduct audits. The audit conducted by EGC personnel applied guidance from existing Nuclear Oversight Department (NOS) procedures. The staff reviewed the qualifications of the EGC personnel who conducted the audit and found that all audit personnel appeared to have adequate qualifications.

As discussed in Inspection Report 0520007/2004001, procedures were in place for the conduct of audits of internal CH2M HILL activities, including those of project subcontractors. The applicant's corrective action process documented audit deficiencies. Some contractors, including subcontractors whose portions of the ESP project were of short duration, were not audited since they were operating under their own previously accepted 10 CFR Part 50, Appendix B, quality processes (e.g., Parsons).

The staff reviewed the results of the audits and assessments the applicant conducted. Inspection Report 0520007/2004001 discusses the review of the audits and assessments and the resultant findings. The audit used the process developed by the Nuclear Utilities Procurement Issues Committee. The staff found the audit process adequate.

The staff discussed the process used to conduct the assessment with the applicant's lead corporate assessor for NOS. A unique template was developed to conduct the assessment based on existing NOS procedures. The staff concluded that the applicant had adequately implemented an assessment process of the project quality controls which provided reasonable assurance of ESP application quality.

17.18.3.1.1 Board of Review

An independent board of review assisted the project staff during the seismic work. This board evaluated the implementation plan for the seismic hazard work, the interim results of the work, and the conclusions reached during the work.

The staff reviewed the board of review's product. The review involved checking Sections 2.5 and 3.4 of the SSAR and providing feedback. The staff reviewed the qualifications of the members of the board of review and found their qualifications to be adequate.

17.18.3.1.2 Independent Review of the SSAR

In addition to the routine audits and performance assessments detailed in Inspection Report 0520007/2004001, EGC had Sargent & Lundy (S&L) and Idaho National Engineering and Environmental Laboratory (INEEL) perform an independent review of draft SSAR sections. The scope of the review included all documents and information, including reference material, that formed the entire ESP application. S&L conducted an overall review, while the INEEL review focused on the geotechnical report and supporting information. The staff found these reviews to be adequate in scope.

17.18.3.2 CH2M HILL

The EGC application contract identified the CH2M HILL internal audit program as the primary process for evaluating the level of implementation and effectiveness of processes used in data collection and report generation. CH2M HILL integrated the audit program with its documentation program, training program, corrective action program, and management program for controlling procurement activities. The audit process evaluated project activities by reviewing procedures against contract requirements for compliance and documenting and addressing nonconforming steps or outputs through the corrective action program.

The PQP provides that planned audits will be conducted to verify compliance with the QA program to determine the effectiveness of the program. An audit program procedure outlined the administration and implementation of the audit program. Procedure guidance covered personnel responsibility, internal auditor training requirements, development of an audit schedule, audit documentation, and processing audit findings.

The staff reviewed the qualifications of the CH2M HILL personnel who conducted audits, concluding that all audit personnel appeared to have adequate qualifications.

Based on its review of the audits and assessments conducted by CH2M HILL, the staff concluded that CH2M HILL adequately implemented its audit program.

17.18.3.2.1 Peer Review

Before forwarding the ESP application to EGC, CH2M HILL conducted an internal, independent technical assessment of the data and reported findings. The assessment evaluated the collection process, performed verifying calculations, and reviewed the methodologies applied in developing the information to be submitted in support of the ESP application.

17.18.4 Conclusion (Audits)

As set forth above, the staff reviewed the QA measures the applicant and its primary contractor used and concluded that they have implemented acceptable audit controls which meet the guidance of Section 17.1.1 of RS-002, Attachment 2, and help provide reasonable assurance that any information derived from ESP activities that is used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.19 Conclusions

Based on its review and evaluation of the QA measures contained in the applicant's ESP program as set forth above, the staff concludes that the applicant's QA measures conform to the guidance in RS-002, Attachment 2, as well as appropriate industry standards, and that the applicant and its contractors implemented them for the ESP application activities.

18. REVIEW BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

The Advisory Committee on Reactor Safeguards (ACRS) completed its review of the application from Exelon Generation Company, LLC (EGC or the applicant) for an early site permit (ESP) for the Exelon Generation Company (EGC) ESP site and the U.S. Nuclear Regulatory Commission (NRC) staff's draft safety evaluation report (DSER) and supplemental DSER for this application. The ACRS ESP subcommittee began its detailed review of the EGC ESP application and the staff's DSER in February 2005.

The ACRS ESP subcommittee met with representatives from EGC and the staff on September 7, 2005. The ACRS held its full committee meeting on the EGC ESP DSER on September 8, 2005. The discussions during these meetings focused on the open items from the DSER and the supplemental DSER . On the basis of its review, the ACRS issued an interim letter report, dated September 22, 2005, which addresses the portions of the EGC ESP application that concern safety. The staff responded to the interim letter report in its letter dated October 26, 2005 (ADAMS Accession No. ML052790028). This final safety evaluation report (FSER) documents the resolution of open items discussed in the DSER and the supplemental DSER. The FSER also captures the actions that the staff has taken in response to the comments and recommendations identified by the ACRS in its interim report of September 22, 2005, as described in the staff's response letter of October 26, 2005.

During its meetings with the ACRS on March 8 and March 9, 2006, the staff discussed the resolution of open items and the responses to ACRS comments on the major elements of the ESP review. At the 530th meeting of the ACRS, the full committee considered the staff's FSER, as well as EGC's ESP application, and issued its final letter report to the NRC Chairman on March 24, 2006. That letter report is included as Appendix E to this report.

In its final letter report dated March 24, 2006, the ACRS concurred with the NRC staff's conclusions concerning EGC's ESP application and concluded that the proposed site, subject to the permit conditions recommended by the staff, can be used for nuclear power plants or modules having a total power generation rate of 2400 to 6800 MW thermal without undue risk to public health and safety.

19. CONCLUSIONS

In accordance with Subpart A, "Early Site Permits," of Title 10 of the *Code of Federal Regulations* (10 CFR), Part 52, "Early Site Permits, Standard Design Certifications, and Combined Licenses for Nuclear Power Plants," the staff of the U.S. Nuclear Regulatory Commission reviewed the site safety analysis report and emergency planning information included in the early site permit (ESP) application submitted by Exelon Generation Company, LLC (EGC or the applicant), for the Exelon Generation Company (EGC) ESP site. On the basis of its evaluation and independent analyses as discussed in this safety evaluation report (SER), the staff concludes that the EGC ESP site characteristics comply with the requirements of 10 CFR Part 100, "Reactor Site Criteria," with the limitations and conditions proposed by the staff in this SER for inclusion in any ESP that might be issued. Further, for the reasons set forth in this SER, the staff concludes that, taking into consideration the site criteria contained in 10 CFR Part 100, a reactor(s), having characteristics that fall within the parameters for the site, and which meets the terms and conditions proposed by the staff in this SER, can be constructed and operated without undue risk to the health and safety of the public. For the same reasons, the staff also concludes that issuance of the requested ESP will not be inimical to the common defense and security or to the health and safety of the public. If issued, the EGC ESP may be referenced in an application to construct or to construct and operate a nuclear power reactor, or reactors, with a total generating capacity of up to 6800 megawatts (thermal) at the ESP site, subject to the terms and conditions of the permit.

Appendix A

Permit Conditions, COL Action Items, Site Characteristics, and Bounding Parameters

A.1 Permit Conditions

Permit Condition: The Commission's regulation in 10 CFR 52.24 authorizes the inclusion of limitations and conditions in an ESP. A permit condition is not needed when an existing NRC regulation requires a future regulatory review of a matter to ensure adequate safety during design, construction, or inspection activities for a new plant. The staff is proposing that the Commission include six permit conditions, which are set forth below, to control various safety matters.

Permit Condition No.	SER Section	Description
2.1 - Introduction		
1	2.1.2	The NRC staff proposes to include a condition in any ESP that might be issued in connection with this application to govern exclusion area control. This permit condition would require an agreement granting EGC an exclusive and irrevocable option to purchase, enter a long-term lease, and/or other legal right in the land required to satisfy the requirements of 10 CFR Part 100 for the ESP facility, be obtained and executed before submission of an application for a COL seeking authority to construct and operate a nuclear power plant referencing the ESP.
2	2.1.2	The NRC staff proposes to include a condition in any ESP that might be issued in connection with this application requiring that the ESP holder obtain the right to implement the site redress plan before initiating any activities authorized by 10 CFR 52.25.

Permit Condition No.	SER Section	Description
		2.4 - Hydrology
3	2.4.12.3	The applicant's description of the effluent-holding facility presumed (see Sections 2.4.13.1 and 2.4.13.3 of this SER) that there will be no scenario where liquid radioactive effluent could be released above the ambient groundwater table, including the scenario where the effluent-holding facility could be flooded raising the release point above the ambient groundwater table. The staff agreed that under these assumptions, release of liquid radioactive effluent to ambient groundwater can be precluded. Therefore, the staff determined that it is necessary to ensure that the hydraulic gradient will always point inwards into the radwaste holding and storage facility from ambient groundwater during construction and operation of the ESP facility, including the time during which recovery of groundwater occurs to near its pre-dewatering elevation.
4	2.4.13.3	The NRC staff proposes to include a condition in any ESP that might be issued in connection with this application requiring a radwaste facility design for a future reactor with features to preclude any and all accidental releases of radio-nuclides into any potential liquid pathway is necessary.
5	2.4.13.3	The staff determined that the preclusion of radioactive effluent discharge into ambient groundwater system at the ESP site is primarily and crucially dependent on the hydraulic gradient pointing from ambient subsurface into the effluent holding facility. The staff also determined that it is essential to institute a groundwater monitoring program at the ESP site to continuously monitor and verify that the central assumption for preclusion of radioactive release to groundwater is not violated. The staff stated this requirement as Permit Condition 3 in Section 2.4.12.3 of this SER. The staff will also require that this monitoring system be kept in place and the monitoring program be kept in operation for the life of the ESP facility, including its decommissioning.
		2.5 - Geology, Seismology, and Geotechnical Engineering
6	2.5.4.3.8	The NRC staff proposes to include a condition in any ESP that might be issued in connection with this application requiring that the ESP holder either remove or replace or improve the soils above 60 ft below the ground surface to reduce any liquefaction potential.

A.2 COL Action Items

COL Action Items: The combined license (COL) action items set forth in the SER and incorporated herein identify certain matters that shall be addressed in the final safety analysis report (FSAR) by an applicant who submits an application referencing the Clinton ESP. These items constitute information requirements but do not form the only acceptable set of information in the FSAR. An applicant may depart from or omit these items, provided that the departure or omission is identified and justified in the FSAR. In addition, these items do not relieve an applicant from any requirement in 10 CFR Parts 50 and 52 that govern the application. After issuance of a construction permit (CP) or COL, these items are not controlled by NRC requirements unless such items are restated in the preliminary safety analysis report or FSAR, respectively.

The staff identified the following COL action items with respect to individual site characteristics in order to ensure that particular significant issues are tracked and considered during the review of a later application referencing any ESP that might be issued for the Clinton ESP site.

Action Item No.	SER Section	Subject To Be Addressed	Reason for Deferral
		2.1- Geography and Demography	
2.1-1	2.1.1	A COL or CP applicant should provide latitude, longitude, and Universal Transverse Mercator coordinates for new unit(s) on the ESP site.	Exact unit locations not known at ESP stage.
2.1-2	2.1.2	A COL or CP applicant should make arrangements with the appropriate local, State, Federal, or other public agencies to provide for control of the portions of Clinton Lake that lies within the exclusion area.	Such arrangements not required at ESP stage.
		2.2 - Nearby Industrial, Transportation, and Military Facilities	
2.2-1	2.2.1.3-2.2.2.3	A COL or CP applicant should assess design-specific interactions between the existing and new units and, if necessary, propose measures to account for such interactions.	New unit design and specific location not known at ESP stage.

Action Item No.	SER Section	Subject To Be Addressed	Reason for Deferral
2.3 - Meteorology			
2.3-1	2.3.2	A COL or CP applicant should, as part of detailed engineering, assess the potential impact of natural and/or mechanical cooling towers on the design and operation of the new facility.	Cooling tower location and design not known at ESP stage.
2.3-2	2.3.4	A COL or CP applicant should assess dispersion of airborne radioactive materials to the control room.	Control room location and design not known at ESP stage.
2.3-3	2.3.5	A COL or CP application should verify specific release point characteristics and specific locations of potential receptors of interest used to generate the long-term (routine release) atmospheric dispersion site characteristics.	Exact release points and receptor locations not known at ESP stage.
2.4 - Hydrology			
2.4-1	2.4.1.3	The COL applicant to ensure that the ESP facility intake piping is installed with adequate clearance from the CPS facility piping.	The feasibility of the use of the existing discharge tunnel from the abandoned units is not known at the ESP stage.
2.4-2	2.4.1.3	The COL applicant should provide the detail design of the UHS system, if a UHS is required by the selected reactor type for the ESP facility.	The design of the UHS system depends on the reactor design. Reactor design not known at ESP stage.
2.4-3	2.4.2.3	The COL applicant should design the ESP intake structures to withstand the combined effects of PMF, coincident wind wave activity, and wind setup, as discussed further in Section 2.4.3 of this SER.	The requirement of a UHS and the necessity of protection of its intake structure from flooding is dependent on reactor design, which has not been selected at the ESP stage.
2.4-4	2.4.2.3	The COL applicant should demonstrate that the ESP site drainage from local intense precipitation at the ESP site can be discharged to Clinton Lake without relying on any active drainage systems that may be blocked during this event.	Detailed design of the plants, including the site grade are beyond the scope of an ESP review.

Action Item No.	SER Section	Subject To Be Addressed	Reason for Deferral
2.4-5	2.4.7.3	The COL applicant should demonstrate that the intake structure can withstand the effects of any ice sheet crushing, bending, buckling, splitting, or a combination of these modes.	The requirement of an ESP facility UHS intake structure is dependent on whether the selected reactor design requires a UHS. The reactor design has not been selected at the ESP stage.
2.4-6	2.4.7.3	The COL applicant should design the ESP facility UHS intake to maintain a minimum water temperature of 40 °F at all times to preclude formation of frazil and anchor ice on the intake inlet.	The requirement of an ESP facility UHS intake structure is dependent on whether the selected reactor design requires a UHS. The reactor design has not been selected at the ESP stage.
2.4-7	2.4.7.3	The COL applicant should ensure that the ice sheet formed on Clinton Lake would not constrain the intake. This is predicated on the ESP facility UHS intake being located at an elevation of 668 ft MSL.	The requirement of an ESP facility UHS intake structure is dependent on whether the selected reactor design requires a UHS. The reactor design has not been selected at the ESP stage.
2.4-8	2.4.8.3	The COL or CP applicant should ensure that any water-cooled UHS that may be required by a selected reactor type for the ESP facility is designed to a maximum 30-day makeup water requirement not exceeding 87 ac-ft.	The ESP water budget analysis relies on independent UHS reservoirs only, but need for a UHS is not known at the ESP stage.
2.4-9	2.4.8.3	The COL or CP applicant should establish that the ESP facility NHS is designed such that there is no over-reliance on the UHS for frequent plant shutdowns.	The requirement of an ESP facility UHS system is dependent on whether the selected reactor design requires a UHS. The reactor design has not been selected at the ESP stage.

Action Item No.	SER Section	Subject To Be Addressed	Reason for Deferral
2.4-10	2.4.8.3	The COL or CP applicant should ensure the monitoring and any required dredging of the submerged UHS pond.	The reliance of the ESP facility UHS on water available in the submerged UHS pond is dependent on the selected reactor type requiring a UHS. The reactor design has not been selected at the ESP stage.
2.4-11	2.4.11.3	The COL Applicant should develop a plant shutdown protocol when the water surface elevation in Clinton Lake falls to 677 ft MSL.	The requirement of an ESP facility UHS intake structure is dependent on whether the selected reactor design requires a UHS. The reactor design has not been selected at the ESP stage.
2.4-12	2.4.12.3	The COL applicant should ensure that ground water would not be used for either normal or safety-related plant operations.	The normal and safety-related requirements for the ESP facility depend on the selected reactor type. The reactor design has not been selected at the ESP stage.
2.4-13	2.4.12.3	The COL or CP applicant should establish conservative groundwater flow velocities and conservative soil properties that are representative of the hydrogeologic conditions at the ESP site.	Exact location and design not known at ESP stage.
2.4-14	2.4.13.3	The COL or CP applicant should conclusively prove that there will be no likely scenario that can lead to liquid radioactive release to the ambient groundwater, either above the ambient groundwater table, or below it.	The maximum elevation at which any radioactive releases can occur within the ESP facility will depend on the chosen reactor design. The reactor design has not been selected at the ESP stage.

Action Item No.	SER Section	Subject To Be Addressed	Reason for Deferral
2.5 - Geology, Seismology, and Geotechnical Information			
2.5.4-1	2.5.4	A COL or CP applicant should submit the analyses of soil-rock-structure interaction for the ESP site.	Exact unit locations and design not known at ESP stage.
2.5.4-2	2.5.4	A COL or CP applicant should address the guidance recommended in RG 1.132 regarding drilling and sampling.	Exact unit locations and design not known at ESP stage.
2.5.4-3	2.5.4	A COL or CP applicant should submit plot plans and the profiles of all seismic Category I facilities for comparison with the subsurface profile and material properties.	Exact unit locations and design not known at ESP stage.
2.5.4-4	2.5.4	The COL or CP applicant should submit excavation and backfill plans for NRC review.	Exact unit locations and design not known at ESP stage
2.5.4-5	2.5.4	The COL applicant should inform the NRC staff (1) if it encounters previously unknown geologic features that could represent a hazard to the plant and (2) when site excavations are open for examination and evaluation.	Exact unit locations and design not known at ESP stage.
2.5.4-6	2.5.4	A COL or CP applicant should assess groundwater conditions as they affect foundation stability or detailed dewatering plans.	Exact unit locations and design not known at ESP stage.
2.5.4-7	2.5.4	The COL or CP applicant should perform a complete static stability assessment (including bearing capacities, settlement analyses, and lateral load assessment) and to ensure that the bearing capacities meet the minimum value of 25 tsf.	Exact unit locations and design not known at ESP stage.
2.5.4-8	2.5.4	The COL or CP applicant should describe the design criteria and methods, including the FOSs from the design analyses.	Exact unit locations and design not known at ESP stage.
2.5.5-1	2.5.5	A COL or CP applicant should conduct a more detailed dynamic analysis of the stability of the existing slope and any new slopes using the safe-shutdown earthquake (SSE) ground motion.	Locations of safety-related structures relative to the existing or new slopes not known at ESP stage.

Action Item No.	SER Section	Subject To Be Addressed	Reason for Deferral
2.5.6-1	2.5.6	The COL applicant should perform evaluations (if appropriate) at the COL stage to assess the performance of the submerged dam forming the UHS under the ESP SSE ground motion.	Exact unit location and design not known, therefore, need for UHS cannot be determined at ESP stage.
11.1 - Radiological Effluents			
11.1-1	11.1	A COL or CP applicant should verify that the calculated radiological doses to members of the public from radioactive gaseous and liquid effluents for any facility to be built on the Exelon ESP site are bounded by the radiological doses included in the ESP application and reviewed by the NRC.	Specific details of how the new facility will control, monitor, and maintain radioactive gaseous and liquid effluents not known at ESP stage.
13.6 - Industrial Security			
13.6-1	13.6	A COL or CP applicant should provide specific designs for protected area barriers.	Exact locations and design of barriers not known at ESP stage.

A.3 Site Characteristics

Site Characteristics: Based on site investigation, exploration, analysis and testing, the applicant initially proposes a set of site characteristics. These site characteristics are specific physical attributes of the site, whether natural or man-made. Site characteristics, if reviewed and approved by the staff, are specified in the ESP. The staff proposes to include the following site characteristics in any ESP that might be issued for the Exelon ESP site.

Site Characteristic	Value	Definition
2.1 - Introduction		
Exclusion Area Boundary	The perimeter of a 3362 ft (0.64 mile) radius circle from the center of the proposed ESP facility footprint.	The area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area
Low Population Zone	13,182 ft (2.5 mile) radius circle from the center of the proposed ESP facility footprint.	The area immediately surrounding the exclusion area which contains residents
Population Center Distance	22 miles	The minimum allowable distance from the reactor to the nearest boundary of a densely populated center containing more than about 25,000 residents

Site Characteristic		Value	Definition
2.3 - Meteorology			
Ambient Air Temperature and Humidity			
Maximum Dry-Bulb Temperature	2% annual exceedance	88 °F with 74 °F concurrent wet-bulb	The ambient dry-bulb temperature (and coincident wet-bulb temperature) that will be exceeded 2% of the time annually
	1% annual exceedance	91 °F	The ambient dry-bulb temperature that will be exceeded 1% of the time annually
	0.4% annual exceedance	94 °F with 77 °F concurrent wet-bulb	The ambient dry-bulb temperature (and coincident wet-bulb temperature) that will be exceeded 0.4% of the time annually
	100-year return period	117 °F	The ambient dry-bulb temperature that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Minimum Dry-Bulb Temperature	99% annual exceedance	0 °F	The ambient dry-bulb temperature below which dry-bulb temperatures will fall 1% of the time annually
	99.6% annual exceedance	-6 °F	The ambient dry-bulb temperature below which dry-bulb temperatures will fall 0.4% of the time annually

Site Characteristic		Value	Definition
	100-year return period	-36 °F	The ambient dry-bulb temperature for which a 1% annual probability of a lower dry-bulb temperature exists (100-year mean recurrence interval)
Maximum Wet-Bulb Temperature	1% annual exceedance	78 °F	The ambient wet-bulb temperature that will be exceeded 1% of the time annually
	0.4% annual exceedance	80 °F	The ambient wet-bulb temperature that will be exceeded 0.4% of the time annually
	100-year return period	86 °F	The ambient wet-bulb temperature that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Basic Wind Speed			
Fastest Mile		75 mi/hr	The fastest-mile wind speed to be used in determining wind loads, defined as the fastest-mile wind speed at 33 feet (10 meters) above the ground that has a 1% annual probability of being exceeded (100-year mean recurrence interval)

Site Characteristic	Value	Definition
3-second Gust	96 mi/hr	The 3-second gust wind speed to be used in determining wind loads, defined as the 3-second gust wind speed at 33 feet (10 meters) above the ground that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Design-Basis Tornado		
Maximum Wind Speed	300 mi/hr	Maximum wind speed resulting from passage of a tornado having a probability of occurrence of 10^{-7} per year
Translational Speed	60 mi/hr	Translation component of the maximum tornado wind speed
Rotational Speed	240 mi/hr	Rotation component of the maximum tornado wind speed
Radius of Maximum Rotational Speed	150 ft	Distance from the center of the tornado at which the maximum rotational wind speed occurs
Maximum Pressure Drop	2.0 lbf/in^2	Decrease in ambient pressure from normal atmospheric pressure resulting from passage of the tornado
Maximum Rate of Pressure Drop	1.2 $lbf/in^2/s$	Rate of pressure drop resulting from the passage of the tornado

Site Characteristic	Value	Definition
Winter Precipitation		
100-year Snowpack	24.4 lbf/ft^2	Weight of the 100-year return period snowpack (to be used in determining normal winter precipitation loads for roofs)
48-Hour Probable Maximum Winter Precipitation	16.6 in. of water	Probable maximum precipitation during the winter months (to be used in conjunction with the 100-year snowpack in determining extreme winter precipitation loads for roofs)
Ultimate Heat Sink Ambient Air Temperature and Humidity		
Meteorological Conditions Resulting in the Minimum Water Cooling During Any 1 Day	81°F wet-bulb temperature with coincident 87.6 °F dry-bulb temperature	Historic worst 1-day daily average wet-bulb temperature and coincident dry-bulb temperature
Meotorological Conditions Resulting in the Minimum Water Cooling During Any Consecutive 5 days	79.7 °F wet-bulb temperature with coincident 86.2 °F dry-bulb temperature	Historic worst 5-day daily average wet-bulb temperature and coincident dry-bulb temperature
Meteorological Conditions Resulting in the Maximum Evaporation and Drift Loss During Any Consecutive 30 Days	74.7 °F wet-bulb temperature with coincident 82 °F dry-bulb temperature	Historic worst 30-day daily average wet-bulb temperature and coincident dry-bulb temperature

Site Characteristic	Value	Definition
Short-Term (Accident Release) Atmospheric Dispersion		
0–2 hr χ/Q Value @ EAB (5% value)	2.52×10^{-4} s/m³	The 0–2 hour atmospheric dispersion factor to be used to estimate dose consequences of design-basis accidents at the EAB
0–8 hr χ/Q Value @ LPZ (5% value)	3.00×10^{-5} s/m³	The 0–8 hour atmospheric dispersion factor to be used to estimate dose consequences of design-basis accidents at the LPZ
8–24 hr χ/Q Value @ LPZ (5% value)	2.02×10^{-5} s/m³	The 8–24 hour atmospheric dispersion factor to be used to estimate dose consequences of design-basis accidents at the LPZ
1–4 day χ/Q Value @ LPZ (5% value)	8.53×10^{-6} s/m³	The 1–4 day atmospheric dispersion factor to be used to estimate dose consequences of design-basis accidents at the LPZ
4–30 day χ/Q Value @ LPZ (5% value)	2.48×10^{-6} s/m³	The 4–30 day atmospheric dispersion factor to be used to estimate dose consequences of design-basis accidents at the LPZ
Long-Term (Routine Release) Atmospheric Dispersion		
Annual Average Undepleted/No Decay χ/Q Value @ EAB	2.04×10^{-6} s/m³	The maximum annual average EAB undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual

Site Characteristic	Value	Definition
Annual Average Undepleted/2.26-day Decay χ/Q Value @ EAB	2.04×10^{-6} s/m^3	The maximum annual average EAB undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-day Decay χ/Q Value @ EAB	1.84×10^{-6} s/m^3	The maximum annual average EAB depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ EAB	1.46×10^{-8} 1/m^2	The maximum annual average EAB D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Milk Cow	1.10×10^{-6} s/m^3	The maximum annual average milk cow undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-day Decay χ/Q Value @ Nearest Milk Cow	1.10×10^{-6} s/m^3	The maximum annual average milk cow undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual

Site Characteristic	Value	Definition
Annual Average Depleted/8.00-day Decay χ/Q Value @ Nearest Milk Cow	9.63×10^{-7} s/m³	The maximum annual average milk cow depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Milk Cow	6.76×10^{-9} 1/m²	The maximum annual average milk cow D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Goat Milk	9.90×10^{-8} s/m³	The maximum annual average goat milk undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-day Decay χ/Q Value @ Nearest Goat Milk	9.72×10^{-8} s/m³	The maximum annual average goat milk undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-day Decay χ/Q Value @ Nearest Goat Milk	7.28×10^{-8} s/m³	The maximum annual average goat milk depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Goat Milk	4.21×10^{-10} 1/m²	The maximum annual average meat animal D/Q value for use in determining gaseous pathway doses to the maximally exposed individual

Site Characteristic	Value	Definition
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Garden	1.10×10^{-6} s/m^3	The maximum annual average garden undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-day Decay χ/Q Value @ Nearest Garden	1.10×10^{-6} s/m^3	The maximum annual average garden undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-day Decay χ/Q Value @ Nearest Garden	9.63×10^{-7} s/m^3	The maximum annual average garden depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Garden	6.76×10^{-9} 1/m^2	The maximum annual average garden D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Meat Animal	1.10×10^{-6} s/m^3	The maximum annual average meat animal undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-day Decay χ/Q Value @ Nearest Meat Animal	1.10×10^{-6} s/m^3	The maximum annual average meat animal undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual

Site Characteristic	Value	Definition
Annual Average Depleted/8.00-day Decay χ/Q Value @ Nearest Meat Animal	9.63×10^{-7} s/m³	The maximum annual average meat animal depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Meat Animal	6.76×10^{-9} 1/m²	The maximum annual average meat animal D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Resident	1.50×10^{-6} s/m³	The maximum annual average resident undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-day Decay χ/Q Value @ Nearest Resident	1.49×10^{-6} s/m³	The maximum annual average resident undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-day Decay χ/Q Value @ Nearest Resident	1.34×10^{-6} s/m³	The maximum annual average resident depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Resident	6.76×10^{-9} 1/m²	The maximum annual average resident D/Q value for use in determining gaseous pathway doses to the maximally exposed individual

Site Characteristic	Value	Definition
2.4 - Hydrology		
Hydrology		
Proposed Facility Boundaries	Appendix A, Figure 1 (FSER Figure 2.4.14) shows the proposed facility boundary	ESP site boundary map
Site Grade	735 ft MSL	Finished plant grade at the ESP site
Highest Ground Water Elevation	733.5 ft MSL	The maximum elevation of ground water at the ESP site
Probable Maximum Flood (PMF) elevation	709.8 ft MSL	The maximum hydrostatic water surface elevation at the ESP site
Coincident Wind Wave Activity	6.4 ft	Increment of change in water surface elevation due to wind waves
Storm Surge	0.3 ft	Increment of change in water surface elevation due to storm surge
Combined Effects Maximum Water Surface Elevation	716.5 ft MSL	Sum of hydrostatic water surface elevation, wind wave activity, and storm surge. Maximum water surface elevation at the ESP site.
Local Intense Precipitation	18.15 in during 1 hour	Maximum potential rainfall at the immediate ESP site
Lake Surface Icing	27 in	Ice sheet thickness at Clinton Lake (based on maximum cumulative degree-days below freezing)

Site Characteristic		Value	Definition
Maximum Cumulative Degree-Days		1141.5 in Fahrenheit	A measure of severity of winter weather conditions conducive to ice formation
Frazil and Anchor Ice		The ESP site has the potential for formation of frazil and anchor ice.	Accumulated ice formation in a turbulent flow condition
2.5 - Geology, Seismology, and Geotechnical Engineering			
Basic Geologic and Seismic Information			
Capable Tectonic Structures		------	No fault displacement potential within the investigative area
Vibratory Ground Motion			
Design Response Spectra (Safe Shutdown Earthquake)		Appendix A, Figure 2 (FSER Figure 2.5.2-16)	Site Specific response spectra
Stability of Subsurface Materials and Foundations			
Minimum Bearing Capacity (Static)		50,0000 lbs/ft^2 (25 tsf)	
Minimum Shear Wave Velocity	0 - 50 ft	820 fps	Propagation of shear waves through foundation materials
	50 - 285 ft	1090 fps	
	285 - 310 ft	2580 fps	

A.4 Bounding Parameters

Plant Parameter Envelope: A plant parameter envelope (PPE) sets forth postulated values of design parameters that provide design details to support the NRC staff's review of an ESP application. A controlling PPE value, or bounding parameter value, is one that necessarily depends on a site characteristic. As the PPE is intended to bound multiple reactor designs, the actual design selected in a combined license (COL) or construction permit (CP) application referencing an ESP would be reviewed to ensure that the design fits within the bounding parameter values. Otherwise, the COL or CP applicant would need to demonstrate that the design, given the site characteristics in the ESP, complies with the Commission's regulations. Should an applicant reference an ESP for a design that is not certified, the applicant would need to demonstrate that the design's characteristics fall within the bounding parameter values.

Bounding Parameters	Value	Definition
2.4 - Hydrology		
Makeup flow rate to mechanical draft cooling towers	555 gpm	Average makeup water needed for mechanical draft cooling towers of the ultimate heat sink for the proposed facility
Maximum inlet temperature to CCW heat exchanger	95 °F	Maximum allowable temperature of water on inlet side of the condenser
Evaporation rate	31,500 gpm (70.2 cfs)	Forced evaporation for the ESP facility under normal operation

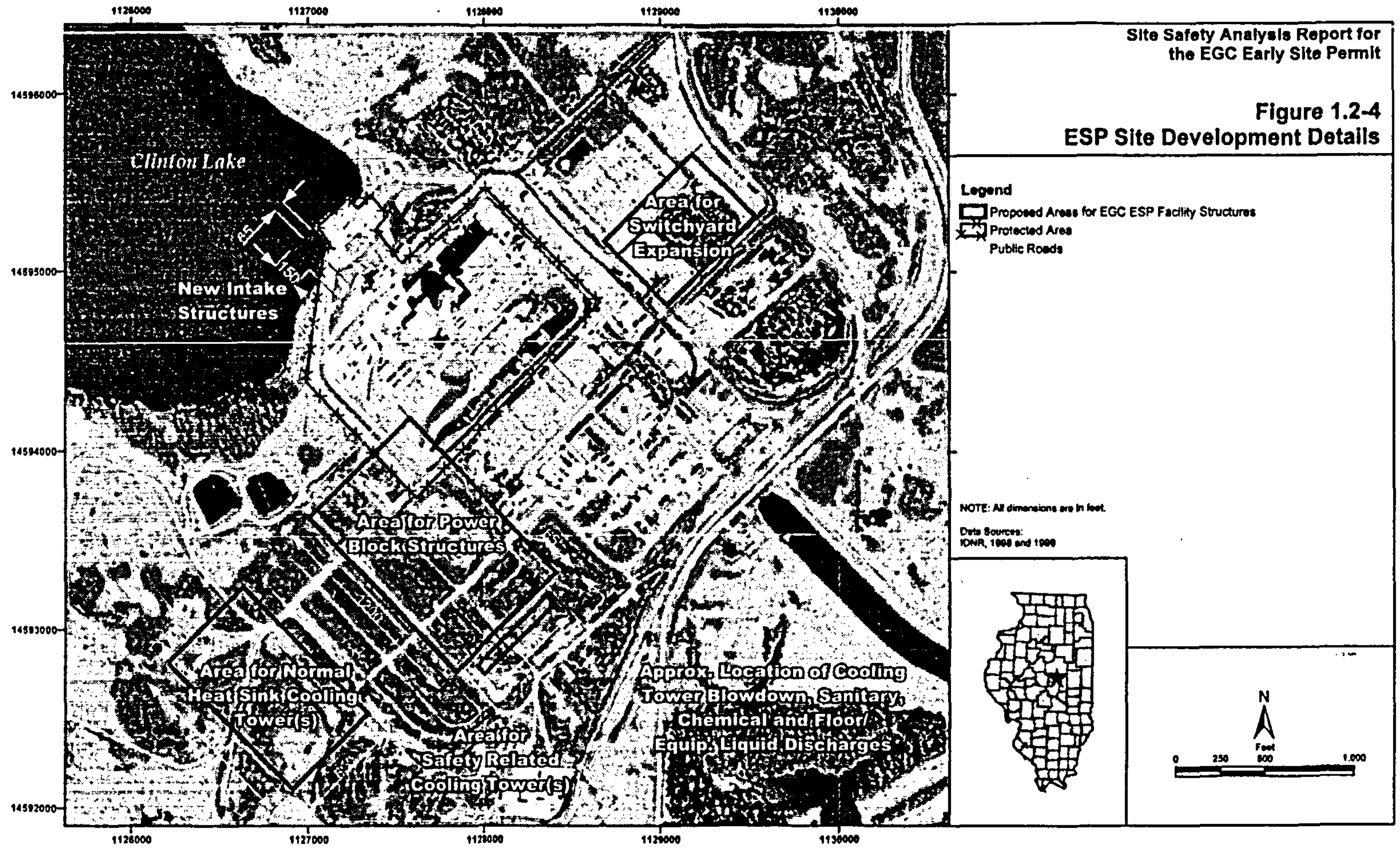

Figure 1 (SER Figure 2.4.14) The proposed facility boundary for the ESP site

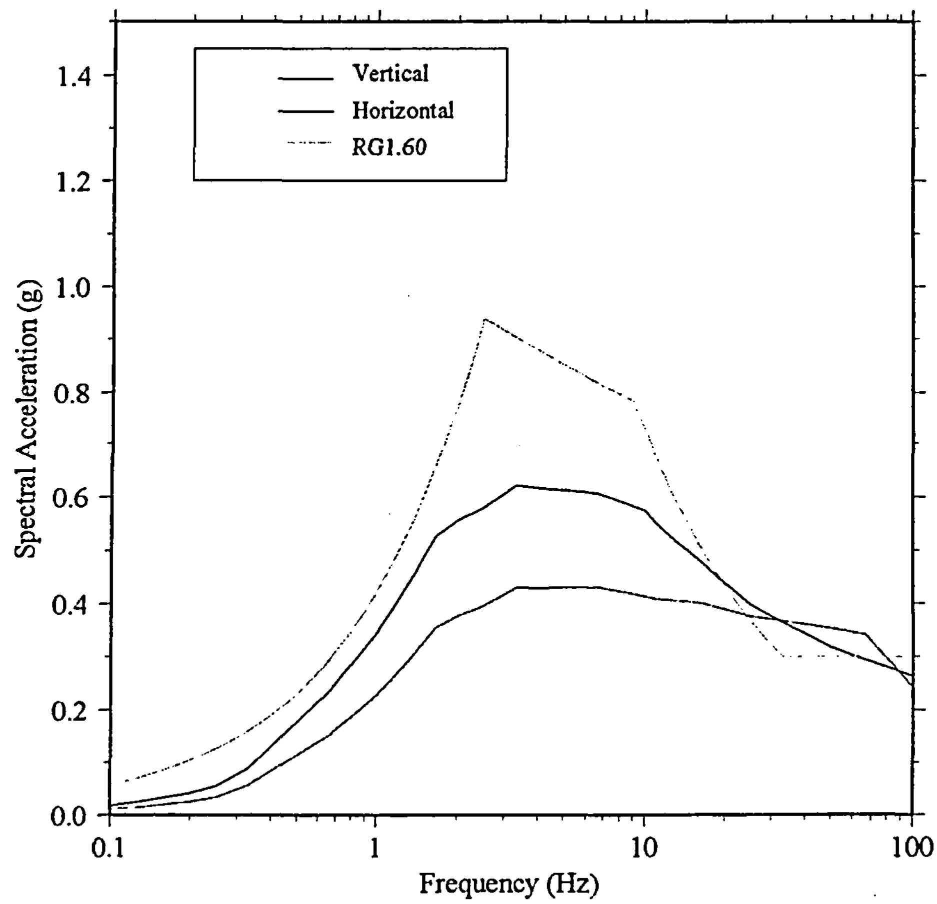

Figure 2 (SER Figure 2.5.2-16) EGC ESP horizontal and vertical ESP SSE as well as the RG 1.60 DRS anchored at 0.3g

Appendix B

Chronology of Early Site Permit Application for the EGC ESP Site

This appendix lists all correspondence between the Exelon Generation Company, LLC (EGC), and the U.S. Nuclear Regulatory Commission regarding the EGC early site permit application through February 16, 2006, with the exception of legal filings related to the hearing. Source: Agencywide Document Access and Management System (ADAMS).

Revisions to the EGC Early Stie Permit Application

Revision	Date	Accession Number
0	September 25, 2003	ML032721596
1	November 23, 2005	ML053420053
2	January 10, 2006	ML060460043
3	March 3, 2006	ML060950511
4	April 14, 2006	ML061100260

This appendix lists all correspondence between the Exelon Generation Company, LLC, and the U.S. Nuclear Regulatory Commission regarding the Exelon early site permit application through December 31, 2004, with the exception of legal filings related to the hearing. Source: Agencywide Documents Access and Management Systems (ADAMS).

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
06/27/2002	ML042280019	2002/06/27-E-mail - Exelon ESP Site Activities. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007
07/08/2002	ML042280020	2002/07/08-E-mail - RE: Exelon ESP Site Activities. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007, PROJ0718
07/12/2002	ML042280021	2002/07/12 - E-mail - Exelon ESP seismic activities. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007, PROJ0718
07/25/2002	ML042280022	2002/07/25-E-mail - RE: NRC-Exelon seismic field work telecon at 2 EDT. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007, PROJ0718
07/31/2002	ML042280023	2002/07/31-E-mail - ESP Schedule of Seismic & Geotechnical Activities. 3 Page(s)	E-Mail	Exelon Corp	NRC	05200007, PROJ0718

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
05/16/2003	ML042300743	2003/05/16-E-mail - Clinton Community Advisory Panel. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
05/29/2003	ML042300745	2003/05/29-E-mail - CD needed for Web Posting. 4 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
06/10/2003	ML042280025	2003/06/10-E-mail Re :Question on Security Info. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007, PROJ0718
06/10/2003	ML042300768	2003/06/10-E-mail - Application TOC. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
06/10/2003	ML042300771	2003/06/10-E-mail - Question on Security Info. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
06/11/2003	ML042300774	2003/06/11-E-mail - Requirements on Number of Copies. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
06/11/2003	ML042300772	2003/06/11-E-mail - RE: Application TOC. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
06/12/2003	ML042300775	2003/06/12-E-mail - Word File. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
06/12/2003	ML042300778	2003/06/12-E-mail - RE: Word File. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
06/13/2003	ML042300779	2003/06/13-E-mail - RE: Word File. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
07/02/2003	ML042300780	2003/07/02-E-mail - RE: Application TOC. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
07/07/2003	ML042300827	2003/07/07-E-mail - Information on Clinton Lake. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
07/14/2003	ML042300782	2003/07/14 - E-mail - Call on Seismic Issues. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
07/14/2003	ML042300784	2003/07/14-E-mail - RE: Call on Seismic Issues. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
08/11/2003	ML042300787	2003/08/11-E-mail - QA Meeting. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
08/26/2003	ML042300788	2003/08/26-E-mail - QA Meeting. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
08/29/2003	ML042300791	2003/08/29-E-mail - Discussion After Entergy QA Meeting. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
08/29/2003	ML042280026	2003/08/29-E-mail - RE: Application TOC. 3 Page(s)	E-Mail	Exelon Corp	NRC	05200007, PROJ0718
08/29/2003	ML042300792	2003/08/29-E-mail - RE: Application TOC. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
09/02/2003	ML042300793	2003/09/02-E-mail - RE: Application TOC. 4 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
09/09/2003	ML042300825	2003/09/09-E-mail - Re: ESP Letter. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
09/11/2003	ML042300795	2003/09/11-E-mail - Re: Yesterday's Mtg. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
09/12/2003	ML042300796	2003/09/12-E-mail - QA Inspection Dates. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
09/25/2003	ML032721594	2003/09/25-Submittal of Exelon Generation Company (EGC) application for an early site permit (ESP) for property co-located with existing Clinton Power Station (CPS) facility in Illinois. 3 Page(s)	Letter, License-Application for Constructio n Permit DKT 50	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Docu ment Control Desk	05000461, 05200007, PROJ0718
09/30/2003	ML042300799	2003/09/30-E-mail - Hard Copies. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
10/01/2003	ML042300815	2003/10/01-E-mail - Picture. 2 Page(s)	E-Mail, Photograph	NRC	Exelon Corp	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/01/2003	ML042300800	2003/10/01-E-mail - Clinton USAR Update. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
10/01/2003	ML042300801	2003/10/01-E-mail - Service List 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007
10/02/2003	ML042310348	2003/10/02-E-mail - RE: Hard Copies. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
10/02/2003	ML042310323	2003/10/02-E-mail - RE: Service List. 3 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
10/03/2003	ML042310342	2003/10/03-E-mail - RE: Hard Copies. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
10/03/2003	ML042310333	2003/10/03-E-mail - Re: Hard Copies. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
10/03/2003	ML042310360	2003/10/03-E-mail - RE: Hard Copies. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007
10/08/2003	ML042440536	2003/10/08-E-mail - RE: Schedule. 3 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/16/2003	ML042300811	2003/10/16-E-mail - Answer to Question on ESP Record Retention. 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007, PROJ0718
10/27/2003	ML032930051	2003/10/27-Letter to M. Kray re: Acceptance of Application for ESP for Property Co-Located With The Existing Clinton Power Station. 6 Page(s)	Letter	NRC/NRR/D RIP	Exelon Generation Co, LLC	05200007
10/27/2003	ML032930059	2003/10/27-Exelon ESP Review Schedule. 1 Page(s)	Spreadshee t File	NRC/NRR/D RIP	Exelon Generation Co, LLC	05200007
11/19/2003	ML033250261	2003/11/19-Notice Of Intent To Prepare An Environmental Impact Statement And Conduct Scoping Process For An Early Site Permit (ESP) At The Clinton ESP Site (TAC NO. MC1125). 13 Page(s)	Federal Register Notice, Letter	NRC/NRR/D RIP	Exelon Generation Co, LLC	05200007
11/21/2003	ML042300813	2003/11/21-E-mail - Request for Additional Information-QA. 11 Page(s)	E-Mail, Letter, Request for Additional Information (RAI)	NRC/NRR/D RIP/RNRP	Exelon Corp	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
11/21/2003	ML042300824	2003/11/21-E-mail - Attorneys. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007
11/21/2003	ML033210018	2003/11/21-Request For Additional Information Letter No. 1 - Exelon ESP Application for the Clinton ESP Site on QA Measures (MC1122). 7 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP	Exelon Generation Co, LLC	05000461, 05200007
12/09/2003	ML033510146	2003/12/09-Service of Notice of Availability of an Application for an Early Site Permit. 3 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk, NRC/NRR	05200007
12/10/2003	ML042280027	2003/12/10-E-mail, Administrative items. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
12/10/2003	ML042280028	2003/12/10-E-mail - Administrative questions. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007
12/11/2003	ML042440541	2003/12/11-E-mail - Re: Administrative questions. 3 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
12/22/2003	ML033640639	2003/12/22-Response to RAI Letter No. 1 Regarding Quality Assurance Measures, per Early Site Permit Application for the Clinton Site. 1 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05000461, 05200007
01/06/2004	ML042440548	2004/01/06-E-mail - Re: Administrative questions. 2 Page(s)	E-Mail, Letter	NRC	Exelon Corp	05200007
01/21/2004	ML040430135	2004/01/21-SUMMARY OF PUBLIC MEETING TO DISCUSS THE ENVIRONMENTAL SCOPING PROCESS FOR THE CLINTON EARLY SITE PERMIT (ESP) APPLICATION 143 Page(s)	Meeting Agenda, Meeting Summary, Transcript	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
01/24/2004	ML050280252	2004/01/24-Response to Request for Additional Information Letter No. 12 re Application for Clinton ESP Site. 82 Page(s)	Letter	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007

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02/13/2004	ML041830102	2004/02/13-Staff E-mail to Exelon Forwarding the Proposed Agenda for Alternative Site Visits for the EGC ESP Review. 4 Page(s)	E-Mail	NRC/NRR/DRIP/RLEP	Exelon Corp	05200007
02/18/2004	ML041830095	2004/02/18-Staff E-mail to Exelon Forwarding Agenda Items for the EGC ESP Site Audit. 13 Page(s)	E-Mail	NRC/NRR/DRIP/RLEP	Exelon Corp	05200007
02/20/2004	ML040540622	2004/02/20-IR 0520007-04-001, on 01/12/04 through 01/16/04, for Exelon Generation Company, Kennett Square, PA; (Clinton) Early Site Permit. 48 Page(s)	Inspection Report, Letter	NRC/RGN-III/DRS	Exelon Generation Co, LLC	05200007
02/23/2004	ML042300818	2004/02/23-E-mail - Requests for Additional Information. 4 Page(s)	Letter, Request for Additional Information (RAI)	NRC	Exelon Corp	05200007
02/24/2004	ML041820385	2004/02/24-Staff E-mail to Exelon Forwarding an Additional Question for the EGC ESP Site Audit re Spent Fuel Storage. 1 Page(s)	E-Mail	NRC/NRR/DRIP/RLEP	Exelon Corp	05200007

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02/25/2004	ML041830104	2004/02/25-Staff E-mail to Exelon Forwarding Additional Agenda Items for the EGC ESP Site Audit. 3 Page(s)	E-Mail	NRC/NRR/DRIP/RLEP	Exelon Corp	05200007
02/26/2004	ML041830124	2004/02/26-Staff E-mail to Exelon Regarding Discussion Items on Worker Dose for the EGC ESP Site Audit. 3 Page(s)	E-Mail	NRC/NRR/DRIP/RLEP	Exelon Corp	05200007
03/05/2004	ML042300803	2004/03/05-E-mail - Seismic Call-REVISION. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
03/08/2004	ML042440552	2004/03/08-E-mail - RE: Seismic Call-REVISION. 2 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
03/11/2004	ML042280029	2004/03/11-E-mail forwarding Amy Lientz Corrected Address, (Privacy Info). 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC/NRR	05200007

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03/15/2004	ML040820570	2004/03/15-Enclosure 2: Exelon Generation Company, LLC Early Site Permit Application of Alternative Site Comparison Process and Attachment 1: Alternative Site Comparison Process. 22 Page(s)	Technical Paper	Exelon Generation Co, LLC	NRC/NRR/ DRIP/RLEP	05200007
03/17/2004	ML040790804	2004/03/17-Clinton Power Station Early Site Permit - Response to Verbal Request for Documentation. 2 Page(s)	Letter	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Docu ment Control Desk	05000461, 05200007
03/17/2004	ML042280030	2004/03/17-E-mail - Clinton ETE. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007
03/19/2004	ML040900247	2004/03/19-Motion for Leave to File Notice of Appearance Out of Time 3 Page(s)	Legal-Motion	Exelon Generation Co, LLC, Harmon, Curran, Spielberg & Eisenberg, LLP	NRC/ASLB P	05200007

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03/19/2004	ML040900251	2004/03/19-Notice of Appearance by Diane Curran on behalf of Blue Ridge Environmental Defense League 3 Page(s)	Legal-Notice of Appearance	Exelon Generation Co, LLC, Harmon, Curran, Spielberg & Eisenberg, LLP	NRC/ASLB P	05200007
03/19/2004	ML042300816	2004/03/19-E-mail - Draft Requests for Additional Information-SSAR 2.5.2. 3 Page(s)	E-Mail, Request for Additional Information (RAI)	NRC	Exelon Corp	05200007
03/30/2004	ML042300805	2004/03/30-E-mail - Seismic Site Visit. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007
04/06/2004	ML040920584	2004/04/06-Letter to M Kray Re Revised Date for Transmitting Environmental RAIs for Exelon ESP Application. 6 Page(s)	Letter	NRC/NRR/D RIP	Exelon Generation Co, LLC	05200007
04/12/2004	ML042300817	2004/04/12-E-mail - Draft Requests for Additional Information-Emergency Plan. 6 Page(s)	E-Mail	NRC/NRR	Exelon Corp	05200007

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04/13/2004	ML041110024	2004/04/13-Exelon Submission of Requested Information, PBMR Ltd Calculation MF 00-016344-2053 dated March 6, 2003. 4 Page(s)	Calculation, Letter	Exelon Generation Co, LLC	NRC/Document Control Desk	05200007
04/14/2004	ML042450111	2004/04/14-E-mail-Re: Chicago Seismic Meeting. 2 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
04/15/2004	ML040930400	2004/04/15-RAI No. 2 - Exelon ESP Application for the Clinton ESP Site on Site Safety Analysis Report Section 2.3.3 (TAC No. MC1122). 7 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP	Exelon Generation Co, LLC	05200007
04/29/2004	ML042450110	2004/04/29-E-mail - Re: May 11-12 site visit. 2 Page(s)	E-Mail, Letter, Trip Report	NRC	Exelon Corp	05200007
04/29/2004	ML042280032	2004/04/29-E-mail, RE: May 18-19 seismic visit. 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007

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04/29/2004	ML042280031	2004/04/29-E-mail - May 11-12 site visit. 3 Page(s)	E-Mail	Exelon Corp	NRC	05200007
04/30/2004	ML042450101	2004/04/30-E-mail - Re: May 11-12 site visit. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007
04/30/2004	ML042450102	2004/04/30-E-mail - RE: May 18-19 seismic visit. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007
04/30/2004	ML042450097	2004/04/30-E-mail - RE: RAI No. 2 re Met Data. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007
04/30/2004	ML042450104	2004/04/30-E-mail - Re: May 11-12 site visit. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007
05/03/2004	ML042450093	2004/05/03-E-mail - Re: May 11-12 site visit. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007

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05/04/2004	ML042450086	2004/05/04-E-mail - RE: Site visit info - May 19. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007
05/05/2004	ML042280033	2004/05/05-E-mail - RE: Emergency Plan draft RAIs - Applicant questions. 3 Page(s)	E-Mail	Exelon Corp	NRC	05200007
05/05/2004	ML042450083	2004/05/05-E-mail - RE: Emergency Plan draft RAIs. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007
05/05/2004	ML042450081	2004/05/05-E-mail - RE: Emergency Plan draft RAIs - Applicant questions. 3 Page(s)	E-Mail, Letter	NRC	Exelon Corp	05200007
05/06/2004	ML042300807	2004/05/06-E-mail - Hydrology Discussion Topics. 5 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007

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05/11/2004	ML041330188	2005/05/11-Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application for the Exelon Generation Company Site (TAC No. MC1125). 17 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
05/12/2004	ML042300520	2004/05/12-E-mail - Fwd: Seismic RAI Topics for Mtg discussion. 3 Page(s)	E-Mail	NRC/NRR	Exelon Corp	05200007
05/14/2004	ML042450079	2004/05/14-E-mail - RE: NRC Seismic visit info - May 17-19. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007
05/18/2004	ML041830135	2004/05/18-Staff E-mail to Exelon Regarding Clarification Items to Site Audit Summary for the EGC ESP Review. 2 Page(s)	E-Mail	NRC/NRR/DRIP/RLEP	Exelon Corp	05200007
05/28/2004	ML041560144	2004/05/28-Exelon Generation Company's Answer to Proposed Contentions 42 Page(s)	Legal-Intervention Petition, Responses and Contentions	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007

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06/02/2004	ML041620360	2004/06/02-Exelon Generation Company's Answer in Opposition to Petitioners' Motion for Extension of Time to Reply to Response to Contentions 7 Page(s)	Legal-Motion	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007
06/08/2004	ML042300808	2004/06/08-E-mail - Figure 1.2-3. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007
06/08/2004	ML042450076	2004/06/08-E-mail Re: SSAR Site Hazards Visit. 3 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007
06/10/2004	ML042450074	2004/06/10-E-mail - RE: Figure 1.2-3. 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007
06/11/2004	ML042300819	2004/06/11-E-mail - RE: Emergency Plan draft RAIs - Applicant questions. 4 Page(s)	E-Mail, Letter	NRC	Exelon Corp	05200007
06/11/2004	ML042300820	2004/06/11-E-mail - Draft Requests for Additional Information. 12 Page(s)	E-Mail, Request for Additional Information (RAI)	NRC/NRR	Exelon Corp	05200007

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06/11/2004	ML042450072	2004/06/11-E-mail - RE: SSAR Site Hazards Visit. 4 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007
06/18/2004	ML041830154	2004/06/18-Exelon E-mail Forwarding Files for Lake Modeling PT 1 for the EGC ESP Review. 25 Page(s)	E-Mail	Exelon Corp	Battelle Memorial Institute, Pacific Northwest National Lab, NRC, NRC/NRR/DRIP/RLEP	05200007
06/20/2004	ML041830159	2004/06/20-Staff E-mail to Exelon Regarding Files for Lake Modeling PT 2 for the EGC ESP Review. 2 Page(s)	E-Mail	Battelle Memorial Institute, Pacific Northwest National Lab	Battelle Memorial Institute, Pacific Northwest National Lab, Exelon Corp, NRC, NRC/NRR/DRIP/RLEP	05200007
06/22/2004	ML041400206	2004/06/22-Letter to M. Kray, Exelon re: ESP Template 6 Page(s)	Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007

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06/23/2004	ML042300809	2004/06/23-E-mail - Question on Draft Met RAIs. 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007
06/23/2004	ML042300810	2004/06/23-E-mail - Response to Question on Met RAI. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007
06/23/2004	ML042280003	2004/06/23-E-mail- RE: Response to Question on Met RAI. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
07/02/2004	ML042180098	2004/07/02-NRC RAI E5.2-3 - Att E1, Clinton Lake Volume - 24 YR Period of Record Analysis with Single Uprated Existing Plant (Forced Loss estimated based on Forced Loss due to two 992 MW Plants). 11 Page(s)	Graphics incl Charts and Tables, Spreadshee t File	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Docu ment Control Desk	05200007

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07/07/2004	ML042180099	2004/07/07-NRC RAI E5.2-3 - Att E2, Clinton Lake Volume - 24 YR Period of Record Analysis with Single Uprated Existing Plant (Forced Loss estimated based on Forced Loss due to two 992 MW Plants) & New Plant with Wet-Dry Cooling Process. 15 Page(s)	Graphics incl Charts and Tables, Spreadsheet File	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/07/2004	ML042180102	2004/07/07-NRC RAI E5.2-3 - Att E3, Clinton Lake Volume - 24 YR Period of Record Analysis with Single Uprated Existing Plant (Forced Loss estimated based on Forced Loss due to two 992 MW Plants) and New Plant with Wet Cooling Process. 11 Page(s)	Graphics incl Charts and Tables, Spreadsheet File	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/08/2004	ML042300821	2004/08/08-E-mail - Draft Request for Additional Information. 10 Page(s)	E-Mail, Request for Additional Information (RAI)	NRC/NRR	Exelon Corp	05200007

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07/09/2004	ML041950227	2004/07/09-Environmental Impact Statement Scoping Process Summary Report - Exelon Generation Company, LLC Early Site Permit, July 2004, U.S. Nuclear Regulatory Commission, Rockville, Maryland. 57 Page(s)	Environmental Impact Statement	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
07/09/2004	ML041950214	2004/07/09-Issuance of Environmental Scoping Summary Report Associated with Staff's Review of Application by Exelon Generation Company, LLC. For an Early Site Permit for Exelon ESP Site. 10 Page(s)	Letter	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
07/14/2004	ML042300822	2004/07/14-E-mail - Draft Request for Additional Information. 9 Page(s)	E-Mail, Request for Additional Information (RAI)	NRC/NRR	Exelon Corp	05200007
07/15/2004	ML042280013	2004/07/15-E-mail-Draft Requests for Additional Information. 9 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007

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07/20/2004	ML042440182	2004/07/20-E-mail - Draft Request for Additional Information. 4 Page(s)	E-Mail	NRC/NRR	Exelon Corp	05200007
07/21/2004	ML042310775	2004/07/21-E-mail, Public EP Info. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
07/22/2004	ML042440477	2004/07/22-E-mail - Draft Request for Additional Information. 4 Page(s)	E-Mail, Letter	NRC/NRR	Exelon Generation Co, LLC	05200007
07/22/2004	ML041890497	2004/07/22-Request for Additional Information Letter No. 3 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 10 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/23/2004	ML042180090	2004/07/23-NRC RAI E5.2-1&-2 - Att A, Lake Drought Model Description. 6 Page(s)	Report, Technical	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007

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07/23/2004	ML042180079	2004/07/23-Exelon Generation Company, LLC (EGC) Application for an Early Site Permit (ESP) Environmental Requests for Additional Information.. 97 Page(s)	Legal-Affidavit, Letter	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/23/2004	ML042440486	2004/07/23-E-mail - Draft Request for Additional Information. 3 Page(s)	E-Mail	NRC/NRR	Exelon Generation Co, LLC	05200007
07/23/2004	ML042180095	2004/07/23-NRC RAI E5.2-1&-2 - Att C, Lake Drought Analysis Model, Clinton Lake Volume - 100 YR RI Dry Period. 4 Page(s)	Graphics incl Charts and Tables, Spreadsheet File	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/23/2004	ML042180088	2004/07/23-NRC RAI E4.4-1 - Att B, Capacity Waste Water Supply - Rev. 2 Page(s)	- No Document Type Applies	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/23/2004	ML042180093	2004/07/23-NRC RAI E5.2-1&-2 - Att B, Lake Drought Analysis Description. 4 Page(s)	Report, Technical	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007

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07/23/2004	ML042180106	2004/07/23-NRC RAI E7.1-3 - Att A, Revised Table 7.1-2. 3 Page(s)	Graphics incl Charts and Tables	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/23/2004	ML042180096	2004/07/23-NRC RAI E5.2-3 - Att D, Clinton Lake Period of Record Analysis - Spreadsheet Column by Column Explanation. 11 Page(s)	Report, Technical	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/23/2004	ML042180105	2004/07/23-NRC RAI E5.2-3 - Att E4, Table 2.3-2, Attachment to July 22, 2002 Memo from Blonn, Keiser and Toll - Revised January 29, 2003. 14 Page(s)	Graphics incl Charts and Tables, Spreadsheet File	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/26/2004	ML042010267	2004/07/26-Clinton ESP Site Request For Additional Information Letter No. 4 - Exelon ESP Application. 14 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/26/2004	ML042440510	2004/07/26-E-mail - RAI Letters. 49 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007

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07/26/2004	ML042020018	2004/07/26-Clinton ESP Site Request For Additional Information Letter No. 7 - Exelon ESP Application. 13 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/26/2004	ML042020371	2004/07/26-Request For Additional Information Letter No. 9 - Exelon ESP Application for the Clinton ESP Site. 9 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/26/2004	ML042020002	2004/07/26-Clinton ESP Site Request For Additional Information Letter No. 6 - Exelon ESP Application. 11 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/27/2004	ML042280018	2004/07/27-E-mail - RE: RAI Letters. 2 Page(s)	E-Mail	Exelon Corp	Exelon Corp, NRC	05200007
07/27/2004	ML042020408	2004/07/27-Request For Additional Information Letter No. 10 - Exelon ESP Application for the Clinton ESP Site. 9 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/27/2004	ML042440530	2004/07/27-E-mail - RAI Letters. 47 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007

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07/27/2004	ML042020021	2004/07/27-Request For Additional Information Letter No. 8 - Exelon ESP Application for the Clinton ESP Site. 10 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/27/2004	ML042440523	2004/07/27-E-mail - RAI Letters. 49 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
07/27/2004	ML042050408	2004/07/27-Exelon ESP Application for the Clinton ESP Site (TAC No. MC1122). 13 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/27/2004	ML042280017	2004/07/27-E-mail- RE: RAI Letters. 2 Page(s)	E-Mail	Exelon Corp	Exelon Corp, NRC	05200007
07/27/2004	ML042010334	2004/07/27-Request For Additional Information Letter No. 5 - Exelon ESP Application for the Clinton ESP Site. 7 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/30/2004	ML042440473	2004/07/30-E-mail - RAI Letter No. 3. 11 Page(s)	E-Mail	NRC	Exelon Corp	05200007

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08/23/2004	ML042370551	2004/08/23-Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application for the Exelon Generation Company Site (TAC NO. MC1125). 9 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/D RIP/RLEP	Exelon Generation Co, LLC	05200007
08/24/2004	ML042230041	2004/08/24-Exelon, Revision to RAI No. 11 - ESP Application for Clinton ESP Site. 12 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/D RIP/RNRP	Exelon Generation Co, LLC	05200007
08/31/2004	ML042530527	2004/08/31-Exelon Generation Company's Answer in Opposition to Petition for Interlocutory Review 40 Page(s)	Legal-Brief	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/OCM	05200007
09/07/2004	ML042660165	2004/09/07-Submittal of Early Site Permit Quality Plans. 7 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

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09/07/2004	ML042600182	2004/09/07-Letter from Paul M. Bessette to Shannon Fisk and Tyson R. Smith attaching disclosures with respect to Contention 3.1 as admitted by the Licensing Board 5 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
09/07/2004	ML042750231	2004/09/07-E-mail w/o att-EGC ESP Quality Plan. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
09/17/2004	ML042590004	2004/09/17 - Summary of Meeting with Dominion, SERI and Exelon Regarding Reviews of EP Aspects of Their Respective ESP Applications. 10 Page(s)	Meeting Summary	NRC/NRR/DRIP/RNRP	Dominion Nuclear North Anna, LLC, Exelon Generation Co, LLC, Exelon Nuclear, System Energy Resources, Inc	05200007, 05200008, 05200009

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09/17/2004	ML042730435	2004/09/17-Exelon Generation Company, LLC (EGC), Delay in Responding to Requests for Additional Information (RAI) regarding the Environmental Portion of the Application for an Early Site Permit (ESP). 2 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
09/17/2004	ML042680065	2004/09/17-Joint Response of Exelon Generation Company and the NRC Staff to Licensing Board Request Regarding Mandatory Hearing Procedures for the Clinton Early Site Permit 14 Page(s)	Legal-Report	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007
09/21/2004	ML042730214	2004/09/21-Letter from Steven P. Frantz to Administrative Judges informing of the agreement of Exelon Generation Company, Intervenors, and the NRC staff regarding updates to discovery disclosures under 10 CFR § 2.336(d) 4 Page(s)	Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007

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09/23/2004	ML042730012	2004/09/23-Exelon Generation Company, LLC (EGC), Response to Requests for Additional Information (RAI) regarding the Environmental Portion of the Application for an Early Site Permit (ESP). 51 Page(s)	Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
09/24/2004	ML042730467	2004/09/24-Letter from Steven P. Frantz to Administrative Judges enclosing a copy of a letter dated 09/23/04 from Exelon Generation Company to the NRC staff responding to several Requests for Additional Information 54 Page(s)	Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007
09/28/2004	ML042790495	2004/09/28-Response to Request for Additional Information (RAI) Letter No. 5 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site (TAC No. MC1122.). 10 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
09/28/2004	ML042780333	2004/09/28-E-mail-Response to RAI Letter No. 5. 12 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007

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10/01/2004	ML042790056	2004/10/01-E-mail-FW: Exelon ESP Quality Plan. 2 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007
10/01/2004	ML042790139	2004/10/01-E-mail-Re: FW: Exelon ESP Quality Plan. 2 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
10/05/2004	ML042890418	Response to Request for Additional Information (RAI) Letter No. 3 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site (TAC No. MC1122). 43 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/06/2004	ML042860252	2004/10/06-E-mail - Typographical Error in RAI Letter No. 7. 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007
10/06/2004	ML042800504	2004/10/06-Telecon Summary to Clarify Responses to NRC Environmental Requests for Additional Information on the Exelon Early Site Permit Application. 9 Page(s)	Note	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007

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10/06/2004	ML042860248	2004/10/06-E-mail-First EP RAI response submittal. 44 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007
10/07/2004	ML042890357	2004/10/07-Response to Request for Additional Information (RAI) Letter No. 8 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 33 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/07/2004	ML042890390	Response to Revision to Request for Additional Information (RAI) Letter- No. 11 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site (TAC No. MC1122.) 67 Page(s)	Emergency Preparedness-Emergency Plan, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/07/2004	ML042870496	2004/10/07-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli attaching updates to disclosures with respect to Contention 3.1 5 Page(s)	Legal-Affidavit, Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007

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10/08/2004	ML042880460	2004/10/08-Response to Request for Additional Information (RAI) Letter No. 10 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site (TAC No. MC1122.) 15 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/08/2004	ML042990572	2004/10/08-Email- Response to RAI Letter No. 11. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/08/2004	ML042920203	10/08/04-E-mail- Response to RAI Letter No. 11. 68 Page(s)	E-Mail, Legal-Affidavit, Letter, Report, Miscellaneous	Exelon Generation Co, LLC	NRC	05200007
10/08/2004	ML042890051	2004/10/08-Response to Request for Additional Information (RAI) Letter No. 4 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 145 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/08/2004	ML042860254	2004/10/08-E-mail - Response to RAI Letter No. 8. 35 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007

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10/08/2004	ML042880466	2004/10/08-Response to NRC Inspection of Applicant and Contractor Quality Assurance Activities Involved with Preparation of the Application for an Early Site Permit, Report 0520007/2004001. 12 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/11/2004	ML042920225	2004/10/11-E-mail-RE: Response to QA IR. 14 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007
10/11/2004	ML042920222	2004/10/11-E-mail- RE: Response to RAI Letter No. 4 147 Page(s)	E-Mail, Legal-Affidavit, Letter, Report, Miscellaneous	Exelon Generation Co, LLC	NRC	05200007
10/11/2004	ML042920213	2004/10/11-E-mail- Response to RAI Letter No. 10. 17 Page(s)	E-Mail, Legal-Affidavit, Letter	Exelon Generation Co, LLC	NRC	05200007

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10/11/2004	ML042960106	2004/10/11-Response to Request for Additional Information (RAI) Letter No. 7 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 91 Page(s)	Letter	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
10/11/2004	ML042960057	2004/10/11-Response to Request for Additional Information (RAI) Letter No. 9 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 8 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/11/2004	ML042960105	Response to Request for Additional Information (RAI) Letter No. 6 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 56 Page(s)	Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/12/2004	ML043030610	2004/10/12-E-mail-FW: 3rd set of seismic attachments #2. 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030613	2004/10/12-E-mail-RAI 2.5.2-6 Figure 1A. 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007

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10/12/2004	ML043030672	2004/10/12-E-mail-RE: 3rd set of seismic attachments (8 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML042920229	2004/10/12-E-mail- Response to RAI Letter No. 6. 383 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030667	2004/10/12-E-mail-RE: 3rd set of seismic attachments (7 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML042920234	2004/10/12-E-mail- Response to RAI Letter No. 9. 10 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030600	2004/10/12-E-mail-FW: 3rd set of seismic attachments. 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030592	2004/10/12-E-mail-2nd set of seismic attachments. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007

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10/12/2004	ML043030583	2004/10/12-E-mail-1st set of seismic attachments 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030700	2004/10/12-E-mail-RE: 3rd set of seismic attachments (12 of 12). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030664	2004/10/12-E-mail-RE: 3rd set of seismic attachments (6 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030660	2004/10/12-E-mail- RE: 3rd set of seismic attachments (5 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030651	2004/10/12-E-mail-FW: 3rd set of seismic attachments (2 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030631	2004/10/12-E-mail-RE: 3rd set of seismic attachments (4 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007

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10/12/2004	ML043030697	2004/10/12-E-mail-RE: 3rd set of seismic attachments (9 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030696	2004/10/12-E-mail- RE: 3rd set of seismic attachments (11 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030617	2004/10/12-E-mail- 3rd set of seismic attachments (1 of 11). 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030626	2004/10/12-E-mail-RE: 3rd set of seismic attachments (3 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030577	2004/10/12-E-mail-Response to RAI Letter No. 7. 2 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030675	2004/10/12-E-mail-RE: 3rd set of seismic attachments (10 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007

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10/19/2004	ML043030553	2004/10/19-E-mail - Seismic Consultant. 1 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/20/2004	ML043030557	2004/10/20-E-mail-Re: Seismic Consultant. 2 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
10/22/2004	ML043060232	2004/10/22-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli attaching an update to disclosures with respect to Contention 3.1 as admitted by the Licensing Board 5 Page(s)	Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
10/28/2004	ML042820082	2004/10/28-Clinton, Withholding From Public Disclosure, Exelon ESP Project Quality Assurance Plan. 6 Page(s)	Letter, Proprietary Information Review	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
11/05/2004	ML043140401	11/05/04-E-mail-Conference Call Information, 1 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007

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11/12/2004	ML043200576	2004/11/12-E-mail-Draft Requests for Additional Information - Emergency Planning. 5 Page(s)	E-Mail, Letter, Request for Additional Information (RAI)	NRC/NRR	Exelon Generation Co, LLC	05200007
11/12/2004	ML043240474	2004/11/12-Exelon Generation Company's Answer in Opposition to Intervenors' Motion to Suspend Proceeding Pending Reinstatement of Agencywide Document Access and Management System 8 Page(s)	Legal-Motion	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007
11/15/2004	ML043210579	2004/11/15-Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application for The Exelon Generation Company Site (TAC No. MC1125). 7 Page(s)	Request for Additional Information (RAI)	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
11/15/2004	ML043090029	2004/11/15-Revised Dates For Conducting the Environmental Review of the Exelon ESP Application. 7 Page(s)	Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007

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11/16/2004	ML043290006	2004/11/16-Corrections / Clarifications to the Exelon Early Site Permit (ESP) Application Environmental Report for the Clinton ESP Site. 67 Page(s)	Environmental Report, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
11/18/2004	ML043410062	2004/11/18-E-mail correspondence regarding ER corrections relating to the EGC ESP environmental review. 1 Page(s)	E-Mail	Exelon Corp	NRC, NRC/NRR/DRIP/RLEP, Pacific National Lab	05200007
11/19/2004	ML043270432	2004/11/19-E-mail- Seismic Primer. 33 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
11/19/2004	ML043350394	2004/11/19-Seismic Risk (Performance Goal) Based Approach Primer - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 31 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
11/30/2004	ML043360250	2004/11/30-E-mail- Final 2004 NRC Invoice. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007

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12/07/2004	ML043510176	2004/12/07-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli attaching an update to disclosures with respect to Contention 3.1 as admitted by the Licensing Board 4 Page(s)	Legal-Affidavit, Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
12/07/2004	ML043510382	2004/12/07-Corrections/Clarifications to the Exelon Generation company, LLC (EGC) Early Site Permit (ESP) Application Site Safety Analysis Report and Emergency Plan for the Clinton ESP Site. 56 Page(s)	Emergency Preparedness-Emergency Plan, Final Safety Analysis Report (FSAR), Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
12/08/2004	ML043480194	2004/12/08-E-mail-Self identified changes. 58 Page(s)	E-Mail, Letter	Exelon Corp	NRC	05200007
12/09/2004	ML043380008	2004/12/09-Request for Additional Information Letter No. 12 - Exelon ESP Application for the Clinton ESP Site. 9 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC, Exelon Nuclear	05200007

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12/13/2004	ML043630425	2004/12/13-Response to Request for Additional Information (RAI) - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 7 Page(s)	Legal-Affidavit, Letter	Exelon Corp, Exelon Nuclear	NRC/Document Control Desk	05200007
12/13/2004	ML043570096	2004/12/13-E-mail correspondence regarding S-3 request for additional information response pertaining to the Exelon ESP project. 9 Page(s)	E-Mail, Environmental Impact Statement	Exelon Corp	Battelle Memorial Institute, Pacific Northwest National Lab, NRC	05200007
12/14/2004	ML050030024	2004/12/14-Revised Response to Request for Additional Information (RAI) Letter No. 3 re: Early Site Permit (ESP) Application for the Clinton ESP Site. 13 Page(s)	- No Document Type Applies	Exelon Corp, Exelon Nuclear	NRC/Document Control Desk	05200007
12/15/2004	ML050030022	2004/12/15-Transmittal of Revised Response to Request for Additional Information (RAI) Letter No. 3 re: Early Site Permit (ESP) Application for the Clinton ESP Site. 3 Page(s)	Legal-Affidavit, Letter	Exelon Corp, Exelon Nuclear	NRC/Document Control Desk	05200007

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12/15/2004	ML043520443	2004/12/15-E-mail-Docket 52-007 re: EGC Revised RAI 13.3-2 Response. 16 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
12/15/2004	ML043520433	2004/12/15-E-mail-Docket 52-007 re: Seismic High Frequency Effects. 6 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
12/15/2004	ML043630437	2004/12/15-Early Site Permit Application for Clinton ESP Site, Seismic High Frequency Considerations (TAC No. MCI122). 4 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
12/16/2004	ML043520441	2004/12/16-E-mail-Re: Projection of NRC Year End Invoices. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
12/16/2004	ML043520438	2004/12/16-E-mail-Projection of NRC Year End Invoices. 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
12/16/2004	ML043520439	2004/12/16-E-mail-Re: Projection of NRC Year End Invoices. 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007

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01/14/2005	ML050250137	2005/01/14-Early Site Permit (ESP) Application for the Clinton ESP Site Seismic Risk (Performance Goal) Based Approach Primer Revision. 32 Page(s)	Graphics incl Charts and Tables, Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
01/14/2005	ML050140051	2005/01/14-Exelon Early Site Permit Project Manager Reassignment. 5 Page(s)	Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
01/24/2005	ML050250305	2005/01/24-E-mail EP ETE RAI Responses to Letter No. 12. 88 Page(s)	E-Mail, Graphics incl Charts and Tables, Legal-Affidavit	Exelon Generation Co, LLC	NRC/NRR/DRIP/RNRP	05200007
02/01/2005	ML043570375	2005/02/01-Clinton, Withholding From Public Disclosure, Exelon ESP Application - State and Local Emergency Plans. 5 Page(s)	Letter, Proprietary Information Review	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/04/2005	ML050320230	2005/02/04-Potential Open Items for the Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 12 Page(s)	Letter	NRC/NRR/DRIP	Exelon Generation Co, LLC	05200007

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02/07/2005	ML050390092	2005/02/07-E-mail-Potential Exelon ESP DSER Open Items. 10 Page(s)	E-Mail, Letter	NRC/NRR	Exelon Generation Co, LLC	05200007
02/10/2005	ML050400350	2005/02/10-Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 9 Page(s)	Letter, Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/11/2005	ML050480478	2005/02/11-E-mail-Re: Copy of Exelon ESP DSER, Appendices A & B. 54 Page(s)	Draft Safety Evaluation Report (DSER), E-Mail, Graphics incl Charts and Tables	NRC	Exelon Generation Co, LLC, NRC	05200007
02/11/2005	ML050480447	2005/02/11-E-mail-Re: Copy of Exelon ESP DSER-#1. 169 Page(s)	Draft Safety Evaluation Report (DSER), E-Mail, Letter	NRC	Exelon Generation Co, LLC, NRC	05200007
02/11/2005	ML050670436	2005/02/11-E-mail- Re: Copy of Exelon ESP DSER. 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC, NRC	05200007

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02/15/2005	ML050550356	2005/02/15-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli providing an update to disclosures with respect to Contention 3.1 as admitted by the Licensing Board 4 Page(s)	Legal-Affidavit, Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
02/23/2005	ML050630552	2005/02/03-Review of Draft Safety Evaluation Report for the Early Site Permit (ESP) Application for the Clinton ESP Site. 2 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

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02/24/2005	ML050600414	2005/02/24-E-Mail - Fwd: Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 10 Page(s)	E-Mail	NRC/NRR/DRIP/RNRP	Advanced Technologies & Labs International, Inc, AECL Technologies, Inc, Dominion, Eckert, Seamans, Cherin & Mellott, LLC, Entergy Nuclear Operations, Inc, Exelon Corp, Framatome ANP, Inc, General Atomics, General Electric Co, Greenpeace, NRC, Nuclear Control Institute, Nuclear	05200007

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02/28/2005	ML050400378	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Chapter 1 with Table of Contents and Abbreviations. 29 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/28/2005	ML050400411	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Chapter 18, Review by the Advisory Committee on Reactor Safeguards. 1 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/28/2005	ML050400404	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Chapter 17, Quality Assurance. 39 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/28/2005	ML050400436	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Appendix A, Chronology of Early Site Permit application for the EGC ESP Site. 43 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007

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02/28/2005	ML050400394	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Chapter 3, Site Safety Assessment. 26 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/28/2005	ML050400423	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Chapter 19, Conclusions. 1 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/28/2005	ML050400386	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Chapter 2, Site Characteristics. 139 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/28/2005	ML050400450	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Appendix B, References. 9 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
03/02/2005	ML050620302	2005/03/02-Notice of Availability of the Draft Environmental Impact Statement (DEIS) for An Early Site Permit (ESP) at the Exelon ESP Site (TAC NO. MC1125). 10 Page(s)	Federal Register Notice, Letter	NRC/NRR/DRIP	Exelon Generation Co, LLC	05200007

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03/03/2005	ML050670270	2005/03/03-E-mail-Exelon ESP re: NRC Invoice for 4th Qtr 2004. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC/NRR/DRIP/RNRP	05200007

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03/04/2005	ML050540039	2005/03/04-Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 7 Page(s)	Letter	NRC/NRR/DRIP/RNRP	- No Known Affiliation, Advanced Technologies & Labs International, Inc, CH2M Hill, Dominion Generation, Enercon Services, Inc, Entergy Nuclear, Inc, Exelon Generation Co, LLC, Exelon Nuclear, Framatome ANP Richland, Inc, Greenpeace, Morgan, Lewis & Bockius, LLP, Nuclear	05200007

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03/04/2005	ML050670302	2005/03/04-E-mail-Exelon ESP re: NRC Invoice for 4th Qtr 2004. 2 Page(s)	E-Mail	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
03/08/2005	ML050670580	2005/03/08-E-mail-Conference line for Thursday Hydrology call. 2 Page(s)	E-Mail	Exelon Corp	NRC/NRR/DRIP/RNRP	05200007

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03/08/2005	ML050670322	2005/03/08-E-mail-Fwd: Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 13 Page(s)	E-Mail	NRC/NRR/DRIP/RNRP	Advanced Technologies & Labs International, Inc, AECL Technologies, Inc, Dominion, Eckert, Seamans, Cherin & Mellott, LLC, Emergi-Lite, Entergy Nuclear Operations, Inc, Exelon Corp, Framatome ANP, Inc, General Atomics, General Electric Co, Greenpeace, NRC, Nuclear Control	05200007

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03/11/2005	ML050800407	2005/03/11-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli attaching an update to disclosures with respect to Contention 3.1 as admitted by the Licensing Board 4 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
03/16/2005	ML050810517	2005/03/16-Seismic Risk (Performance Goal) Based Approach Calculation re: Early Site Permit Application for Clinton Site. 11 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
03/17/2005	ML050870594	2005/03/17-Exelon's Motion for Summary Disposition of Contention 3.1 180 Page(s)	Legal-Motion	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007
03/18/2005	ML050800214	2005/03/18-E-mail from Eddie R. Grant to John Segal regarding March 16 submittal. 13 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC/NRR/DRIP/RNRP	05200007

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03/21/2005	ML050890143	2005/03/21-Letter from Steven P. Frantz to Members of the Licensing Board regarding Certification for Motion for Summary Disposition 4 Page(s)	Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007
03/29/2005	ML051010274	2005/03/29-Two E-Mails to Bill Maher for the public hearing record for the Exelon ESP site. 4 Page(s)	E-Mail, Environmental Impact Statement	NRC/NRR	Exelon Corp	05200007
03/31/2005	ML050920004	2005/03/3-Notice of Change of Location for Public Meeting on the Draft Environmental Impact Statement (DEIS) for an Early Site Permit (ESP) at the Exelon ESP Site (TAC No. MC1125). 11 Page(s)	Federal Register Notice, Letter, Meeting Notice	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
04/04/2005	ML051020249	2005/04/04-Partial Response to Draft Safety Evaluation Report (DSER) Items. 63 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

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04/05/2005	ML051010295	2005/04/05-E-mail from Eddie R. Grant to John Segala regarding April 4 submittal. 65 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC/NRR/DRIP/RNRP	05200007
04/07/2005	ML051080047	2005/04/07-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli providing an update to disclosures with respect to Contention 3.1 as admitted by the Licensing Board 4 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
04/08/2005	ML050980379	2004/04/08-Notice of Change of Location for Public Meeting on the Draft Environmental Impact Statement (DEIS) for an Early Site Permit (ESP) at the Exelon ESP Site (TAC No. MC1125). 10 Page(s)	Federal Register Notice, Letter	NRC/NRR/DRIP	Exelon Generation Co, LLC	05200007
04/19/2005	ML051150509	2005/04/19-E-mail from Eddie R. Grant to John Segala Regarding Exelon ESP DSER Hydrology Discussion Items. 5 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC/NRR/DRIP/RNRP	05200007

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04/22/2005	ML051190409	2005/06/22-Intervenors' Motion to Amend Contention 3.1 78 Page(s)	Legal-Motion	Blue Ridge Environmental Defense League, Environmental Law & Policy Ctr, Exelon Generation Co, LLC, Harmon, Curran, Spielberg & Eisenberg, LLP, Nuclear Energy Information Service, Nuclear Information & Resource Service (NIRS), Public Citizen, Inc	NRC/ASLBP	05200007

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04/25/2005	ML051240310	2005/04/25-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli providing an update to disclosures with respect to Contention 3.1 as admitted by the Licensing Board 4 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
04/26/2005	ML051170014	2005/04/26-E-mail from Eddie R. Grant to John Segala Regarding Exelon ESP DSER OI Response. 82 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC/NRR/DRIP/RNRP	05200007
04/26/2005	ML051230326	2005/04/25-Response to Draft Safety Evaluation Report (DSER) Regarding the Early Site Permit (ESP) Application for the Clinton ESP Site. 79 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

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05/05/2005	ML051320313	2005/05/05-Sixth Additional Disclosures of Intervenors Environmental Law and Policy Center, Blue Ridge Environmental Defense League, Nuclear Information and Resource Service, Nuclear Energy Information Service, and Public Citizen 7 Page(s)	Legal-Intervention Petition, Responses and Contentions	Environmental Law & Policy Ctr, Exelon Generation Co, LLC, Harmon, Curran, Spielberg & Eisenberg, LLP, Nuclear Energy Information Service, Nuclear Information & Resource Service (NIRS), Public Citizen, Inc	NRC/ASLBP	05200007
05/06/2005	ML051320285	2005/05/06-Exelon's Answer to Intervenors' Motion to Amend Contention 3.1 52 Page(s)	Legal-Motion	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007

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05/06/2005	ML051290002	2005/05/06-E-mail from Eddie R. Grant to John Segala Regarding May 6 Letter on NRC Fee Payment. 4 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007
05/11/2005	ML051390202	2005/05/11-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli providing an update to disclosures pursuant to 10 CFR § 2.336(d) (Supplement 8) 4 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
05/17/2005	ML051430338	2005/05/17-Exelon Brief in Response to Commission Memorandum and Order (CLI-05-09) 28 Page(s)	Legal-Brief	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/OCM	05200007
05/24/2005	ML051540317	2005/05/24-Comment (32) of Marilyn C. Kray on behalf of Exelon Nuclear on Review of Draft Environmental Impact Statement for Clinton ESP Site. 46 Page(s)	General FR Notice Comment Letter	Exelon Nuclear	NRC/ADM/DAS/RDB	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
06/03/2005	ML051640439	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Figure 2.3-14 - Figure 2.3-25.. 12 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640440	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Figure 2.4-1 - Figure 2.5-9. 12 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640436	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Figure 2.3-7 - Figure 2.3-12. 6 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007

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06/03/2005	ML051640428	2005/06/03-Transmittal of Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Cover Letter. 3 Page(s)	Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640438	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Figure 2.3-13. 1 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640441	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Figure 2.7-1 - Figure 2.7-18. 18 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007

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06/03/2005	ML051640448	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Environmental Consequences of the Proposed Action - Table B-1. 60 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640446	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Environmental Measurement and Monitoring Programs - Figure 9.2-4. 212 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640444	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Environmental Impacts of Station Operation - Figure 5.3-2. 127 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007

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06/03/2005	ML051640434	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Figure 2.2-6 - Figure 2.3-6. 9 Page(s)	Environmen tal Report	Exelon Nuclear	NRC/Docu ment Control Desk	05200007
06/03/2005	ML051640431	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Contents - Figure 2.2-5. 245 Page(s)	Environmen tal Report	Exelon Nuclear	NRC/Docu ment Control Desk	05200007
06/03/2005	ML051640442	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Plant Description - Figure 4.5-1. 120 Page(s)	Environmen tal Report	Exelon Nuclear	NRC/Docu ment Control Desk	05200007

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06/30/2005	ML051920121	2005/06/30-Submission of Reviewers Aid for Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report. 3 Page(s)	Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
06/30/2005	ML051920127	2005/06/30-Reviewers Aid for Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report. 95 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
07/14/2005	ML051960277	2005/07/14-E-Mail re: Revised DSER Response. 64 Page(s)	E-Mail, Legal-Affidavit, Letter	Exelon Corp	NRC/NRR/DRIP/RNRP	05200007
07/14/2005	ML052150136	Revised Response to Draft Safety Evaluation Report (DSER) Items re: Letter, U.S. NRC (W. D. Beckner) to Exelon Generation Company, LLC, (M. Kray), dated February 10, 2005, Draft Safety Evaluation Report for the Exelon ESP Application. 62 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

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07/18/2005	ML051930155	Clinton ESP Quality Assurance Assessment and Resolution of Confirmatory Item (CI) and Open Item (OI) 17.1-1. 8 Page(s)	Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
08/03/2005	ML052210410	2005/08/03-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli enclosing updates to disclosures with respect to Contention 3.1 (Supplement 9) 35 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007

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08/12/2005	ML052360416	2005/08/12-Intervenors' Petition for Review of the Atomic Safety and Licensing Board's Dismissal of Contention 3.1 and Rejection of Intervenors' Proposed Amended Contention 3.1 23 Page(s)	Legal-Brief	Blue Ridge Environmental Defense League, Exelon Generation Co, LLC, Harmon, Curran, Spielberg & Eisenberg, LLP, Nuclear Energy Information Service, Nuclear Information & Resource Service (NIRS)	NRC/OCM	05200007
08/16/2005	ML051540054	Revised Schedule for Review of the Exelon Early Site Permit Application for the Exelon ESP Site. 10 Page(s)	Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007

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08/19/2005	ML052300522	Potential Open Items for the Supplemental Draft Safety Evaluation Report for the Exelon ESP Application. 14 Page(s)	Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
08/22/2005	ML052410437	2005/08/22-Exelon Generation Company's Answer in Opposition to Intervenors' Petition for Review 30 Page(s)	Legal-Brief	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/OCM	05200007
08/26/2005	ML052310469	Cover Letter to M. Kray re: Supplemental Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 4 Page(s)	Draft Safety Evaluation Report (DSER), Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
08/31/2005	ML052310478	Supplemental Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 125 Page(s)	Draft Safety Evaluation Report (DSER)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007

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09/07/2005	ML052590007	2005/09/07-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli providing updates to disclosures with respect to Contention 3.1 (Supplement 10) 4 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
09/30/2005	ML052860134	Early Site Permit (ESP) Application for the Clinton ESP Site - Revised Response to Draft Safety Evaluation Report (DSER) Items. 6 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/11/2005	ML052860325	10/11/05 - Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application for the Exelon Generation Company Site (TAC No. MC1125). 8 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007

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10/11/2005	ML052860274	10/11/05 - Summary of Telephone Conference Call Held on September 19, 2005 Between the U.S. Nuclear Regulatory Commission (NRC) and the Illinois Department of Natural Resources (IDNR) Regarding the Review of the Exelon Early Site Permit (ESP). 6 Page(s)	Meeting Summary, Note to File incl Telcon Record, Verbal Comm	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
10/11/2005	ML052860253	10/11/05 - Summary of Telephone Conference Call Held on September 13, 2005 Between the U.S. Nuclear Regulatory Commission (NRC) and the Illinois Environmental Protection Agency (EPA) Regarding the Review of the Exelon Early Site Permit (ESP). 6 Page(s)	Note	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
10/12/2005	ML052930270	Early Site Permit Application for the Clinton ESP Site, ESP Site Soil Hazard Data. 6 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

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10/27/2005	ML053070508	Early Site Permit (ESP) Application for the Clinton ESP Site, Revised Response to Request for Additional Information Letter No. 12. 10 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/31/2005	ML053120131	Clinton ESP Site, Responses to Supplemental Draft Safety Evaluation Report (DSER) Items. 285 Page(s)	Graphics incl Charts and Tables, Letter, Map	Exelon Nuclear	NRC/Document Control Desk	05200007
11/23/2005	ML053420057	Submittal of Revision 1 to Exelon Generation Company's Early Site Permit Application. 4 Page(s)	Letter	Exelon Generation Co, LLC	NRC/Document Control Desk	05200007
12/13/2005	ML053540218	Response to Request for Additional Information (RAI) - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 4 Page(s)	Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
12/21/2005	ML060030484	Early Site Permit Application for the Clinton ESP Site, Revised Response to Draft Safety Evaluation Report Open Items. 13 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

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06/27/2002	ML042280019	2002/06/27-E-mail - Exelon ESP Site Activities. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007
07/08/2002	ML042280020	2002/07/08-E-mail - RE: Exelon ESP Site Activities. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007, PROJ0718
07/12/2002	ML042280021	2002/07/12 - E-mail - Exelon ESP seismic activities. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007, PROJ0718
07/25/2002	ML042280022	2002/07/25-E-mail - RE: NRC-Exelon seismic field work telecon at 2 EDT. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007, PROJ0718
07/31/2002	ML042280023	2002/07/31-E-mail - ESP Schedule of Seismic & Geotechnical Activities. 3 Page(s)	E-Mail	Exelon Corp	NRC	05200007, PROJ0718
05/16/2003	ML042300743	2003/05/16-E-mail - Clinton Community Advisory Panel. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718

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05/29/2003	ML042300745	2003/05/29-E-mail - CD needed for Web Posting. 4 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
06/10/2003	ML042280025	2003/06/10-E-mail Re :Question on Security Info. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007, PROJ0718
06/10/2003	ML042300768	2003/06/10-E-mail - Application TOC. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
06/10/2003	ML042300771	2003/06/10-E-mail - Question on Security Info. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
06/11/2003	ML042300774	2003/06/11-E-mail - Requirements on Number of Copies. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
06/11/2003	ML042300772	2003/06/11-E-mail - RE: Application TOC. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
06/12/2003	ML042300775	2003/06/12-E-mail - Word File. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718

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06/12/2003	ML042300778	2003/06/12-E-mail - RE: Word File. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
06/13/2003	ML042300779	2003/06/13-E-mail - RE: Word File. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
07/02/2003	ML042300780	2003/07/02-E-mail - RE: Application TOC. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
07/07/2003	ML042300827	2003/07/07-E-mail - Information on Clinton Lake. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
07/14/2003	ML042300782	2003/07/14 - E-mail - Call on Seismic Issues. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
07/14/2003	ML042300784	2003/07/14-E-mail - RE: Call on Seismic Issues. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
08/11/2003	ML042300787	2003/08/11-E-mail - QA Meeting. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718

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08/26/2003	ML042300788	2003/08/26-E-mail - QA Meeting. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
08/29/2003	ML042300791	2003/08/29-E-mail - Discussion After Entergy QA Meeting. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
08/29/2003	ML042280026	2003/08/29-E-mail - RE: Application TOC. 3 Page(s)	E-Mail	Exelon Corp	NRC	05200007, PROJ0718
08/29/2003	ML042300792	2003/08/29-E-mail - RE: Application TOC. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
09/02/2003	ML042300793	2003/09/02-E-mail - RE: Application TOC. 4 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
09/09/2003	ML042300825	2003/09/09-E-mail - Re: ESP Letter. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
09/11/2003	ML042300795	2003/09/11-E-mail - Re: Yesterday's Mtg. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718

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09/12/2003	ML042300796	2003/09/12-E-mail - QA Inspection Dates. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
09/25/2003	ML032721594	2003/09/25-Submittal of Exelon Generation Company (EGC) application for an early site permit (ESP) for property co-located with existing Clinton Power Station (CPS) facility in Illinois. 3 Page(s)	Letter, License-Application for Construction Permit DKT 50	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05000461, 05200007, PROJ0718
09/30/2003	ML042300799	2003/09/30-E-mail - Hard Copies. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
10/01/2003	ML042300815	2003/10/01-E-mail - Picture. 2 Page(s)	E-Mail, Photograph	NRC	Exelon Corp	05200007
10/01/2003	ML042300800	2003/10/01-E-mail - Clinton USAR Update. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
10/01/2003	ML042300801	2003/10/01-E-mail - Service List 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007

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10/02/2003	ML042310348	2003/10/02-E-mail - RE: Hard Copies. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
10/02/2003	ML042310323	2003/10/02-E-mail - RE: Service List. 3 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
10/03/2003	ML042310342	2003/10/03-E-mail - RE: Hard Copies. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
10/03/2003	ML042310333	2003/10/03-E-mail - Re: Hard Copies. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
10/03/2003	ML042310360	2003/10/03-E-mail - RE: Hard Copies. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007
10/08/2003	ML042440536	2003/10/08-E-mail - RE: Schedule. 3 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
10/16/2003	ML042300811	2003/10/16-E-mail - Answer to Question on ESP Record Retention. 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007, PROJ0718

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10/27/2003	ML032930051	2003/10/27-Letter to M. Kray re: Acceptance of Application for ESP for Property Co-Located With The Existing Clinton Power Station. 6 Page(s)	Letter	NRC/NRR/DRIP	Exelon Generation Co, LLC	05200007
10/27/2003	ML032930059	2003/10/27-Exelon ESP Review Schedule. 1 Page(s)	Spreadsheet File	NRC/NRR/DRIP	Exelon Generation Co, LLC	05200007
11/19/2003	ML033250261	2003/11/19-Notice Of Intent To Prepare An Environmental Impact Statement And Conduct Scoping Process For An Early Site Permit (ESP) At The Clinton ESP Site (TAC NO. MC1125). 13 Page(s)	Federal Register Notice, Letter	NRC/NRR/DRIP	Exelon Generation Co, LLC	05200007
11/21/2003	ML042300813	2003/11/21-E-mail - Request for Additional Information-QA. 11 Page(s)	E-Mail, Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Corp	05200007
11/21/2003	ML042300824	2003/11/21-E-mail - Attorneys. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007

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11/21/2003	ML033210018	2003/11/21-Request For Additional Information Letter No. 1 - Exelon ESP Application for the Clinton ESP Site on QA Measures (MC1122). 7 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP	Exelon Generation Co, LLC	05000461, 05200007
12/09/2003	ML033510146	2003/12/09-Service of Notice of Availability of an Application for an Early Site Permit. 3 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk, NRC/NRR	05200007
12/10/2003	ML042280027	2003/12/10-E-mail, Administrative items. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
12/10/2003	ML042280028	2003/12/10-E-mail - Administrative questions. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007
12/11/2003	ML042440541	2003/12/11-E-mail - Re: Administrative questions. 3 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007

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12/22/2003	ML033640639	2003/12/22-Response to RAI Letter No. 1 Regarding Quality Assurance Measures, per Early Site Permit Application for the Clinton Site. 1 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05000461, 05200007
01/06/2004	ML042440548	2004/01/06-E-mail - Re: Administrative questions. 2 Page(s)	E-Mail, Letter	NRC	Exelon Corp	05200007
01/21/2004	ML040430135	2004/01/21-SUMMARY OF PUBLIC MEETING TO DISCUSS THE ENVIRONMENTAL SCOPING PROCESS FOR THE CLINTON EARLY SITE PERMIT (ESP) APPLICATION 143 Page(s)	Meeting Agenda, Meeting Summary, Transcript	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
01/24/2004	ML050280252	2004/01/24-Response to Request for Additional Information Letter No. 12 re Application for Clinton ESP Site. 82 Page(s)	Letter	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007

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02/13/2004	ML041830102	2004/02/13-Staff E-mail to Exelon Forwarding the Proposed Agenda for Alternative Site Visits for the EGC ESP Review. 4 Page(s)	E-Mail	NRC/NRR/DRIP/RLEP	Exelon Corp	05200007
02/18/2004	ML041830095	2004/02/18-Staff E-mail to Exelon Forwarding Agenda Items for the EGC ESP Site Audit. 13 Page(s)	E-Mail	NRC/NRR/DRIP/RLEP	Exelon Corp	05200007
02/20/2004	ML040540622	2004/02/20-IR 0520007-04-001, on 01/12/04 through 01/16/04, for Exelon Generation Company, Kennett Square, PA; (Clinton) Early Site Permit. 48 Page(s)	Inspection Report, Letter	NRC/RGN-III/DRS	Exelon Generation Co, LLC	05200007
02/23/2004	ML042300818	2004/02/23-E-mail - Requests for Additional Information. 4 Page(s)	Letter, Request for Additional Information (RAI)	NRC	Exelon Corp	05200007
02/24/2004	ML041820385	2004/02/24-Staff E-mail to Exelon Forwarding an Additional Question for the EGC ESP Site Audit re Spent Fuel Storage. 1 Page(s)	E-Mail	NRC/NRR/DRIP/RLEP	Exelon Corp	05200007

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02/25/2004	ML041830104	2004/02/25-Staff E-mail to Exelon Forwarding Additional Agenda Items for the EGC ESP Site Audit. 3 Page(s)	E-Mail	NRC/NRR/DRIP/RLEP	Exelon Corp	05200007
02/26/2004	ML041830124	2004/02/26-Staff E-mail to Exelon Regarding Discussion Items on Worker Dose for the EGC ESP Site Audit. 3 Page(s)	E-Mail	NRC/NRR/DRIP/RLEP	Exelon Corp	05200007
03/05/2004	ML042300803	2004/03/05-E-mail - Seismic Call-REVISION. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007, PROJ0718
03/08/2004	ML042440552	2004/03/08-E-mail - RE: Seismic Call-REVISION. 2 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
03/11/2004	ML042280029	2004/03/11-E-mail forwarding Amy Lientz Corrected Address, (Privacy Info). 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC/NRR	05200007

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03/15/2004	ML040820570	2004/03/15-Enclosure 2: Exelon Generation Company, LLC Early Site Permit Application of Alternative Site Comparison Process and Attachment 1: Alternative Site Comparison Process. 22 Page(s)	Technical Paper	Exelon Generation Co, LLC	NRC/NRR/ DRIP/RLEP	05200007
03/17/2004	ML040790804	2004/03/17-Clinton Power Station Early Site Permit - Response to Verbal Request for Documentation. 2 Page(s)	Letter	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Docu ment Control Desk	05000461, 05200007
03/17/2004	ML042280030	2004/03/17-E-mail - Clinton ETE. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007
03/19/2004	ML040900247	2004/03/19-Motion for Leave to File Notice of Appearance Out of Time 3 Page(s)	Legal-Motion	Exelon Generation Co, LLC, Harmon, Curran, Spielberg & Eisenberg, LLP	NRC/ASLB P	05200007

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03/19/2004	ML040900251	2004/03/19-Notice of Appearance by Diane Curran on behalf of Blue Ridge Environmental Defense League 3 Page(s)	Legal-Notice of Appearance	Exelon Generation Co, LLC, Harmon, Curran, Spielberg & Eisenberg, LLP	NRC/ASLBP	05200007
03/19/2004	ML042300816	2004/03/19-E-mail - Draft Requests for Additional Information-SSAR 2.5.2. 3 Page(s)	E-Mail, Request for Additional Information (RAI)	NRC	Exelon Corp	05200007
03/30/2004	ML042300805	2004/03/30-E-mail - Seismic Site Visit. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007
04/06/2004	ML040920584	2004/04/06-Letter to M Kray Re Revised Date for Transmitting Environmental RAIs for Exelon ESP Application. 6 Page(s)	Letter	NRC/NRR/DRIP	Exelon Generation Co, LLC	05200007
04/12/2004	ML042300817	2004/04/12-E-mail - Draft Requests for Additional Information-Emergency Plan. 6 Page(s)	E-Mail	NRC/NRR	Exelon Corp	05200007

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04/13/2004	ML041110024	2004/04/13-Exelon Submission of Requested Information, PBMR Ltd Calculation MF 00-016344-2053 dated March 6, 2003. 4 Page(s)	Calculation, Letter	Exelon Generation Co, LLC	NRC/Document Control Desk	05200007
04/14/2004	ML042450111	2004/04/14-E-mail-Re: Chicago Seismic Meeting. 2 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
04/15/2004	ML040930400	2004/04/15-RAI No. 2 - Exelon ESP Application for the Clinton ESP Site on Site Safety Analysis Report Section 2.3.3 (TAC No. MC1122). 7 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP	Exelon Generation Co, LLC	05200007
04/29/2004	ML042450110	2004/04/29-E-mail - Re: May 11-12 site visit. 2 Page(s)	E-Mail, Letter, Trip Report	NRC	Exelon Corp	05200007
04/29/2004	ML042280032	2004/04/29-E-mail, RE: May 18-19 seismic visit. 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007

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04/29/2004	ML042280031	2004/04/29-E-mail - May 11-12 site visit. 3 Page(s)	E-Mail	Exelon Corp	NRC	05200007
04/30/2004	ML042450101	2004/04/30-E-mail - Re: May 11-12 site visit. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007
04/30/2004	ML042450102	2004/04/30-E-mail - RE: May 18-19 seismic visit. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007
04/30/2004	ML042450097	2004/04/30-E-mail - RE: RAI No. 2 re Met Data. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007
04/30/2004	ML042450104	2004/04/30-E-mail - Re: May 11-12 site visit. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007
05/03/2004	ML042450093	2004/05/03-E-mail - Re: May 11-12 site visit. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007

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05/04/2004	ML042450086	2004/05/04-E-mail - RE: Site visit info - May 19. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007
05/05/2004	ML042280033	2004/05/05-E-mail - RE: Emergency Plan draft RAIs - Applicant questions. 3 Page(s)	E-Mail	Exelon Corp	NRC	05200007
05/05/2004	ML042450083	2004/05/05-E-mail - RE: Emergency Plan draft RAIs. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007
05/05/2004	ML042450081	2004/05/05-E-mail - RE: Emergency Plan draft RAIs - Applicant questions. 3 Page(s)	E-Mail, Letter	NRC	Exelon Corp	05200007
05/06/2004	ML042300807	2004/05/06-E-mail - Hydrology Discussion Topics. 5 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007

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05/11/2004	ML041330188	2005/05/11-Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application for the Exelon Generation Company Site (TAC No. MC1125). 17 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
05/12/2004	ML042300520	2004/05/12-E-mail - Fwd: Seismic RAI Topics for Mtg discussion. 3 Page(s)	E-Mail	NRC/NRR	Exelon Corp	05200007
05/14/2004	ML042450079	2004/05/14-E-mail - RE: NRC Seismic visit info - May 17-19. 3 Page(s)	E-Mail	NRC	Exelon Corp	05200007
05/18/2004	ML041830135	2004/05/18-Staff E-mail to Exelon Regarding Clarification Items to Site Audit Summary for the EGC ESP Review. 2 Page(s)	E-Mail	NRC/NRR/DRIP/RLEP	Exelon Corp	05200007
05/28/2004	ML041560144	2004/05/28-Exelon Generation Company's Answer to Proposed Contentions 42 Page(s)	Legal-Intervention Petition, Responses and Contentions	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007

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06/02/2004	ML041620360	2004/06/02-Exelon Generation Company's Answer in Opposition to Petitioners' Motion for Extension of Time to Reply to Response to Contentions 7 Page(s)	Legal-Motion	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007
06/08/2004	ML042300808	2004/06/08-E-mail - Figure 1.2-3. 1 Page(s)	E-Mail	NRC	Exelon Corp	05200007
06/08/2004	ML042450076	2004/06/08-E-mail Re: SSAR Site Hazards Visit. 3 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007
06/10/2004	ML042450074	2004/06/10-E-mail - RE: Figure 1.2-3. 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007
06/11/2004	ML042300819	2004/06/11-E-mail - RE: Emergency Plan draft RAIs - Applicant questions. 4 Page(s)	E-Mail, Letter	NRC	Exelon Corp	05200007
06/11/2004	ML042300820	2004/06/11-E-mail - Draft Requests for Additional Information. 12 Page(s)	E-Mail, Request for Additional Information (RAI)	NRC/NRR	Exelon Corp	05200007

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06/11/2004	ML042450072	2004/06/11-E-mail - RE: SSAR Site Hazards Visit. 4 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007
06/18/2004	ML041830154	2004/06/18-Exelon E-mail Forwarding Files for Lake Modeling PT 1 for the EGC ESP Review. 25 Page(s)	E-Mail	Exelon Corp	Battelle Memorial Institute, Pacific Northwest National Lab, NRC, NRC/NRR/ DRIP/RLEP	05200007
06/20/2004	ML041830159	2004/06/20-Staff E-mail to Exelon Regarding Files for Lake Modeling PT 2 for the EGC ESP Review. 2 Page(s)	E-Mail	Battelle Memorial Institute, Pacific Northwest National Lab	Battelle Memorial Institute, Pacific Northwest National Lab, Exelon Corp, NRC, NRC/NRR/ DRIP/RLEP	05200007
06/22/2004	ML041400206	2004/06/22-Letter to M. Kray, Exelon re: ESP Template 6 Page(s)	Letter	NRC/NRR/D RIP/RNRP	Exelon Generation Co, LLC	05200007

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06/23/2004	ML042300809	2004/06/23-E-mail - Question on Draft Met RAIs. 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007
06/23/2004	ML042300810	2004/06/23-E-mail - Response to Question on Met RAI. 2 Page(s)	E-Mail	NRC	Exelon Corp	05200007
06/23/2004	ML042280003	2004/06/23-E-mail- RE: Response to Question on Met RAI. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
07/02/2004	ML042180098	2004/07/02-NRC RAI E5.2-3 - Att E1, Clinton Lake Volume - 24 YR Period of Record Analysis with Single Uprated Existing Plant (Forced Loss estimated based on Forced Loss due to two 992 MW Plants). 11 Page(s)	Graphics incl Charts and Tables, Spreadsheet File	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007

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07/07/2004	ML042180099	2004/07/07-NRC RAI E5.2-3 - Att E2, Clinton Lake Volume - 24 YR Period of Record Analysis with Single Uprated Existing Plant (Forced Loss estimated based on Forced Loss due to two 992 MW Plants) & New Plant with Wet-Dry Cooling Process. 15 Page(s)	Graphics incl Charts and Tables, Spreadsheet File	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/07/2004	ML042180102	2004/07/07-NRC RAI E5.2-3 - Att E3, Clinton Lake Volume - 24 YR Period of Record Analysis with Single Uprated Existing Plant (Forced Loss estimated based on Forced Loss due to two 992 MW Plants) and New Plant with Wet Cooling Process. 11 Page(s)	Graphics incl Charts and Tables, Spreadsheet File	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/08/2004	ML042300821	2004/08/08-E-mail - Draft Request for Additional Information. 10 Page(s)	E-Mail, Request for Additional Information (RAI)	NRC/NRR	Exelon Corp	05200007

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07/09/2004	ML041950227	2004/07/09-Environmental Impact Statement Scoping Process Summary Report - Exelon Generation Company, LLC Early Site Permit, July 2004, U.S. Nuclear Regulatory Commission, Rockville, Maryland. 57 Page(s)	Environmental Impact Statement	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
07/09/2004	ML041950214	2004/07/09-Issuance of Environmental Scoping Summary Report Associated with Staff's Review of Application by Exelon Generation Company, LLC. For an Early Site Permit for Exelon ESP Site. 10 Page(s)	Letter	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
07/14/2004	ML042300822	2004/07/14-E-mail - Draft Request for Additional Information. 9 Page(s)	E-Mail, Request for Additional Information (RAI)	NRC/NRR	Exelon Corp	05200007
07/15/2004	ML042280013	2004/07/15-E-mail-Draft Requests for Additional Information. 9 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007

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07/20/2004	ML042440182	2004/07/20-E-mail - Draft Request for Additional Information. 4 Page(s)	E-Mail	NRC/NRR	Exelon Corp	05200007
07/21/2004	ML042310775	2004/07/21-E-mail, Public EP Info. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
07/22/2004	ML042440477	2004/07/22-E-mail - Draft Request for Additional Information. 4 Page(s)	E-Mail, Letter	NRC/NRR	Exelon Generation Co, LLC	05200007
07/22/2004	ML041890497	2004/07/22-Request for Additional Information Letter No. 3 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 10 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/23/2004	ML042180090	2004/07/23-NRC RAI E5.2-1&-2 - Att A, Lake Drought Model Description. 6 Page(s)	Report, Technical	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007

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07/23/2004	ML042180079	2004/07/23-Exelon Generation Company, LLC (EGC) Application for an Early Site Permit (ESP) Environmental Requests for Additional Information.. 97 Page(s)	Legal-Affidavit, Letter	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/23/2004	ML042440486	2004/07/23-E-mail - Draft Request for Additional Information. 3 Page(s)	E-Mail	NRC/NRR	Exelon Generation Co, LLC	05200007
07/23/2004	ML042180095	2004/07/23-NRC RAI E5.2-1&-2 - Att C, Lake Drought Analysis Model, Clinton Lake Volume - 100 YR RI Dry Period. 4 Page(s)	Graphics incl Charts and Tables, Spreadsheet File	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/23/2004	ML042180088	2004/07/23-NRC RAI E4.4-1 - Att B, Capacity Waste Water Supply - Rev. 2 Page(s)	- No Document Type Applies	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/23/2004	ML042180093	2004/07/23-NRC RAI E5.2-1&-2 - Att B, Lake Drought Analysis Description. 4 Page(s)	Report, Technical	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007

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07/23/2004	ML042180106	2004/07/23-NRC RAI E7.1-3 - Att A, Revised Table 7.1-2. 3 Page(s)	Graphics incl Charts and Tables	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/23/2004	ML042180096	2004/07/23-NRC RAI E5.2-3 - Att D, Clinton Lake Period of Record Analysis - Spreadsheet Column by Column Explanation. 11 Page(s)	Report, Technical	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/23/2004	ML042180105	2004/07/23-NRC RAI E5.2-3 - Att E4, Table 2.3-2, Attachment to July 22, 2002 Memo from Blonn, Keiser and Toll - Revised January 29, 2003. 14 Page(s)	Graphics incl Charts and Tables, Spreadsheet File	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
07/26/2004	ML042010267	2004/07/26-Clinton ESP Site Request For Additional Information Letter No. 4 - Exelon ESP Application. 14 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/26/2004	ML042440510	2004/07/26-E-mail - RAI Letters. 49 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007

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07/26/2004	ML042020018	2004/07/26-Clinton ESP Site Request For Additional Information Letter No. 7 - Exelon ESP Application. 13 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/26/2004	ML042020371	2004/07/26-Request For Additional Information Letter No. 9 - Exelon ESP Application for the Clinton ESP Site. 9 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/26/2004	ML042020002	2004/07/26-Clinton ESP Site Request For Additional Information Letter No. 6 - Exelon ESP Application. 11 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/27/2004	ML042280018	2004/07/27-E-mail - RE: RAI Letters. 2 Page(s)	E-Mail	Exelon Corp	Exelon Corp, NRC	05200007
07/27/2004	ML042020408	2004/07/27-Request For Additional Information Letter No. 10 - Exelon ESP Application for the Clinton ESP Site. 9 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/27/2004	ML042440530	2004/07/27-E-mail - RAI Letters. 47 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007

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07/27/2004	ML042020021	2004/07/27-Request For Additional Information Letter No. 8 - Exelon ESP Application for the Clinton ESP Site. 10 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/27/2004	ML042440523	2004/07/27-E-mail - RAI Letters. 49 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
07/27/2004	ML042050408	2004/07/27-Exelon ESP Application for the Clinton ESP Site (TAC No. MC1122). 13 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/27/2004	ML042280017	2004/07/27-E-mail- RE: RAI Letters. 2 Page(s)	E-Mail	Exelon Corp	Exelon Corp, NRC	05200007
07/27/2004	ML042010334	2004/07/27-Request For Additional Information Letter No. 5 - Exelon ESP Application for the Clinton ESP Site. 7 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
07/30/2004	ML042440473	2004/07/30-E-mail - RAI Letter No. 3. 11 Page(s)	E-Mail	NRC	Exelon Corp	05200007

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08/23/2004	ML042370551	2004/08/23-Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application for the Exelon Generation Company Site (TAC NO. MC1125). 9 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
08/24/2004	ML042230041	2004/08/24-Exelon, Revision to RAI No. 11 - ESP Application for Clinton ESP Site. 12 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
08/31/2004	ML042530527	2004/08/31-Exelon Generation Company's Answer in Opposition to Petition for Interlocutory Review 40 Page(s)	Legal-Brief	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/OCM	05200007
09/07/2004	ML042660165	2004/09/07-Submittal of Early Site Permit Quality Plans. 7 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

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09/07/2004	ML042600182	2004/09/07-Letter from Paul M. Bessette to Shannon Fisk and Tyson R. Smith attaching disclosures with respect to Contention 3.1 as admitted by the Licensing Board 5 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
09/07/2004	ML042750231	2004/09/07-E-mail w/o att-EGC ESP Quality Plan. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
09/17/2004	ML042590004	2004/09/17 - Summary of Meeting with Dominion, SERI and Exelon Regarding Reviews of EP Aspects of Their Respective ESP Applications. 10 Page(s)	Meeting Summary	NRC/NRR/DRIP/RNRP	Dominion Nuclear North Anna, LLC, Exelon Generation Co, LLC, Exelon Nuclear, System Energy Resources, Inc	05200007, 05200008, 05200009

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09/17/2004	ML042730435	2004/09/17-Exelon Generation Company, LLC (EGC), Delay in Responding to Requests for Additional Information (RAI) regarding the Environmental Portion of the Application for an Early Site Permit (ESP). 2 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
09/17/2004	ML042680065	2004/09/17-Joint Response of Exelon Generation Company and the NRC Staff to Licensing Board Request Regarding Mandatory Hearing Procedures for the Clinton Early Site Permit 14 Page(s)	Legal-Report	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007
09/21/2004	ML042730214	2004/09/21-Letter from Steven P. Frantz to Administrative Judges informing of the agreement of Exelon Generation Company, Intervenors, and the NRC staff regarding updates to discovery disclosures under 10 CFR § 2.336(d) 4 Page(s)	Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007

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09/23/2004	ML042730012	2004/09/23-Exelon Generation Company, LLC (EGC), Response to Requests for Additional Information (RAI) regarding the Environmental Portion of the Application for an Early Site Permit (ESP). 51 Page(s)	Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
09/24/2004	ML042730467	2004/09/24-Letter from Steven P. Frantz to Administrative Judges enclosing a copy of a letter dated 09/23/04 from Exelon Generation Company to the NRC staff responding to several Requests for Additional Information 54 Page(s)	Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007
09/28/2004	ML042790495	2004/09/28-Response to Request for Additional Information (RAI) Letter No. 5 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site (TAC No. MC1122.). 10 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
09/28/2004	ML042780333	2004/09/28-E-mail-Response to RAI Letter No. 5. 12 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007

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10/01/2004	ML042790056	2004/10/01-E-mail-FW: Exelon ESP Quality Plan. 2 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007
10/01/2004	ML042790139	2004/10/01-E-mail-Re: FW: Exelon ESP Quality Plan. 2 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
10/05/2004	ML042890418	Response to Request for Additional Information (RAI) Letter No. 3 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site (TAC No. MC1122). 43 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/06/2004	ML042860252	2004/10/06-E-mail - Typographical Error in RAI Letter No. 7. 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007
10/06/2004	ML042800504	2004/10/06-Telecon Summary to Clarify Responses to NRC Environmental Requests for Additional Information on the Exelon Early Site Permit Application. 9 Page(s)	Note	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007

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10/06/2004	ML042860248	2004/10/06-E-mail-First EP RAI response submittal. 44 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007
10/07/2004	ML042890357	2004/10/07-Response to Request for Additional Information (RAI) Letter No. 8 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 33 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/07/2004	ML042890390	Response to Revision to Request for Additional Information (RAI) Letter- No. 11 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site (TAC No. MC1122.) 67 Page(s)	Emergency Preparedness-Emergency Plan, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/07/2004	ML042870496	2004/10/07-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli attaching updates to disclosures with respect to Contention 3.1 5 Page(s)	Legal-Affidavit, Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007

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10/08/2004	ML042880460	2004/10/08-Response to Request for Additional Information (RAI) Letter No. 10 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site (TAC No. MC1122.) 15 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/08/2004	ML042990572	2004/10/08-Email- Response to RAI Letter No. 11. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/08/2004	ML042920203	10/08/04-E-mail- Response to RAI Letter No. 11. 68 Page(s)	E-Mail, Legal-Affidavit, Letter, Report, Miscellaneous	Exelon Generation Co, LLC	NRC	05200007
10/08/2004	ML042890051	2004/10/08-Response to Request for Additional Information (RAI) Letter No. 4 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 145 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/08/2004	ML042860254	2004/10/08-E-mail - Response to RAI Letter No. 8. 35 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007

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10/08/2004	ML042880466	2004/10/08-Response to NRC Inspection of Applicant and Contractor Quality Assurance Activities Involved with Preparation of the Application for an Early Site Permit, Report 0520007/2004001. 12 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/11/2004	ML042920225	2004/10/11-E-mail-RE: Response to QA IR. 14 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007
10/11/2004	ML042920222	2004/10/11-E-mail- RE: Response to RAI Letter No. 4 147 Page(s)	E-Mail, Legal-Affidavit, Letter, Report, Miscellaneous	Exelon Generation Co, LLC	NRC	05200007
10/11/2004	ML042920213	2004/10/11-E-mail- Response to RAI Letter No. 10. 17 Page(s)	E-Mail, Legal-Affidavit, Letter	Exelon Generation Co, LLC	NRC	05200007

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10/11/2004	ML042960106	2004/10/11-Response to Request for Additional Information (RAI) Letter No. 7 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 91 Page(s)	Letter	Exelon Generation Co, LLC, Exelon Nuclear	NRC/Document Control Desk	05200007
10/11/2004	ML042960057	2004/10/11-Response to Request for Additional Information (RAI) Letter No. 9 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 8 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/11/2004	ML042960105	Response to Request for Additional Information (RAI) Letter No. 6 - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 56 Page(s)	Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/12/2004	ML043030610	2004/10/12-E-mail-FW: 3rd set of seismic attachments #2. 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030613	2004/10/12-E-mail-RAI 2.5.2-6 Figure 1A. 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007

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10/12/2004	ML043030672	2004/10/12-E-mail-RE: 3rd set of seismic attachments (8 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML042920229	2004/10/12-E-mail- Response to RAI Letter No. 6. 383 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030667	2004/10/12-E-mail-RE: 3rd set of seismic attachments (7 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML042920234	2004/10/12-E-mail- Response to RAI Letter No. 9. 10 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030600	2004/10/12-E-mail-FW: 3rd set of seismic attachments. 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030592	2004/10/12-E-mail-2nd set of seismic attachments. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007

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10/12/2004	ML043030583	2004/10/12-E-mail-1st set of seismic attachments 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030700	2004/10/12-E-mail-RE: 3rd set of seismic attachments (12 of 12). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030664	2004/10/12-E-mail-RE: 3rd set of seismic attachments (6 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030660	2004/10/12-E-mail- RE: 3rd set of seismic attachments (5 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030651	2004/10/12-E-mail-FW: 3rd set of seismic attachments (2 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030631	2004/10/12-E-mail-RE: 3rd set of seismic attachments (4 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007

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10/12/2004	ML043030697	2004/10/12-E-mail-RE: 3rd set of seismic attachments (9 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030696	2004/10/12-E-mail- RE: 3rd set of seismic attachments (11 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030617	2004/10/12-E-mail- 3rd set of seismic attachments (1 of 11). 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030626	2004/10/12-E-mail-RE: 3rd set of seismic attachments (3 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030577	2004/10/12-E-mail-Response to RAI Letter No. 7. 2 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007
10/12/2004	ML043030675	2004/10/12-E-mail-RE: 3rd set of seismic attachments (10 of 11). 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007

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10/19/2004	ML043030553	2004/10/19-E-mail - Seismic Consultant. 1 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
10/20/2004	ML043030557	2004/10/20-E-mail-Re: Seismic Consultant. 2 Page(s)	E-Mail, Letter	NRC	Exelon Generation Co, LLC	05200007
10/22/2004	ML043060232	2004/10/22-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli attaching an update to disclosures with respect to Contention 3.1 as admitted by the Licensing Board 5 Page(s)	Legal-Correspond ence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environme ntal Law & Policy Ctr, NRC/OGC	05200007
10/28/2004	ML042820082	2004/10/28-Clinton, Withholding From Public Disclosure, Exelon ESP Project Quality Assurance Plan. 6 Page(s)	Letter, Proprietary Information Review	NRC/NRR/D RIP/RNRP	Exelon Generation Co, LLC	05200007
11/05/2004	ML043140401	11/05/04-E-mail-Conference Call Information, 1 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007

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11/12/2004	ML043200576	2004/11/12-E-mail-Draft Requests for Additional Information - Emergency Planning. 5 Page(s)	E-Mail, Letter, Request for Additional Information (RAI)	NRC/NRR	Exelon Generation Co, LLC	05200007
11/12/2004	ML043240474	2004/11/12-Exelon Generation Company's Answer in Opposition to Intervenors' Motion to Suspend Proceeding Pending Reinstatement of Agencywide Document Access and Management System 8 Page(s)	Legal-Motion	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007
11/15/2004	ML043210579	2004/11/15-Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application for The Exelon Generation Company Site (TAC No. MC1125). 7 Page(s)	Request for Additional Information (RAI)	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
11/15/2004	ML043090029	2004/11/15-Revised Dates For Conducting the Environmental Review of the Exelon ESP Application. 7 Page(s)	Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007

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11/16/2004	ML043290006	2004/11/16-Corrections / Clarifications to the Exelon Early Site Permit (ESP) Application Environmental Report for the Clinton ESP Site. 67 Page(s)	Environmental Report, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
11/18/2004	ML043410062	2004/11/18-E-mail correspondence regarding ER corrections relating to the EGC ESP environmental review. 1 Page(s)	E-Mail	Exelon Corp	NRC, NRC/NRR/DRIP/RLEP, Pacific National Lab	05200007
11/19/2004	ML043270432	2004/11/19-E-mail- Seismic Primer. 33 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
11/19/2004	ML043350394	2004/11/19-Seismic Risk (Performance Goal) Based Approach Primer - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 31 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
11/30/2004	ML043360250	2004/11/30-E-mail- Final 2004 NRC Invoice. 2 Page(s)	E-Mail	Exelon Corp	NRC	05200007

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12/07/2004	ML043510176	2004/12/07-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli attaching an update to disclosures with respect to Contention 3.1 as admitted by the Licensing Board 4 Page(s)	Legal-Affidavit, Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
12/07/2004	ML043510382	2004/12/07-Corrections/Clarifications to the Exelon Generation company, LLC (EGC) Early Site Permit (ESP) Application Site Safety Analysis Report and Emergency Plan for the Clinton ESP Site. 56 Page(s)	Emergency Preparedness-Emergency Plan, Final Safety Analysis Report (FSAR), Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
12/08/2004	ML043480194	2004/12/08-E-mail-Self identified changes. 58 Page(s)	E-Mail, Letter	Exelon Corp	NRC	05200007
12/09/2004	ML043380008	2004/12/09-Request for Additional Information Letter No. 12 - Exelon ESP Application for the Clinton ESP Site. 9 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC, Exelon Nuclear	05200007

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12/13/2004	ML043630425	2004/12/13-Response to Request for Additional Information (RAI) - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 7 Page(s)	Legal-Affidavit, Letter	Exelon Corp, Exelon Nuclear	NRC/Document Control Desk	05200007
12/13/2004	ML043570096	2004/12/13-E-mail correspondence regarding S-3 request for additional information response pertaining to the Exelon ESP project. 9 Page(s)	E-Mail, Environmental Impact Statement	Exelon Corp	Battelle Memorial Institute, Pacific Northwest National Lab, NRC	05200007
12/14/2004	ML050030024	2004/12/14-Revised Response to Request for Additional Information (RAI) Letter No. 3 re: Early Site Permit (ESP) Application for the Clinton ESP Site. 13 Page(s)	- No Document Type Applies	Exelon Corp, Exelon Nuclear	NRC/Document Control Desk	05200007
12/15/2004	ML050030022	2004/12/15-Transmittal of Revised Response to Request for Additional Information (RAI) Letter No. 3 re: Early Site Permit (ESP) Application for the Clinton ESP Site. 3 Page(s)	Legal-Affidavit, Letter	Exelon Corp, Exelon Nuclear	NRC/Document Control Desk	05200007

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12/15/2004	ML043520443	2004/12/15-E-mail-Docket 52-007 re: EGC Revised RAI 13.3-2 Response. 16 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
12/15/2004	ML043520433	2004/12/15-E-mail-Docket 52-007 re: Seismic High Frequency Effects. 6 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
12/15/2004	ML043630437	2004/12/15-Early Site Permit Application for Clinton ESP Site, Seismic High Frequency Considerations (TAC No. MCI122). 4 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
12/16/2004	ML043520441	2004/12/16-E-mail-Re: Projection of NRC Year End Invoices. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
12/16/2004	ML043520438	2004/12/16-E-mail-Projection of NRC Year End Invoices. 3 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC	05200007
12/16/2004	ML043520439	2004/12/16-E-mail-Re: Projection of NRC Year End Invoices. 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC	05200007

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01/14/2005	ML050250137	2005/01/14-Early Site Permit (ESP) Application for the Clinton ESP Site Seismic Risk (Performance Goal) Based Approach Primer Revision. 32 Page(s)	Graphics incl Charts and Tables, Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
01/14/2005	ML050140051	2005/01/14-Exelon Early Site Permit Project Manager Reassignment. 5 Page(s)	Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
01/24/2005	ML050250305	2005/01/24-E-mail EP ETE RAI Responses to Letter No. 12. 88 Page(s)	E-Mail, Graphics incl Charts and Tables, Legal-Affidavit	Exelon Generation Co, LLC	NRC/NRR/DRIP/RNRP	05200007
02/01/2005	ML043570375	2005/02/01-Clinton, Withholding From Public Disclosure, Exelon ESP Application - State and Local Emergency Plans. 5 Page(s)	Letter, Proprietary Information Review	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/04/2005	ML050320230	2005/02/04-Potential Open Items for the Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 12 Page(s)	Letter	NRC/NRR/DRIP	Exelon Generation Co, LLC	05200007

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02/07/2005	ML050390092	2005/02/07-E-mail-Potential Exelon ESP DSER Open Items. 10 Page(s)	E-Mail, Letter	NRC/NRR	Exelon Generation Co, LLC	05200007
02/10/2005	ML050400350	2005/02/10-Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 9 Page(s)	Letter, Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/11/2005	ML050480478	2005/02/11-E-mail-Re: Copy of Exelon ESP DSER, Appendices A & B. 54 Page(s)	Draft Safety Evaluation Report (DSER), E-Mail, Graphics incl Charts and Tables	NRC	Exelon Generation Co, LLC, NRC	05200007
02/11/2005	ML050480447	2005/02/11-E-mail-Re: Copy of Exelon ESP DSER-#1. 169 Page(s)	Draft Safety Evaluation Report (DSER), E-Mail, Letter	NRC	Exelon Generation Co, LLC, NRC	05200007
02/11/2005	ML050670436	2005/02/11-E-mail- Re: Copy of Exelon ESP DSER. 2 Page(s)	E-Mail	NRC	Exelon Generation Co, LLC, NRC	05200007

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02/15/2005	ML050550356	2005/02/15-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli providing an update to disclosures with respect to Contention 3.1 as admitted by the Licensing Board 4 Page(s)	Legal-Affidavit, Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
02/23/2005	ML050630552	2005/02/03-Review of Draft Safety Evaluation Report for the Early Site Permit (ESP) Application for the Clinton ESP Site. 2 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

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02/24/2005	ML050600414	2005/02/24-E-Mail - Fwd: Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 10 Page(s)	E-Mail	NRC/NRR/DRIP/RNRP	Advanced Technologies & Labs International, Inc, AECL Technologies, Inc, Dominion, Eckert, Seamans, Cherin & Mellott, LLC, Entergy Nuclear Operations, Inc, Exelon Corp, Framatome ANP, Inc, General Atomics, General Electric Co, Greenpeace, NRC, Nuclear Control Institute, Nuclear	05200007

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02/28/2005	ML050400378	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Chapter 1 with Table of Contents and Abbreviations. 29 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/28/2005	ML050400411	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Chapter 18, Review by the Advisory Committee on Reactor Safeguards. 1 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/28/2005	ML050400404	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Chapter 17, Quality Assurance. 39 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/28/2005	ML050400436	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Appendix A, Chronology of Early Site Permit application for the EGC ESP Site. 43 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007

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02/28/2005	ML050400394	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Chapter 3, Site Safety Assessment. 26 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/28/2005	ML050400423	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Chapter 19, Conclusions. 1 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/28/2005	ML050400386	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Chapter 2, Site Characteristics. 139 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
02/28/2005	ML050400450	2005/02/28-Clinton, Early Site Permit Draft Safety Evaluation Report, Appendix B, References. 9 Page(s)	Safety Evaluation Report, Draft	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
03/02/2005	ML050620302	2005/03/02-Notice of Availability of the Draft Environmental Impact Statement (DEIS) for An Early Site Permit (ESP) at the Exelon ESP Site (TAC NO. MC1125). 10 Page(s)	Federal Register Notice, Letter	NRC/NRR/DRIP	Exelon Generation Co, LLC	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
03/03/2005	ML050670270	2005/03/03-E-mail-Exelon ESP re: NRC Invoice for 4th Qtr 2004. 2 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC/NRR/DRIP/RNRP	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
03/04/2005	ML050540039	2005/03/04-Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 7 Page(s)	Letter	NRC/NRR/DRIP/RNRP	- No Known Affiliation, Advanced Technologies & Labs International, Inc, CH2M Hill, Dominion Generation, Enercon Services, Inc, Entergy Nuclear, Inc, Exelon Generation Co, LLC, Exelon Nuclear, Framatome ANP Richland, Inc, Greenpeace, Morgan, Lewis & Bockius, LLP, Nuclear	05200007

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03/04/2005	ML050670302	2005/03/04-E-mail-Exelon ESP re: NRC Invoice for 4th Qtr 2004. 2 Page(s)	E-Mail	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
03/08/2005	ML050670580	2005/03/08-E-mail-Conference line for Thursday Hydrology call. 2 Page(s)	E-Mail	Exelon Corp	NRC/NRR/DRIP/RNRP	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
03/08/2005	ML050670322	2005/03/08-E-mail-Fwd: Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 13 Page(s)	E-Mail	NRC/NRR/DRIP/RNRP	Advanced Technologies & Labs International, Inc, AECL Technologies, Inc, Dominion, Eckert, Seamans, Cherin & Mellott, LLC, Emergi-Lite, Entergy Nuclear Operations, Inc, Exelon Corp, Framatome ANP, Inc, General Atomics, General Electric Co, Greenpeace, NRC, Nuclear Control	05200007

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03/11/2005	ML050800407	2005/03/11-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli attaching an update to disclosures with respect to Contention 3.1 as admitted by the Licensing Board 4 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
03/16/2005	ML050810517	2005/03/16-Seismic Risk (Performance Goal) Based Approach Calculation re: Early Site Permit Application for Clinton Site. 11 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
03/17/2005	ML050870594	2005/03/17-Exelon's Motion for Summary Disposition of Contention 3.1 180 Page(s)	Legal-Motion	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007
03/18/2005	ML050800214	2005/03/18-E-mail from Eddie R. Grant to John Segal regarding March 16 submittal. 13 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC/NRR/DRIP/RNRP	05200007

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03/21/2005	ML050890143	2005/03/21-Letter from Steven P. Frantz to Members of the Licensing Board regarding Certification for Motion for Summary Disposition 4 Page(s)	Legal-Correspondence	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007
03/29/2005	ML051010274	2005/03/29-Two E-Mails to Bill Maher for the public hearing record for the Exelon ESP site. 4 Page(s)	E-Mail, Environmental Impact Statement	NRC/NRR	Exelon Corp	05200007
03/31/2005	ML050920004	2005/03/3-Notice of Change of Location for Public Meeting on the Draft Environmental Impact Statement (DEIS) for an Early Site Permit (ESP) at the Exelon ESP Site (TAC No. MC1125). 11 Page(s)	Federal Register Notice, Letter, Meeting Notice	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
04/04/2005	ML051020249	2005/04/04-Partial Response to Draft Safety Evaluation Report (DSER) Items. 63 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

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04/05/2005	ML051010295	2005/04/05-E-mail from Eddie R. Grant to John Segala regarding April 4 submittal. 65 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC/NRR/DRIP/RNRP	05200007
04/07/2005	ML051080047	2005/04/07-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli providing an update to disclosures with respect to Contention 3.1 as admitted by the Licensing Board 4 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
04/08/2005	ML050980379	2004/04/08-Notice of Change of Location for Public Meeting on the Draft Environmental Impact Statement (DEIS) for an Early Site Permit (ESP) at the Exelon ESP Site (TAC No. MC1125). 10 Page(s)	Federal Register Notice, Letter	NRC/NRR/DRIP	Exelon Generation Co, LLC	05200007
04/19/2005	ML051150509	2005/04/19-E-mail from Eddie R. Grant to John Segala Regarding Exelon ESP DSER Hydrology Discussion Items. 5 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC/NRR/DRIP/RNRP	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
04/22/2005	ML051190409	2005/06/22-Intervenors' Motion to Amend Contention 3.1 78 Page(s)	Legal-Motion	Blue Ridge Environmental Defense League, Environmental Law & Policy Ctr, Exelon Generation Co, LLC, Harmon, Curran, Spielberg & Eisenberg, LLP, Nuclear Energy Information Service, Nuclear Information & Resource Service (NIRS), Public Citizen, Inc	NRC/ASLBP	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
04/25/2005	ML051240310	2005/04/25-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli providing an update to disclosures with respect to Contention 3.1 as admitted by the Licensing Board 4 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
04/26/2005	ML051170014	2005/04/26-E-mail from Eddie R. Grant to John Segala Regarding Exelon ESP DSER OI Response. 82 Page(s)	E-Mail	Exelon Generation Co, LLC	NRC/NRR/DRIP/RNRP	05200007
04/26/2005	ML051230326	2005/04/25-Response to Draft Safety Evaluation Report (DSER) Regarding the Early Site Permit (ESP) Application for the Clinton ESP Site. 79 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
05/05/2005	ML051320313	2005/05/05-Sixth Additional Disclosures of Intervenors Environmental Law and Policy Center, Blue Ridge Environmental Defense League, Nuclear Information and Resource Service, Nuclear Energy Information Service, and Public Citizen 7 Page(s)	Legal-Intervention Petition, Responses and Contentions	Environmental Law & Policy Ctr, Exelon Generation Co, LLC, Harmon, Curran, Spielberg & Eisenberg, LLP, Nuclear Energy Information Service, Nuclear Information & Resource Service (NIRS), Public Citizen, Inc	NRC/ASLBP	05200007
05/06/2005	ML051320285	2005/05/06-Exelon's Answer to Intervenors' Motion to Amend Contention 3.1 52 Page(s)	Legal-Motion	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/ASLBP	05200007

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05/06/2005	ML051290002	2005/05/06-E-mail from Eddie R. Grant to John Segala Regarding May 6 Letter on NRC Fee Payment. 4 Page(s)	E-Mail, Letter	Exelon Generation Co, LLC	NRC	05200007
05/11/2005	ML051390202	2005/05/11-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli providing an update to disclosures pursuant to 10 CFR § 2.336(d) (Supplement 8) 4 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
05/17/2005	ML051430338	2005/05/17-Exelon Brief in Response to Commission Memorandum and Order (CLI-05-09) 28 Page(s)	Legal-Brief	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/OCM	05200007
05/24/2005	ML051540317	2005/05/24-Comment (32) of Marilyn C. Kray on behalf of Exelon Nuclear on Review of Draft Environmental Impact Statement for Clinton ESP Site. 46 Page(s)	General FR Notice Comment Letter	Exelon Nuclear	NRC/ADM/DAS/RDB	05200007

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06/03/2005	ML051640439	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Figure 2.3-14 - Figure 2.3-25.. 12 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640440	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Figure 2.4-1 - Figure 2.5-9. 12 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640436	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Figure 2.3-7 - Figure 2.3-12. 6 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007

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06/03/2005	ML051640428	2005/06/03-Transmittal of Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Cover Letter. 3 Page(s)	Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640438	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Figure 2.3-13. 1 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640441	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Figure 2.7-1 - Figure 2.7-18. 18 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007

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06/03/2005	ML051640448	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Environmental Consequences of the Proposed Action - Table B-1. 60 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640446	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Environmental Measurement and Monitoring Programs - Figure 9.2-4. 212 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640444	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Environmental Impacts of Station Operation - Figure 5.3-2. 127 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007

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06/03/2005	ML051640434	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Figure 2.2-6 - Figure 2.3-6. 9 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640431	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Contents - Figure 2.2-5. 245 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
06/03/2005	ML051640442	2005/06/03-Early Site Permit (ESP) Application for the Clinton ESP Site, Submittal of Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report, Plant Description - Figure 4.5-1. 120 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007

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06/30/2005	ML051920121	2005/06/30-Submission of Reviewers Aid for Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report. 3 Page(s)	Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
06/30/2005	ML051920127	2005/06/30-Reviewers Aid for Revision 1 to Exelon Generation Company's Early Site Permit, Environmental Report. 95 Page(s)	Environmental Report	Exelon Nuclear	NRC/Document Control Desk	05200007
07/14/2005	ML051960277	2005/07/14-E-Mail re: Revised DSER Response. 64 Page(s)	E-Mail, Legal-Affidavit, Letter	Exelon Corp	NRC/NRR/DRIP/RNRP	05200007
07/14/2005	ML052150136	Revised Response to Draft Safety Evaluation Report (DSER) Items re: Letter, U.S. NRC (W. D. Beckner) to Exelon Generation Company, LLC, (M. Kray), dated February 10, 2005, Draft Safety Evaluation Report for the Exelon ESP Application. 62 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

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07/18/2005	ML051930155	Clinton ESP Quality Assurance Assessment and Resolution of Confirmatory Item (CI) and Open Item (OI) 17.1-1. 8 Page(s)	Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
08/03/2005	ML052210410	2005/08/03-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli enclosing updates to disclosures with respect to Contention 3.1 (Supplement 9) 35 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007

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08/12/2005	ML052360416	2005/08/12-Intervenors' Petition for Review of the Atomic Safety and Licensing Board's Dismissal of Contention 3.1 and Rejection of Intervenors' Proposed Amended Contention 3.1 23 Page(s)	Legal-Brief	Blue Ridge Environmental Defense League, Exelon Generation Co, LLC, Harmon, Curran, Spielberg & Eisenberg, LLP, Nuclear Energy Information Service, Nuclear Information & Resource Service (NIRS)	NRC/OCM	05200007
08/16/2005	ML051540054	Revised Schedule for Review of the Exelon Early Site Permit Application for the Exelon ESP Site. 10 Page(s)	Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
08/19/2005	ML052300522	Potential Open Items for the Supplemental Draft Safety Evaluation Report for the Exelon ESP Application. 14 Page(s)	Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
08/22/2005	ML052410437	2005/08/22-Exelon Generation Company's Answer in Opposition to Intervenors' Petition for Review 30 Page(s)	Legal-Brief	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	NRC/OCM	05200007
08/26/2005	ML052310469	Cover Letter to M. Kray re: Supplemental Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 4 Page(s)	Draft Safety Evaluation Report (DSER), Letter	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007
08/31/2005	ML052310478	Supplemental Draft Safety Evaluation Report for the Exelon Early Site Permit Application. 125 Page(s)	Draft Safety Evaluation Report (DSER)	NRC/NRR/DRIP/RNRP	Exelon Generation Co, LLC	05200007

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09/07/2005	ML052590007	2005/09/07-Letter from Paul M. Bessette to Shannon Fisk and Mauri T. Lemoncelli providing updates to disclosures with respect to Contention 3.1 (Supplement 10) 4 Page(s)	Legal-Interrogatories and Response	Exelon Generation Co, LLC, Morgan, Lewis & Bockius, LLP	Environmental Law & Policy Ctr, NRC/OGC	05200007
09/30/2005	ML052860134	Early Site Permit (ESP) Application for the Clinton ESP Site - Revised Response to Draft Safety Evaluation Report (DSER) Items. 6 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/11/2005	ML052860325	10/11/05 - Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application for the Exelon Generation Company Site (TAC No. MC1125). 8 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007

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10/11/2005	ML052860274	10/11/05 - Summary of Telephone Conference Call Held on September 19, 2005 Between the U.S. Nuclear Regulatory Commission (NRC) and the Illinois Department of Natural Resources (IDNR) Regarding the Review of the Exelon Early Site Permit (ESP). 6 Page(s)	Meeting Summary, Note to File incl Telcon Record, Verbal Comm	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
10/11/2005	ML052860253	10/11/05 - Summary of Telephone Conference Call Held on September 13, 2005 Between the U.S. Nuclear Regulatory Commission (NRC) and the Illinois Environmental Protection Agency (EPA) Regarding the Review of the Exelon Early Site Permit (ESP). 6 Page(s)	Note	NRC/NRR/DRIP/RLEP	Exelon Generation Co, LLC	05200007
10/12/2005	ML052930270	Early Site Permit Application for the Clinton ESP Site, ESP Site Soil Hazard Data. 6 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

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10/27/2005	ML053070508	Early Site Permit (ESP) Application for the Clinton ESP Site, Revised Response to Request for Additional Information Letter No. 12. 10 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
10/31/2005	ML053120131	Clinton ESP Site, Responses to Supplemental Draft Safety Evaluation Report (DSER) Items. 285 Page(s)	Graphics incl Charts and Tables, Letter, Map	Exelon Nuclear	NRC/Document Control Desk	05200007
11/23/2005	ML053420057	Submittal of Revision 1 to Exelon Generation Company's Early Site Permit Application. 4 Page(s)	Letter	Exelon Generation Co, LLC	NRC/Document Control Desk	05200007
12/13/2005	ML053540218	Response to Request for Additional Information (RAI) - Exelon Early Site Permit (ESP) Application for the Clinton ESP Site. 4 Page(s)	Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007
12/21/2005	ML060030484	Early Site Permit Application for the Clinton ESP Site, Revised Response to Draft Safety Evaluation Report Open Items. 13 Page(s)	Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
01/10/2006	ML060460042	Clinton ESP Site - Submittal of Revision 2 to the Exelon Generation Company's Early Site Permit Application	Legal-Affidavit, Letter	Exelon Nuclear	NRC/Document Control Desk	05200007

APPENDIX C
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APPENDIX D

PRINCIPAL CONTRIBUTORS

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Hinson, Charles	Occupational Radiation Safety Analysis
Klementowicz, Stephen	Normal Radiological Dose Analyses
Lee, Jay	Accident Analyses
Moody, Robert	Emergency Planning
Munson, Cliff	Geology and Seismology
Patel, Nitin	Project Management
Prescott, Paul	Quality Assurance
Segala, John	Project Management
Tardiff, Albert	Security

Contractors	Technical Area
Brookhaven National Laboratory	Geotechinical Engineering
Federal Emergency Management Agency	Emergency Planning
Pacific Northwest Laboratory	Emergency Planning, Hydrology, Meteorology, and Site Hazards
U.S. Geologic Survey	Geology and Seismology

APPENDIX E

REPORT BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

ACRSR-2182

March 24, 2006

The Honorable Nils J. Diaz
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

SUBJECT: FINAL REVIEW OF THE EXELON GENERATION COMPANY, LLC, APPLICATION FOR EARLY SITE PERMIT AND THE ASSOCIATED NRC STAFF'S FINAL SAFETY EVALUATION REPORT

Dear Chairman Diaz:

During the 530th meeting of the Advisory Committee on Reactor Safeguards, March 9-11, 2006, we completed our review of the early site permit application for the Clinton site and the associated final Safety Evaluation Report (SER) prepared by the NRC staff. We reviewed the application and the final SER to fulfill the requirement of 10 CFR 52.23 that the ACRS report on those portions of an early site permit application that concern safety. We issued an interim letter on this application and the associated draft SER on September 22, 2005.. This matter was also discussed during our Subcommittee meeting on March 8, 2006. During these reviews, we had the benefit of discussions with representatives of the NRC staff and Exelon Generation Company, LLC (Exelon). We also had the benefit of the documents referenced.

CONCLUSIONS AND RECOMMENDATIONS

- The early site permit application and the staff's final SER show that the proposed nuclear power plant site adjacent to the existing Clinton Nuclear Power Station is an acceptable site for nuclear power plants that meet the plant parameter envelope proposed by the applicant.
- The staff has thoroughly reviewed a performance-based method proposed by the applicant for determining the safe shutdown earthquake (SSE) ground motion. This method is an attractive alternative to methods endorsed in current regulatory guides.
- The staff should consider development of a regulatory guide dealing with the alternative, performance-based, method for assessing the seismic hazard of a site.

DISCUSSION

Exelon has applied for an early site permit for locating nuclear power plants or modules having a total power generation rate of 2400 to 6800 MWt on a site adjacent to the currently operating Clinton plant, which is a BWR 6 within a Mark III containment. The early site permit application is based on the now familiar "plant parameter envelope" approach since the applicant has not identified the particular reactor technology that will be adopted. The plant parameter envelope is based on the characteristics of certified designs such as the AP1000 and Advanced Boiling

Water Reactor (ABWR) as well as other designs such as the International Reactor Innovative and Secure (IRIS), Economic Simplified Boiling Water Reactor (ESBWR), Gas-Turbine Modular Helium Reactor (GT-MHR), and Pebble Bed Modular Reactor (PBMR).

The staff's review of this application included a detailed review of the alternative, performance-based method proposed by the applicant for determining the SSE ground motion spectrum. The staff identified six permit conditions for the proposed site. The staff has used technically sound, objective criteria for identifying these permit conditions. The staff and the applicant have agreed to 32 combined license (COL) action items. The action items for the proposed Clinton site can be compared to 30 action items for the North Anna early site permit and 26 action items for the Grand Gulf early site permit.

Nature of the Site

The proposed site is located in a rural setting in central Illinois. The terrain is essentially flat with some rolling hills. Nearby populations centers with populations in excess of 25,000 include Springfield (74 km), Peoria (75 km), Champaign (49 km), Urbana (66 km), Decatur (36 km), and Bloomington (36 km). Near the site (<16 km) are the small towns Clinton (population 7,000), as well as DeWitt, Weldon, and Wapella each with a population of less than 1,000.

Population trends in the larger cities near the site have been estimated based on census data. Modest growth in population is anticipated in these cities over the next 60 years. Interestingly, data obtained from other sources led the applicant to anticipate that populations in the rural regions around the site will decline modestly over the next 60 years.

Weather

Weather at the proposed site is well characterized in recent years as would be expected for a site with an operating nuclear power plant. The weather is marked by rather warm summer periods and harsh winters. Weather extreme characteristics of the site have been based on historical data. Neither the applicant nor the staff has considered the potential for cycles in weather that may complicate the prediction of future weather extremes based on historical records. Nevertheless, we believe that the applicant has adequately characterized the site weather for the purposes of an early site permit.

Seismicity

The proposed site is affected by the New Madrid seismic zone and the Wabash Valley seismic zone. Since the nuclear power plant at the Clinton site was licensed, the estimated frequency of major earthquakes at the New Madrid seismic zone has been increased. The estimate of the maximum potential magnitude of earthquakes at the Wabash Valley seismic zone has also been increased. There is a background seismicity of the site represented by the Springfield earthquake estimated to have occurred at a location about 70 km from the site, approximately 6,000 years ago and to have had a magnitude of 6.2 to 6.8 on the Richter scale.

In other applications for early site permits, the applicants have adopted the methods recommended in Regulatory Guide 1.165 to estimate the SSE ground motion spectrum. Exelon has adopted an alternative method. This alternative is based on an industry standard (ASCE 43-05) that itself is based on work done by the Department of Energy for assessing the seismic safety of its nuclear facilities. The alternative is considered "performance based" because it uses a target probability for the maximum acceptable facility damage from an earthquake.

Exelon has selected the frequency of 10^{-5}/yr for the onset of significant inelastic deformation of systems, structures, and components. This target provides a rather substantial margin to core damage and containment failure.

The staff has reviewed thoroughly the proposed alternative method for estimating the seismic hazard at the proposed site. The staff's review included examination of the credibility of parametric quantities in the models and an independent assessment of the analysis results by direct integration of the seismic risk equation. Also, the staff has reviewed carefully the applicant's assessment of the local seismic hazard. We concur with the staff that the alternative approach adopted by Exelon for this application provides a high level of safety. The seismic core damage frequency that can be inferred from the proposed ground motion spectrum (~$2x10^{-6}$/yr) is significantly less than the median found in seismic probabilistic risk assessments for 29 existing nuclear power plants. The performance-based alternative method yields results that are in concert with the Commission's expectation that advanced reactors will provide enhanced margins of safety and/or utilize simplified, inherent, passive, or other innovative means to accomplish their safety functions.

The alternative, performance-based, method uses a target frequency that does not change with time as new information on the seismicity of power plant sites changes. In this sense, the alternative method provides some additional regulatory stability. For this reason, if no other, we expect that the alternative method will be attractive to licensees and applicants for a variety of purposes. The staff may want to consider developing a regulatory guide on the use of the alternative methodology. Certainly, the detailed review of the method conducted by the staff for this early site permit would provide a substantial technical basis for the development of such a regulatory guide.

Sincerely,

/RA/

Graham B. Wallis
Chairman

References:
1. Exelon Generation Company, LLC, Early Site Permit Application, September 23, 2003.
2. ACRS Interim Letter, Exelon Generation Company, LLC, Application for Early Site Permit and the Associated NRC Staff's Draft Safety Evaluation Report, dated September 22, 2005.
3. EDO response to ACRS Interim Letter, "Interim Letter: Exelon Generation Company, LLC, Application for Early Site Permit and the Associated NRC Staff's Draft Safety Evaluation Report on the Clinton Early Site Permit Site," dated October 26, 2005.
4. Final Safety Evaluation Report for Exelon Early Site Permit Application, dated February 17, 2006.
5. Exelon Generation Company, LLC, letter to the U.S. Nuclear Regulatory Commission Subject: "Seismic Risk (Performance Goal) Based Approach Primer Revision," dated January 14, 2005.
6. NRC Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion," March 1997.
7. American Society of Civil Engineers, Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities, ASCE/SEI 43-05 (ASCE Standard 43-05), 2005.

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7. American Society of Civil Engineers, Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities, ASCE/SEI 43-05 (ASCE Standard 43-05), 2005.

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10. SUPPLEMENTARY NOTES

Project No. 718, Docket No. 52-007

11. ABSTRACT *(200 words or less)*

This safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's technical review of the site safety analysis report (SSAR) and emergency planning information in the early site permit (ESP) application submitted by Exelon Generation Company, LLC (EGC or the applicant), for the EGC ESP site. By letter dated September25, 2003, Exelon submitted the ESP application for the EGC ESP site in accordance with SubpartA, "Early Site Permits," of Title10 of the Code of Federal Regulations (10CFR) Part52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants." The EGC ESP site is located approximately 6miles east of the city of Clinton in central Illinois, and is adjacent to an existing nuclear power reactor operated by AmerGen, which is a subsidiary of Exelon Generation Company. In its application, EGC seeks an ESP that could support a future application to construct and operate additional nuclear power reactors at the ESP site with a total nuclear generating capacity of up to 6800megawatts (thermal).

This SER presents the results of the staff's review of information submitted in conjunction with the ESP application. The staff has identified, in AppendixA to this SER, certain site-related items that will need to be addressed at the combined license or construction permit stage, if an applicant desires to construct one or more new nuclear reactors on the EGC ESP site. The staff determined that these items do not affect the staff's regulatory findings at the ESP stage and are, for reasons specified in Section1.7, more appropriately addressed at later stages in the licensing process. AppendixA to this SER also identifies the permit conditions that the staff recommends the Commission impose, if an ESP is issued to the applicant.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

Early Site Permit (ESP)
Final Safety Evaluation Report
Combined License (COL)
Permit Conditions
COL Action Items
Site Characteristics
Bounding Parameters
Exelon Generation Company, LLC (EGC) ESP Site

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