3. SITE SAFETY ASSESSMENT

3.1 Radiological Effluents

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 applicant's 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.

3.1.1 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 by-product of nuclear power operations. These radioactive materials would be collected, processed, stored, and discharged in a controlled manner to the local environment or transported off site 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 reasonably achievable (ALARA).

3.1.2 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 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 3.1 addresses radiological effluents per Title 10, Section 52.17, "Contents of Applications," of the *Code of Federal Regulations* (10 CFR 52.17), paragraph (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 finds that the applicant correctly identified the applicable regulations.

3.1.3 Technical Evaluation

3.1.3.1 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 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."

The applicant has estimated the bounding quantity of radioactive gaseous effluents that might be released from the gaseous waste management and the 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 has also provided bounding gaseous effluent release data to support its compliance with the gaseous effluent release concentration limits in Table 2 of Appendix B, "Annual Limits on Intakes (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," to 10 CFR Part 20.

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.

3.1.3.2 Liquid Effluents

The liquid waste management system would control, collect, process, store, and dispose of, as required, 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 effluent discharges would be through the existing discharge of the Clinton Power Station (CPS).

Currently, the CPS facility does not routinely discharge radioactive liquid wastes into Clinton Lake. Exelon stated that it is likely to continue this practice with its ESP facility. However, to provide for operating flexibility, the applicant has given a bounding assessment 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 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 those for any selected reactor design. SSAR Table 3.1-5 compares the projected liquid effluent release concentrations with the 10 CFR Part 20 liquid effluent concentration limits. These data show that the bounding liquid effluent release concentrations will fall within the 10 CFR Part 20 effluent concentration limits.

The applicant calculated the estimated 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.

3.1.3.3 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 shipping them off site. 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 off site 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."

3.1.4 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, as well as maintain them at ALARA levels in accordance with the effluent design objectives contained in Appendix I to 10 CFR Part 50. A COL applicant that references an ESP for the EGC ESP site will need to 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 included in the SSAR for the ESP application and reviewed by the NRC staff as described above. This is **COL Action Item 3.1-1**.

3.2 Thermal Discharges

3.2.1 Normal Plant Heat Sink

The 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 draft safety evaluation report (SER) discusses these events.

The normal plant heat sink (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).

3.2.1.1 Technical Information in the Application

In Section 3.2.1 of the SSAR, the applicant provides a brief description of the NPHS.

In SSAR Section 3.2.1.2, the applicant states that the flow from the normal cooling system to the cooling towers is 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 states that the cooling tower blowdown would normally be 12,000 gpm, with a maximum of 49,000 gpm.

The applicant states that the maximum NPHS load during normal operation would be 15.08x10^9 Btu/hr, with a maximum discharge temperature of 100 EF. The staff intends to identify these values as **Permit Conditions 3.2-1 and 3.2-2.**

The discharge temperature is based on a design approach of 15 EF and a maximum wet bulb temperature of 85 EF. The applicant states that a wet bulb temperature of 77.2 EF would only be exceeded 1 percent of the time and that the maximum wet bulb temperature is 84.7 EF.

3.2.1.2 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 per 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 found in Appendix A, “General Design Criteria for Nuclear Power Plants,” to Title 10, Part 50, “Domestic Licensing and Production and Utilization Facilities,” of the *Code of Federal Regulations* (10 CFR Part 50) 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 believes that two regulatory guides (RGs) are applicable—RGs 1.27, “Ultimate Heat Sink for Nuclear Power Plants,” and 1.70, “Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition).” Also, an ESP applicant need not demonstrate compliance with the GDC.

Acceptance criteria for this section relate to the following 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,” require that a site evaluation consider hydrological characteristics.

- 10 CFR 100.23, “Geologic and Seismic Siting Criteria,” requires that siting factors to be evaluated must include the cooling water supply.

The regulations at 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 ultimate heat sink (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 structures, systems, and components (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 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 Section 3.2 of the applicant’s SSAR 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 design essential cooling water flow, as well as the maximum design flow for normal plant needs at power and at shutdown.

3.2.1.3 Technical Evaluation

The NPHS has no safety function and is not required for shutdown or accident mitigation. However, in the event that the NPHS failed frequently and suddenly, there would be excessive reliance on the UHS. This is the only safety-related consideration associated with the NPHS. Section 3.2.2 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, 227 mi^2, to that of the drainage area contributing flow to Clinton Lake, 89.2 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 cubic feet per second (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 is 8.38 inches 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 feet per month. 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.

3.2.1.4 Conclusions

As set forth above, the staff concludes that the applicant has 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 ultimate heat sink.

3.2.2 Ultimate Heat Sink

The 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 where the NPHS failed suddenly and frequently enough that the ESP facility was required to rely excessively on the UHS. Section 3.2.1 of this SER discusses the NPHS.

3.2.2.1 Technical Information in the Application

In Section 3.2.2 of the SSAR, the applicant provides a brief description of the UHS.
In Section 3.2.2.1, the applicant states 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 states 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 states that the cooling tower evaporation rate would normally be 411 gpm, with a maximum of 700 gpm.

The applicant states that the maximum UHS load during normal operation would be 225×10^6 Btu/hr and 411.4×10^6 Btu/hr during shutdown, with a maximum discharge temperature of 95 EF in both cases.

The applicant indicates 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.

3.2.2.2 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 SSAR Section 3.2 addresses thermal discharges per 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 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 design essential cooling water flow, as well as the maximum design flow for normal plant needs at power and at shutdown.

3.2.2.3 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 states that the maximum UHS load during normal operation is 411.4×10^6 Btu/hr, with a maximum discharge temperature of 95 EF. The staff intends to identify these values as **Permit Conditions 3.2-3 and 3.2-4.**

3.2.2.4 Conclusions

As set forth above, the applicant has 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 has 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.

3.3. <u>Radiological Consequences of Accidents</u>

3.3.1 Technical Information in the Application

In Section 3.3, "Radiological Consequences of Accidents," of the SSAR, the applicant analyzes and provides the radiological consequences of design-basis accidents (DBAs) to demonstrate that a new nuclear unit(s) could be sited at the proposed ESP site without undue risk to the health and safety of the public, in compliance with the requirements of Title 10, Section 52.17, "Contents of Applications," of the *Code of Federal Regulations* (10 CFR 52.17) 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 an accident analysis 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 reactor (IRIS). 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 (GT-MHR) and (2) the Pebble Bed Modular Reactor (PBMR). The applicant stated that the PPE values were intended not to be limited to these reactor designs, but rather to provide a broad overall outline of a design concept and to include other potential reactor designs if they fall within the parameter values provided in the PPE.

In selecting DBAs for dose 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)
- loss-of-coolant accidents (AP1000, ABWR, ESBWR, and ACR-700)
- fuel handling accident (AP1000 and ABWR)

The applicant calculated site-specific DBA doses by first obtaining DBA dose information from the proposed AP1000 design control document (DCD). (The reactor designer used postulated atmospheric dispersion factors (χ/Q values) to obtain such values.) The applicant then calculated site-specific χ/Q values using onsite meteorological information. (The applicant provided the site-specific χ/Q values used in its radiological consequence analyses in Table 1.4-1, "Plant Parameter Envelope," of the SSAR.) Finally, the applicant multiplied the doses from the proposed AP1000 design by the ratios of the site-specific χ/Q values to the postulated χ/Q values from the proposed DCD. For the ABWR design, the doses provided were not based on the ratios of the χ/Q values, but were calculated using the activity releases provided in the ABWR DCD, the EGC ESP site-specific χ/Q values, and the dose conversion factors in Federal Guidance Reports 11 and 12.

The applicant presented the dose consequence assessment results in SSAR Table 3.3-2, "Design Basis Accident Off-Site Dose Consequences." 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), "Contents of Applications; Technical Information." The applicant provided the accident-specific source terms (i.e., release rates of radioactive materials from the

[1] As discussed later in this section, Exelon referenced the version of the AP1000 design available at the time its ESP application was submitted. The final SER for the AP1000 design certification is based on a revised AP1000 design.

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 RAI 3.3.1-1, the staff noted that Westinghouse had revised its χ/Q values in the AP1000 DCD since the applicant had submitted the EGC ESP application. The staff asked whether the applicant planned to use the updated values in revising its application. The applicant responded that it had elected not to update the ESP application to incorporate the latest χ/Q values in the AP1000 design certification. It went on to state that the Exelon 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 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 which included the calculated thyroid and whole body doses, in addition to the estimated TEDE values.

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 listed above. The applicant responded that the respective design certification documents for the ABWR and AP1000 designs present the methodologies used for calculating time-dependent releases. The staff finds the methodologies used 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.

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, the applicant provided the requested information in a new SSAR Table 3.3-2a for the AP1000 design. For the ABWR design, the applicant stated that the doses provided were not based on the ratios of the χ/Q values, but were calculated using the activity releases, the EGC ESP site-specific χ/Q values, and Federal Guidance Reports 11 and 12 dose conversion factors. 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 estimated activity releases are PPE values.

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, except that the period from 1 to 3 hours yields the greatest EAB dose for a loss-of-coolant accident (LOCA) for the AP1000 design. The applicant further stated that it will annotate its ESP application to clarify this information.

3.3.2 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 NRC Review Standard (RS)-002, “Processing Applications for Early Site Permits,” identifies the NRC regulations applicable to its ESP SSAR. In response to RAI 1.5-1, and in SSAR Table 1.5-1, “Regulatory Guide Applicability/Conformance,” the applicant identified the following applicable NRC regulations and guidance cited in Attachment 2, Chapter 15 of RS-002 regarding reactor accident radiological consequence analyses:

- 10 CFR 52.17
- 10 CFR Part 100
- 10 CFR 50.34
- 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
- TID-14844, “Calculation of Distance Factors for Power and Test Reactor Sites,” issued March 1962

The staff finds that the applicant correctly identified the applicable regulations and 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 at 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 at 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 the applicant 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 to be 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.

3.3.3 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.

3.3.3.1 Selection of DBAs

The applicant selected the DBAs listed in Section 3.3.1 of this SER predominantly based on the proposed AP1000 design and the certified ABWR design 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 in 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 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 COL or CP application that might be filed with respect to construction and operation of a reactor design at the Exelon ESP site.

3.3.3.2 Design-Specific (Postulated) χ/Q Values

In evaluating the AP1000 design, the applicant used those χ/Q values in the proposed AP1000 DCD that were being reviewed by the staff at the time the ECG ESP application was submitted. Westinghouse subsequently revised the χ/Q values in the AP1000 DCD. Consequently, the postulated χ/Q values and the calculated design-specific doses used in the Exelon ESP application may differ from those associated with a certified AP1000 DCD. However, the staff determined that the PPE values for the assumed χ/Q values associated with the AP1000 design used by the applicant in its accident analyses are reasonable and adequate for the purpose of demonstrating that a reactor with design characteristics similar to an AP1000 could be sited at the proposed ESP site. Table 1.4-1 of the SSAR lists the χ/Q values the applicant used for the version of the AP1000 design that it considered.

In evaluating the ABWR, the applicant did not use postulated χ/Q values in its 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 Federal Guidance Reports 11 and 12 dose conversion factors.

3.3.3.3 Site-Specific χ/Qs

In Section 2.3.4., “Short-Term Diffusion Estimates,” 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 this SER, that the applicant needs to provide appropriate meteorological data and appropriate distances from the postulated release points in the proposed ESP site to the proposed EAB and the LPZ outer boundary for use in estimating the site-specific χ/Q values used in the radiological consequence evaluations for the proposed ESP site. This is identified as Open Item 2.3-3 in Section 2.3.4 of this SER.

3.3.3.4 Source Terms and Radiological Consequence Evaluations

To evaluate the suitability of the site using the radiological consequence evaluation factors specified 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 guidance provided in RG 1.183 forms the basis for the AP1000 source terms. 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 guidance in TID-14844 forms the basis for the ABWR source terms. The resulting doses for the proposed ESP site using the ABWR source terms, postulated site parameters assumed in the ABWR DCD, and the EGC ESP site-specific χ/Qs calculated by the applicant meet the dose consequence evaluation factors specified 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.

However, as stated in Section 3.3.3.3 above, the staff concludes that neither appropriate meteorological data nor appropriate distances from postulated release points to the EAB and the LPZ outer boundary have been used by the applicant for estimating the site specific χ/Q values used in the radiological consequence evaluations. Therefore, the radiological consequence evaluation for the proposed ESP site is unresolved. This is identified as **Open Item 3.3-1**.

The staff finds acceptable the references provided by the applicant and the methodology it used to determine the timing and release rate of fission product source terms to the environment (and consequent dose consequences) from the proposed ESP site. Therefore, the staff finds the source terms from the PPE to be reasonable and acceptable. The staff intends to include the source terms in any ESP that the NRC might issue for the Exelon ESP site.

In response to RAI 15.4-6, the applicant stated that the greatest EAB dose occurs during the first 2 hours of all DBAs, except in the case of an AP1000 LOCA. In view of the accident progression sequences for the designs used in the DBA dose assessment, the staff agrees with this conclusion.

At the COL stage, in accordance with 10 CFR 52.79(a)(1), "Contents of Applications; Technical Information," 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 source term and postulated χ/Qs for the chosen design fall within the PPE source term and the site characteristic χ/Q values specified in the ESP, 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 in 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.

The staff has identified the following site χ/Q values as appropriate for inclusion in any ESP that NRC might issue for the EGC ESP site.

Table 3.3-1 Site-Specific χ/Q Values

Location and Time Interval	χ/Q Value
0 to 2 hour EAB	(Open Item 2.3-3)
0 to 8 hour LPZ	(Open Item 2.3-3)
8 to 24 hour LPZ	(Open Item 2.3-3)
1 to 4 day LPZ	(Open Item 2.3-3)
4 to 30 day LPZ	(Open Item 2.3-3)

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 either multiplied these inputs by the ratios of the site χ/Q values to the postulated design χ/Q values (for the AP1000), or multiplied the activity releases to the environment in the DCD by the site-specific χ/Q values (for the ABWR), the staff did not consider an independent calculation to be useful or necessary, and therefore did not perform one.

3.3.4 Conclusions

As set forth above, the applicant submitted its radiological consequence analyses using site-specific χ/Q values calculated by the applicant and PPE source term values specified in the respective AP1000 and ABWR DCDs, and concluded that the proposed 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 the source terms that it included as inputs to the radiological consequence analyses are reasonable and dose consequence evaluation methodology are acceptable. However, as discussed above regarding Open Item 3.3-1 and as described in more detail in Section 2.3 of this DSER, the staff finds that the applicant has not provided appropriate site-specific χ/Q values. The staff will determine whether the applicant's proposed site meets the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1) after reviewing the applicant's response to Open Items 2.3-3 and 3.3-1 and will document the results of that evaluation in the final SER.

3.4 <u>Conformance with 10 CFR Part 100</u>

3.4.1 10 CFR 100.21—Non-seismic Site Criteria

3.4.1.1 Exclusion Area and Low-Population Zone

Section 2.1 of this safety evaluation report (SER) discusses the staff's evaluation of the applicant's information regarding the site exclusion area and low population zone.

3.4.1.2 Population Center Distance

Section 2.1 of the SER discusses the staff's evaluation of the applicant's information regarding population center distance.

3.4.1.3 Site Atmospheric Dispersion Characteristics and Dispersion Parameters

Section 2.3 of this SER discusses the staff's evaluation of the applicant's information regarding site atmospheric dispersion characteristics and dispersion parameters. Section 3.3 of the SER summarizes the staff's evaluation of the applicant's information regarding the potential consequences of postulated accidents used in the evaluation of the EGC ESP site. Section 3.1 of the SER provides the staff's evaluation of the applicant's information regarding the potential consequences of normal radiological effluent releases used in the evaluation of the EGC ESP site.

3.4.1.4 Site Characteristics—Meteorology, Geology, Seismology, and Hydrology

<u>Meteorology</u>

Section 2.3 of the SER presents the staff's evaluation of the applicant's information regarding the site's meteorological characteristics.

<u>Geology</u>

The staff will issue a supplemental draft safety evaluation report (DSER), which will discuss its evaluation of the applicant's information regarding the site's geological characteristics. The supplemental DSER will include the staff's review of the information in Section 2.5, "Geology, Seismology, and Geotechnical Engineering," of the applicant's site safety analysis report (SSAR).

<u>Seismology</u>

The staff will issue a supplemental DSER, which will discuss its evaluation of the applicant's information regarding the site's seismological characteristics. The supplemental DSER will include the staff's review of the information in Section 2.5, "Geology, Seismology, and Geotechnical Engineering," of the applicant's site safety analysis report (SSAR).

Hydrology

Section 2.4 of the SER presents the staff's evaluation of the applicant's information regarding the site's hydrological characteristics.

3.4.1.5 Potential OffSite Hazards

Sections 2.2 and 3.5.1.6 of the SER provide the staff's evaluation of the applicant's information regarding potential offsite hazards.

3.4.1.6 Site Characteristics—Security Plans

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.

3.4.1.6.1 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 existing depicted ESP footprint. The applicant further states that the site characteristics are such that applicable NRC regulations, guidance documents, and orders can be met. This conclusion was 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 its Request for Additional Information (RAI) 3.4.1.6-1, the staff asked the applicant to provide a scale drawing that depicts the relationship between the ESP site and the PA boundary, the OCA boundary, the shore of Clinton Lake, and other site characteristics such as roads and railroad lines. In response, the applicant provided a figure indicating that adequate area is available within the OCA to meet the 360-foot distance criterion.

SSAR Section 3.4.1.6 also states that Exelon Generation Company (EGC) has a security program in place for the existing unit and notes 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 being stored or transported near the site).

3.4.1.6.2 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 for 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 indicates 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 that 10 CFR 100.21(f) and 10 CFR 73.55 are the applicable regulations. The staff finds that the applicant correctly identified the applicable regulations and guidance.

3.4.1.6.3 Technical Evaluation

The staff reviewed the application and responses to the RAIs and examined aspects of the application during an onsite visit. The proposed ESP site is located on the shore of Clinton Lake in DeWitt County, Illinois, near one 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 applicant's ESP site footprint, within which all safety-related structures would be located if one or more reactors were constructed there. 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 a minimum of 360 feet should be provided to allow for appropriate barriers, detection equipment, and isolation zones to protect vital equipment. In its response, the applicant provided a figure (Figure 3.4-1) which portrays adequate distances between planned locations of vital equipment and structures and the OCA boundary to permit the development of adequate security plans and measures. The staff concluded that the distance from planned 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 such that barriers, detection equipment, and isolation zones can be appropriately located 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 do not preclude the establishment of adequate vehicle control measures to (1) prevent potential adversaries from gaining close proximity to vital equipment or (2) 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 proposed 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. Railroad lines and spurs were identified and found not to have features that would preclude the development of adequate security plans or measures. Further, the staff confirmed during a site visit that the terrain features on all borders of the site are amenable to the implementation of a vehicle barrier system.

With respect to threats posed by deliberate vehicle explosions on nearby transportation routes, the staff performed an analysis of a gasoline tanker explosion of 8500 gallons of gasoline detonated 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 which 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 features (including existing manmade features such as culverts as well as natural features) that potential adversaries could use to their advantage; no such 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 3.4.1.6-1**.

3.4.1.6.4 Conclusions

As set forth above, the staff examined the proposed ESP site characteristics with respect to their potential to 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 reactor(s) that it might construct and operate there.

3.4.1.7 Site Characteristics—Emergency Plans

Section 13.3 of the SER presents the staff’s evaluation of the applicant’s emergency response planning information.

3.4.1.8 Population Density

Section 2.1 of the SER discusses the staff’s evaluation of the applicant’s information regarding population density.

3.4.2 10 CFR 100.23—Geologic and Seismic Siting Criteria

The staff will issue a supplemental DSER, which will evaluate the information contained in Section 3.4.2 of the applicant's SSAR and will include a detailed review of the information in SSAR Section 2.5, "Geology, Seismology, and Geotechnical Engineering."

3.5.1.6 Aircraft Hazards

For an ESP application, the NRC staff reviews the applicant's assessment of aircraft hazards to verify that the risks for a new nuclear power plant that might be constructed on the proposed site due to such hazards are sufficiently low.

3.5.1.6.1 Technical Information in the Application

In Section 2.2.2.5 of the SSAR the applicant presents information concerning the site relative to airports and airways that could affect the design of systems, structures, and components important to the safety of a nuclear power plant(s) falling within the applicant's 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.

None of these airports has a sufficient number of flight operations per year to rise above the threshold set forth in Section 3.5.1.6 of RS-002, which would call for a detailed evaluation of potential hazards associated with airport flight operations. Therefore, the applicant did not include a detailed evaluation of potential hazards associated with airport flight operations in the SSAR. However, the CPS USAR does include an evaluation of the hazards associated with operations from 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 within 2 miles east of the site. The centerline of V233 passes within 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 does include 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 their potential hazards. In response to the staff’s RAI 2.2.2-2, the applicant committed to revise SSAR Section 2.2.2.5.3 to provide details regarding the estimation of the probability of aircraft impacts from these Federal airways. The SSAR states that these airways are identical to the airways addressed in the CPS USAR and that the probability of incidence of an aircraft crash from these airways is within the guidelines of SRP Section 3.5.1.6. 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 found 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 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 identifies the NRC regulations applicable to its ESP SSAR. The staff considered the regulatory requirements in 10 CFR Part 100, 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 finds that the applicant correctly identified the applicable regulations and 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 is low is met if the probability of aircraft accidents having the potential for radiological consequences greater than the exposure guidelines 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 by inspection 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 the site-to-airport distance, 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 those associated with a usage greater 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 the above 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 performance of such reviews.

In SSAR Table 1.5-1, the applicant identifies the applicable NRC guidance related to the identification and evaluation of hazards associated with aircraft:

- RG 1.70, Revision 3
- 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 have a sufficiently large number of 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 the Thorp Airport and Bakers Strip do not require a detailed analysis because their distance and the number of annual operations for each of these airfields satisfies the first criterion.

The staff has conducted an independent evaluation of the hazard associated with the Martin RLA Airport because it is within 5 miles of the ESP site. Because the 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 for safety-related structures in the ESP site powerblock footprint of 0.02 mi^2 (estimated from 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. On this basis, 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, using the procedure set forth in Section III.3(a) of Section 3.5.1.6 in Attachment 2 to RS-002. This probability is lower than the 1×10^{-7} threshold set forth 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 criterion (1) above. The staff conducted an independent review of public airports in the vicinity of the proposed ESP site which 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. For each airport, the table provides the distance from the airport to the proposed ESP site, the number of operations per year, and a description of the distribution of operations by aircraft type (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 related to the site is effective as of September 30, 2004). On the basis of the airport distances and the annual number of operations, these airports satisfy criterion (1). Hence, hazards associated with operations at these airports in the vicinity of 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 risk associated with the airways. Rather, it relies on an analysis of the risk to CPS described in the CPS USAR. AmerGen updated this analysis in November 2002. The USAR analysis follows the guidance set forth in SRP Section 3.5.1.6, which is similar to the guidance for the review of ESP applications set forth in RS-002. Using the results of the USAR analysis, the applicant estimates that a safety-related structure associated with the 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 $1x10^{-7}$ 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 (estimated from Figure 2.1-4 of the Environmental Report submitted with the ESP application). The staff estimated the traffic along each airway in 2065 from the traffic estimates in the USAR and an annual growth rate of 1.5 percent. This growth rate is slightly larger than that 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 impacting 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 10 CFR 50.34(a)(1) guidelines 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 that result in a probability less than about $1x10^{-7}$ per year for an accident having the potential for radiological consequences greater than the exposure guidelines in 10 CFR 50.34(a)(1). The staff also conducted its own independent analyses. On the basis of the results of 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 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 in the Vicinity of 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	$1.62x10^{-8}$
V233	2.0	7,300	18,650	0.02	9.21	$1.62x10^{-8}$
V434	6.0	5,475	13,988	0.02	12.0	$9.3x10^{-9}$
V72	4.75	3,650	9,325	0.02	9.5	$7.9x10^{-9}$
					Total	$4.96x10^{-8}$

[(a)] An inflight crash probability of $4x10^{-10}$ per mile is used.