13.3C.18 Evacuation Time Estimate Analysis

For the convenience of the reviewer, this template contains the applicable ETE-related regulations and guidance in one document.

[**Reviewer's note:** ESP and 10 CFR Part 50 application requirements for ETEs will not be addressed in this document.]

13.3C.18.1 Regulatory Basis

10 CFR Part 52.79(a)(21), Subpart C, "Combined Licenses," includes the requirements and procedures applicable to Commission's issuance of COLs for approval of a site or sites for one or more nuclear power facilities. 10 CFR 52.79(a)(21) states that the applicant's final safety analysis report shall include an emergency plan that complies with 10 CFR 50.47 and Appendix E to 10 CFR 50. Appendix E states that the applicant shall provide an analysis of the time required to evacuate various sectors and distances within the plume exposure pathway emergency planning zone for transient and permanent populations.

a. Comment: Not Applicable. A Combined License Application was not submitted.

b. **RAI**: No RAIs identified.

10 CFR 52.79(b)(4) states in part, that if the early site permit approves a complete and integrated emergency plan or a major features plan, the applicant's final safety analysis report (FSAR) must include any new or additional information that updates and corrects the information that was provided under 10 CFR 52.17(b), and discuss whether the new or additional information "materially changes" the bases for compliance with applicable requirements.

[**Reviewer's note**: Where the applicant refers to an ETE analysis that was found acceptable for an ESP, the contractor will only need to review the analysis according to the requirements of 10 CFR 52.79(b)(4) and the guidance in Chapter 13.3 "Emergency Planning," of NUREG-0800, "Standard Review Plan." The relevant guidance from NUREG-0800 has been included in this template.]

a. Comment: The PSEG Early Site Permit (ESP) Application Emergency Response Plan (PSEG Emergency Plan) includes an analysis of the time required to evacuate the plume exposure pathway emergency planning zone (EPZ) for various sectors and distances within the plume exposure pathway EPZ for transient and permanent populations. The report titled "PSEG Site Development of Evacuation Time Estimates," dated August 2009, (ETE Report) was provided as a separate document in the ESP application, but it is considered to be part of the PSEG Emergency Plan and is incorporated into the PSEG Emergency Plan as Attachment 11, "Development of Evacuation Time Estimates."

b. RAI: No RAIs identified.

[**Reviewer's notes:** The reviewer should coordinate with the Environmental SRP Project Manager to ensure the population projections described in Section 2.1.3, "Population Distribution," of NUREG-0800, "Standard Review Plan," and Section 2.5.1, "Demography,"

of NUREG-1555, "Environmental Standard Review Plan," are consistent with population projections in the ETE. Even though the purposes of the population projection for the siting and environmental reviews may be different than the one for the safety review, any differences in projected population numbers need to be clearly explained.]

NUREG-0654/FEMA-REP-1, Rev. 1 Planning Standard J, evaluation criteria 8, states: "Each licensee's plan shall contain time estimates for evacuation within the plume exposure EPZ. These shall be in accordance with Appendix 4."]

[**Reviewer's note:** There is additional guidance related to ETE analyses in NUREG/CR-6863, "Development of Evacuation Time Estimate Studies for Nuclear Power Plants," that updates the guidance in NUREG/CR-4831, "State of the Art in Evacuation Time Estimate Studies for Nuclear Power Plants." However, the information in NUREG/CR-6863 and NUREG/CR-4831 has not been officially endorsed by the NRC. The guidance in NUREG-4831 and NUREG/CR-6863 may be used by an applicant to develop the ETE analysis as long as the ETE analysis continues to meet the guidance in Appendix 4 to NUREG-0654.]

[**Reviewer's note:** The remainder of this template is from Appendix 4 to NUREG-0654. The numbering in this section matches the numbering in Appendix 4.]

13.3C.18.2 Introductory Materials Related to the ETE Report

This section of the report should make the reader aware of the general location of the nuclear power plant and plume exposure pathway emergency planning zone, and generally discuss how the analysis was done.

[**Reviewer's note:** The word "report" in this section means the ETE analysis.]

I.A. Site Location and Emergency Planning Zone: A vicinity map showing the plant location shall be provided along with a detailed map of the plume exposure pathway emergency planning zone (EPZ). The map shall be legible and identify transportation networks, topographical features and political boundaries.

a. Comment: Section 1.2, "The PSEG Site Location," includes a description of the PSEG site which is located on the southern part of Artificial Island on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, New Jersey. The EPZ consists of parts of Salem and Cumberland Counties in New Jersey and parts of New Castel and Kent Counties in Delaware. Figure 1-1, "PSEG Site Location," shows the plant location, EPZ boundary and topographical features including the Delaware Bay, major roadways, and county boundaries. The mapping provided throughout the ETE study is as good as or better than USGS 7½-minute series quadrant maps.

The plume exposure pathway EPZ is described in Appendix L, "ERPA Boundaries," which identifies Emergency Response Planning Areas (ERPAs) 1 through 8 located in New Jersey and ERPAs A through D located in Delaware. The ERPAs are typically bounded by major roadways, the shoreline of the Delaware River, and the state lines.

Section 1.1, "Overview of the ETE Process," provides a description of the activities and methods used in developing the ETE. Section 1.1 describes the information gathering, development of trip generation times, defining of the

evacuation scenarios, development of input data for the traffic modeling and briefly explains how the modeling is applied.

b. **RAIs:** No RAIs identified.

General Assumptions: All assumptions used in the analysis shall be provided. The assumptions shall include such things as automobile occupancy factors, method of determining roadway capacities, and method of estimating populations.

[**Reviewer's note**: Assumptions described in the analysis should also have the basis for the assumption described.]

a. Comment: Section 2, "Study Estimates and Assumptions," identifies assumptions for data estimates, methodology, and general study assumptions used in the development of the ETE. Section 2.1, "Data Estimates," describes the assumptions regarding population estimates which were projected from the 2000 US Census data and states that estimates for special facilities were based on state emergency management information. Section 2.1 states that roadway capacity estimates were based on field surveys and the use of the Highway Capacity Manual [1]. Section 2.1 also explains the process for developing the automobile occupancy factors which used information obtained from a telephone survey of residents of the EPZ.

Section 2.2, "Study Methodological Assumptions," explains that the ETE is assumed to begin at the Advisory to Evacuate and describes the assumptions regarding shadow evacuation and voluntary evacuation which were included in the analyses. Section 2.3, "Study Assumptions," states that it is assumed all residents evacuate and describes how the assumptions related to residents evacuating directly or returning home prior to evacuation were derived from the telephone survey. Section 2.3 explains the assumptions regarding traffic control and explains why it is assumed the ETE does not consider the effects of traffic control. Section 2.3 describes the assumptions regarding mobilization of schools buses, provisions for evacuating transit dependent persons, and also describes the assumptions regarding adverse weather.

b. **RAI:** No RAIs identified.

Methodology: A description of the method of analyzing the evacuation times shall be provided. If computer models are used, a general description of the algorithm shall be provided along with a source for obtaining further information or documentation.

a. Comment: Section 1, "Introduction," describes the approach used to develop information and calculate the evacuation times. Section 1 explains that meetings were held with Delaware and New Jersey response agencies, and a field survey of the EPZ was conducted and archived. Demographic data was gathered, trip generation times estimated, evacuation regions defined, and the procedures specified in the 2000 Highway Capacity Manual were

applied.

Section 1.3, "Preliminary Activities," explains that the IDYNEV traffic simulation modeling system was used in the analysis and references NUREG/CR-4873, "Benchmark Study of the IDYNEV Evacuation Time Estimate Computer Code," [2] and NUREG/CR-4874, "The Sensitivity of Evacuation Time Estimates to Changes in Input Parameters for the IDYNEV Computer Code," [3] as references for additional detail regarding the model.

Section 1.3 states that the overall study procedure is outlined in Appendix D, "Detailed Description of Study Procedure." Appendix D provides 17 steps that are undertaken in an iterative manner to produce the ETE. These steps are graphically displayed in Figure D-1, "Flow Diagram of Activities," which shows that after the roadway network is surveyed and the modeling network is developed, the trip assignment and distribution model is used to produce a traffic simulation input stream. Appendix B, "Traffic Assignment Model," describes the trip assignment and distribution model and provides the algorithm used to compute the link travel time which was based on the Bureau of Public Roads formula. Appendix C, "Traffic Simulation Model: PC-DYNEV," describes the method and computer model used in analyzing the evacuation times and includes a description of histograms developed and used in the analysis.

b. RAI: No RAIs identified.

13.3C.18.3 Demand Estimation

The objective of this section is to provide an estimate of the number of people to be evacuated. Three potential population segments shall be considered: permanent residents, transients, and persons in special facilities. "Permanent residents" includes all people having a residence in the area, but not in institutions. Transients shall include tourists, employees not residing in the area, or other groups that may visit the area. Special facility residents include those confined to institutions such as hospitals and nursing homes. The school population shall be evaluated in the special facility segment. Care should be taken to avoid double counting.

II.A. Permanent Residents. The number of permanent residents shall be estimated using the U.S. Census data or other reliable data, adjusted as necessary, for growth (See planning element J.10.b.). This population data shall then be 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. A range of two to three persons per vehicle would probably be reasonable in most cases.

An alternative approach is to calculate the number of vehicles based on the number of households that own vehicles, assuming one vehicle per household is used in evacuation. Regardless of the approach used, special attention must be given to those households not having automobiles. The public transport-dependent population must, therefore, be considered as a special case.

[**Reviewer's note**: Permanent residents are assumed to evacuate from their homes,

however, they should not be assumed to be at home at all times. A discussion of how this potential time frame is addressed needs to be included (e.g. a discussion of phone survey results in the description of trip generation times) in the ETE.]

a. Comment: Section 2.1, "Data Estimates," states that the population is based on the 2000 census data and population estimates are extrapolated to 2010 using municipality specific data. Table 3.1, "EPZ Permanent Resident Population," presents the 2000 and 2010 populations by ERPA and shows that a 26.4 percent growth in population has occurred over this time period. Section 2.1.3.1, "Resident Population within 10 Miles," of the Site Safety Analysis Report (SSAR) states that there were 33,871 people living within 10 miles of the plant in 2000, and the projected 2010 population provided in the SSAR is 42,743. Section 3.1, "Permanent Residents," states that the same methodology was used for developing the population values for the Safety Analysis Report and explains that any difference in population values is due to the use of a 10 mile boundary for estimating population in the Safety Analysis Report while the actual ERPA boundaries were used to develop populations for the ETE. EPZ population values presented in the New Jersey and Delaware Radiological Emergency Response Plans differ from those presented in the ETE.

   Section 2.3, "Study Assumptions," describes the assumptions regarding evacuation of households. The assumptions are based on a telephone survey which was conducted for the ETE and is presented in Appendix F, "Telephone Survey." Based on the survey, 65 percent of households in the EPZ have at least one commuter and 60 percent of those will await the return of the commuter before evacuating.

   Section 3, "Demand Estimation," explains that double counting of people and vehicles is considered. Care was taken not to double count a resident who works and shops within the EPZ and not to double count transients who may stay in a hotel, visit a park, or shop. Section 3.1, "Permanent Residents," explains that the average household size and number of evacuating vehicles per household were developed from the telephone survey. The number of evacuating vehicles was developed using the population information, number of people per household, and number of evacuating vehicles per household. Table 3-3, "Permanent Resident Population and Vehicles by ERPA," shows the total number of vehicles needed to evacuate the population to be 20,801 and a total 2010 population of 45,034, which corresponds to 2.16 persons per vehicle.

   Permanent residents without vehicles were addressed in the ETE report. Section 8.1, "Transit-Dependent People – Demand Estimate," describes the process for estimating the number of residents who do not have an automobile available for evacuation. The estimate was based on information obtained from the telephone survey. The telephone survey, described in Appendix F, was conducted to obtain demographic data and found that approximately 3.5 percent of households do not have access to an automobile. The ETE also considers households with one vehicle when the commuter would not return prior to evacuating. The survey identified 65

percent of households in the EPZ have at least one commuter and 60 percent of those will await the return of the commuter before evacuating. Table 8-1, "Transit-Dependent Population Estimates," provides the information and calculation to show that 1,029 residents will require transportation.

b. **RAIs:** No RAIs identified.

II.B. Transient Populations. Estimates of transient populations shall be developed using local data such as peak tourist volumes and employment data for large factories. Automobile occupancy factors would vary for different transient groups. Tourists might have automobile occupancy factors in the range of three to four, while a factory would probably have a factor of less than 1.5 persons per vehicle. This population segment, along with the permanent population subgroup using automobiles, constitutes the general population group for which an evacuation time estimate shall be made.

[**Reviewer's note**: Special events that draw large groups of transients into the EPZ should all be listed; however, only one event need be analyzed. The total attendance for an event may not be the most accurate number to use for the event analysis. If the event is a weekend festival that draws 100,000 people over the course of the event, then an average number or expected number of people in attendance at a given time should be used as opposed to the total number. If the event draws 100,000 people for the duration of the event (i.e. a college football game), then the 100,000 number should be used.]

a. **Comment**: Section 2.1 explains that estimates of employees who commute into the EPZ to work are based on the state Journey to Work database for 2000 and considered surveys of major employers in the EPZ.

Section 3, "Demand Estimation," defines Transients as people who reside outside of the EPZ, enter the area for a specific purpose, and then leave the area. Section 3.2, "Transient Population," provides a detailed description of the facilities considered in the estimating of the transient population which included lodging facilities, marinas, wildlife areas, Fort Mott State Park, and Fort Delaware State Park. Section 3 explains that lodging facilities were surveyed to determine the number of rooms, percent occupancy, and number of vehicles per room. State parks were assumed to have a vehicle occupancy rate of 2.92 persons per vehicle which is consistent with the average household size within the EPZ.

Approximately 30 recreational facilities were identified and are listed in Table E-5, "Recreational Areas within the PSEG Site EPZ." Table 3-4, "Summary of Transients and Transient Vehicles," provides the number of transients in each ERPA and shows a total 3,323 transients within the EPZ. Table E-7, "Major Employers within the PSEG Site EPZ," provides a detailed listing of employees working for large employers within the EPZ and shows a total of 5,918.

Research shows that the annual Olde Tyme Peach Festival is held in Middletown, Delaware and brings 27,000 people into town for the one day event. **RAI ETE-2** requested the applicant explain whether this event should be added as a special event within the EPZ. **[Response]**

b. **RAI ETE-2:** The annual Olde Tyme Peach Festival in Middletown, Delaware brings 27,000 people into the town for the one day event. **Explain whether this should be added as a special event within the EPZ and include the analysis in the ETE Report, if appropriate.**

Special Facility Population. An estimate for this special population group shall usually be done on an institution-by-institution basis. The means of transportation are also highly individualized, and shall be described. Schools shall be included in this segment.

[**Reviewer's note:** Facility populations used in the analysis do not need to be the maximum facility occupancy. The population should be the average population or the most likely population, whichever is higher.

Specially trained individuals and specialized transportation vehicles and drivers also should be noted i.e. security for moving jail inmates (can local law enforcement move Federal prisoners?), medical support staff.]

a. Comment: Section 8, "Transit-Dependent and Special Facility Evacuation Time Estimates," describes the process for developing and obtaining data regarding special facilities and schools which was performed on an institution-by-institution basis. The schools are included as a separate analysis. Appendix E, "Special Facility Data," includes tabulated information at the facility level for special facilities and schools. Table E-1, "Schools within the PSEG Site EPZ," lists the name of each public and private school and identifies a total of 13,967 student and Table E-2, "Day Care Facilities within the PSEG Site EPZ," an enrollment of 1,503. Table 8-2, "School Population Demand Estimate," lists 15,059 students and includes some schools from Table E-2. Staff requested additional information in **RAI ETE-3** regarding why only some of the Table E-2 schools were included. **[Response]** Table 8-2 lists 275 students at St. George's Technical High School, however the school's website shows 1,000 students enrolled at this school. **RAI ETE-4.A** requested clarification regarding the number of students used in the ETE analysis. **[Response]** Research shows St. Mary's School, Bacons Neck School, and Union School are located within the EPZ. **RAI ETE-4.B** requested the applicant explain whether these schools should be included the ETE. **[Response]**

Table E-3, "Medical Facilities and Assisted Living Facilities within the PSEG Site EPZ," lists 12 facilities with a total capacity of 463 residents. The number of wheelchair patients, bed-bound patients, and ambulatory patients is provided. Section 8.5, "Special Needs Population," describes the resources available and explains how the number of patients per vehicle was determined for ambulances, wheelchair vans and buses.

Section 8.6, "Correctional Facilities," states that there are two facilities located within the EPZ. Table E-4, "Correctional Facilities within the PSEG Site EPZ," identifies the two correctional facilities and a total of 2,750 inmates. The two facilities are located beyond 10 miles from the site, but are located within ERPA B, in Delaware. Section 8.6 explains that the Standard Operating Procedure 1000-D of the Delaware Radiological Emergency Plan identifies shelter in place as the protective action for these facilities. Section 8.6 states that this protective

action was confirmed in discussions with the Delaware Emergency Management Agency.

b. **RAI ETE-3:** Table 8-2, "School Population Demand Estimate," lists 15,059 students which includes all of the schools identified in Table E-1, "Schools within the PSEG Site EPZ," and some of the schools from Table E-2, "Day Care Facilities within the PSEG Site EPZ." **Explain why only some of the Table E-2 schools were included in the analysis. Include this information in the ETE Report.**

RAI ETE-4: Table 8-2 lists 275 students at St. George's Technical High School, however an independent review of schools within the EPZ found that the school's website lists 1,000 enrolled students. The review also found additional schools, including St. Mary's School, Bacons Neck School and Union School, located within the EPZ.

A. **Explain whether 1,000 students for St. George's Technical High School should be used in the analysis, and include this in the ETE Report, if appropriate.**

B. **Explain whether St. Mary's School, Bacons Neck School and Union School should be included in the ETE and include them if appropriate.**

II.C. Emergency Planning Zone and Sub-Areas. The sub-areas, for which evacuation time estimates are required, must encompass the entire area within the plume exposure emergency planning zone (EPZ). Additionally, evacuation time estimates are also required for simultaneous evacuation of the entire plume exposure pathway. The areas to be considered are (approximate radius/area): two miles/four 90 degree sectors, five miles/four 90 degree sectors, 10 miles (EPZ)/four 90 degree sectors, and 10 miles (EPZ)/entire EPZ.

a. Comment: Section 6, "Demand Estimation for Evacuation Scenarios," describes the ERPAs and explains how these are grouped into regions to calculate the ETEs for simultaneous evacuation of regions and of the entire EPZ. ERPAs 1 through 8 are located in New Jersey and ERPAs A through D are located in Delaware. Figure 6-1, "PSEG Site EPZ ERPAs," identifies the plant location, EPZ boundary and the ERPAs, and a detailed description of each ERPA is provided in Appendix L, "ERPA Boundaries. The protective action areas, for which evacuation time estimates are provided, encompass the entire area within EPZ.

b. RAI: No RAIs identified

When making estimates for the outer sectors, assume that the inner adjacent sectors are being evacuated simultaneously. The boundaries of the sub-areas shall be 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 shall not divide densely populated areas. Where meteorological conditions such as dominant wind directions warrant special consideration, an additional sub-area may need to be defined and a separate estimate made for this case. The EPZ and its sub-areas shall be identified by mapping on U.S. Geological Survey (USGS) 7½-minute series quadrant maps, when available. Special facilities shall also be noted on these maps, to the extent that their locations can be geographically specified. Populations

shall be provided by evacuation areas specified in planning element [sic] J.10.b.

[**Reviewer's notes:** Mapping as good as or better than USGS 7½-minute series quadrant maps is acceptable.]

[For purposes of determining evacuation times, it may also be useful to summarize population data by sector and distance from the plant. Figure 1 is an example of such a summary.]

[Figure 2 in App. 4 of NUREG-0654 shows the population totals, translated into the number of vehicles estimated to be used in evacuation.]

a. Comment: The PSEG ETE was developed considering that evacuation movements are generally outbound relative to the power plant as described in Section 2.2, "Study Methodological Assumptions." The sub-areas are defined as ERPAs and these are based upon the same factors as the EPZ boundary. A description of each ERPA boundary is provided in Appendix L, "ERPA Boundaries."

Table 3-3, "Permanent Resident Population and Vehicles by ERPA," provides the 2010 population and corresponding number of vehicles for each ERPA. Figure 3-2, "Permanent Residents by Sector," provides the population distribution in the form of radial sectors projecting out from the plant. Table 3-4, "Summary of Transients and Transient Vehicles," provides the 2009 transient population and corresponding vehicles, and Table 3-5, "Summary of Non-EPZ Employees and Employee Vehicles," provides the 2009 population and vehicles for commuting employees. Staff requested additional information in **RAI ETE-1** regarding why 2009 population values were provided. Figure 3-4, "Transient Population by Sector," and Figure 3-6, "Employee Population by Sector," provide the population values by sector and distance from the plant for each of these demographic groups. Special facilities are included in Figure E-2, "Day Care Centers, Medical Facilities, and Correctional Facilities within the PSEG Site EPZ." The mapping provided throughout the ETE study is as good as or better than USGS 7½-minute series quadrant maps.

b. **RAI ETE-1:** Permanent resident population values were provided for the year 2010, and transient population values were provided for the year 2009 as shown in Table 3-4, "Summary of Transients and Transient Vehicles," and Table 3-5, "Summary of Non-EPZ Employees and Employee Vehicles." **Explain why 2009 population data was used for transients and non-EPZ employees. Include this information in the ETE Report.**

13.3C.18.4 Traffic Capacity

This section of the report shall show the facilities to be used in evacuation. It shall include their location, types, and capacities. A complete review shall be made of the road network. Analyses shall be made of travel times and potential locations for serious congestion in potential corridors. The analyses may be simplified in extreme rural areas. The entire road network shall be used. Local routes shall be carefully selected and analyzed to minimize their impact on the major routes, should queuing or cross-traffic conflicts occur. Care should be taken to avoid depending only on high-capacity interstate and similar type routes, because of limitations of on-ramp capacities. Alternately, special traffic management plans

may be developed to effectively utilize available capacity. Evacuation shall be based on general radial dispersion.

III.A. Evacuation Roadway Network: A map showing only those roads used as primary evacuation routes shall be provided. The map need not show local access streets necessary to get to the evacuation routes. Each segment of the network shall be numbered in some manner for reference. The sector and quadrant boundaries shall also be indicated.

a. Comment: Evacuation routes are illustrated on Figures 10-2, "Evacuation Route Map for the Northeastern Quadrant of the EPZ (ERPAs 1-5)," and subsequent Figures 10-3 through 10-5. These maps provide roadway level detail of the evacuation routes and show that the entire roadway network was used in the analysis. The maps also show the travel direction of evacuees.

Appendix K, "Evacuation Roadway Network," provides an overview map, Figure K-1, "PSEG Site Link-Node Analysis Network," which is a gridded reference map showing the full roadway network with all nodes and is used to cross reference to more detailed maps. Figures K-2 through K-25 provide legible nodal networks covering the full EPZ and these maps also show the county and ERPA boundaries.

b. **RAI**: No RAIs identified.

Roadway Segment Characteristics: A table shall be provided indicating all the evacuation route segments and their characteristics, including capacity. The characteristics of a segment shall be given for the narrowest section (or bottleneck) if the roadway is not uniform in the number of lanes throughout the segment.

[Reviewer's note: The roadway characteristic table should include the following: a Link number that uniquely identifies each roadway segment between two nodes, the upstream node number for associated link, the downstream node number for associated link, the length of the roadway segment, the lane width of the link, the number of lanes in the direction of travel, roadway type i.e. interstate, major arterial, minor arterial, etc., saturation flow rate, the equivalent hourly rate at which vehicles can traverse the link, and free flow speed over the link.]

a. Comment: Section 4, "Estimation of Highway Capacity," describes the method for estimating highway capacity and provides the algorithm and equation used for the lane capacity for the approach to an intersection. Appendix D, "Detailed Description of Study Procedure," identifies the steps to perform the evacuation time estimate calculations. Section 4.1, "Capacity Estimations on Approaches to Intersections," describes the approach to analyzing signalized intersections and provides a description of each of the parameters used in the analysis. Section 5, "Estimation of Trip Generation Time," describes the process of combining distribution functions to establish the time-dependent traffic loading. Together these sections describe how the data obtained in other sections of the ETE report are integrated into the calculation to produce the ETE.

Information regarding the roadway characteristics is provided in Table K-1, "Evacuation Roadway Network Characteristics," and includes the upstream

and downstream node numbers for each segment, the length of the roadway segment, the number of lanes in the direction of travel, the saturation flow rate, and the free flow speed. The information provided within Table K-1 was reviewed to determine where roadways are not uniform or where impediments may affect the roadway capacity. For instance, from Upstream Node 103 to Downstream Node 99, there are two lanes, a free flow speed of 60 mph, and a saturation flow rate of 2250 vehicles per hour. From Upstream Node 103 to Downstream Node 109, there is one lane, a free flow speed of 20 mph and a saturation flow rate of 1200 vehicles per hour. Further review of this node sequence using the nodal maps provided shows that the link is an onramp to a cloverleaf intersection, which explains why the saturation flow and speed changed considerably at this location. There are 5 lanes identified in one direction between nodes 872 and 112. Review of the corresponding mapping shows that there is an acceleration lane on the interstate at this point which is the reason for the number of lanes.

Traffic queuing and congestion areas are presented in Figure 7-3, "Areas of Traffic Congestion *1 Hour* after the Advisory to Evacuate, (Scenario 6, Region 03)," and at 2 hours and 2 hours and 30 minutes in Figures 7-4 and 7-5 respectively. As indicated in Figure 7-3, the availability of many roadways results in only a few relatively short roadway segments that operate at a Level of Service F, which would indicate heavy congestion [1].

b. **RAI**: No RAIs identified.

13.3C.18.5 Analysis of Evacuation Times

IV.A. Reporting Format:

The adverse weather frequency used in this analysis shall be identified, and shall be severe enough to define the sensitivity of the analysis to the selected events. These conditions will affect both travel times and capacity. More than one adverse condition may need to be considered. That is, a northern site with a high summer tourist population should consider rain, flooding, or fog as the adverse condition, as well as snow with winter population estimates.

a. Comment: Adverse weather is considered in the analysis for all scenarios and for the special facility ETEs. Section 2.3 identifies the factors applied to the ETE for rain and snow. For rain, the highway capacity and free flow speed factors are each 90 percent. For snow, the highway capacity and free flow speed factors are each 90 percent. Section 2.3 references "Impacts of Weather on Urban Freeway Traffic Flow Characteristics and Facility Capacity," [4] which describes the affects of rain and snow on highway travel ad was the basis for the factors used.

b. **RAI**: No RAIs identified.

The text accompanying the ETE tables shall clearly indicate the critical assumptions that underlie the time estimates; e.g., day vs. night, workday vs. weekend, peak transient vs. off-peak transient, and evacuation on adjacent sectors vs. non-evacuation. The relative significance of alternative assumptions shall be addressed; especially with regard to time-dependent traffic loading of the segments of the evacuation roadway network. Some modifications of the reporting format may be

appropriate, depending on local circumstances.

a. Comment: Section 5, "Estimation of Trip Generation Time," provides a detailed discussion regarding the development of time dependent traffic loading for population segments. Section 5 explains that the information required to develop the trip generation times was obtained from the telephone survey conducted of residents within the EPZ. The development of the time elements considered time for evacuee notification, awareness of the situation, departing work, travel and arriving home, and departing on the evacuation trip.

Evacuation time estimates are provided for the 15 scenarios identified in Table 6-2, "Evacuation Scenario Definitions." Table 6-2 identifies the season, day of week, time of day, weather and special conditions. The special condition identified is new plant construction. Additional scenarios are developed for a proposed Causeway and for Refueling. The critical assumptions regarding the population and vehicle demand estimates applied to each evacuation scenario are described, and quantified, under Table 6.3, "Percent of Population Groups Evacuating for Various Scenarios." Table 6.3 identifies the population percentage for residents with commuters, residents without commuters, employees, transients and shadow evacuation that evacuate for each of the 15 scenarios. The assumptions identify that 1 bus equals 2 passenger vehicles and external traffic is stopped 90 minutes after the evacuation begins.

b. **RAI**: No RAIs identified.

IV.B. Methodology:

The method for computing total evacuation time shall be specified. Two approaches are acceptable. The simplest approach is to assume that events are sequential. For example, all persons are warned and prepared to leave before anyone starts moving. The time is estimated by simply adding the maximum time for each component. This approach tends to over-estimate the evacuation time. The second approach, which is more complex, is to combine the distribution functions for the various evacuation time components. This second approach may result in reduced time estimates due to more realistic assumptions. The added complexity of analysis, therefore, may be warranted at sites with long evacuation times. When distribution functions are used, estimates are made of the likelihood that each stage in an evacuation sequence will be accomplished within a given period of time. These conditional probabilities depend upon completion of the preceding stage. For example, formulation of family units (or other evacuation groups) do not commence until notification is received. Some of these distribution functions must be based on the judgment of the estimators. Computations of the joint distribution functions of evacuation times are made. Typically, the joint distribution assumes the form of an S-shape curve [see Figure 4 in App. 4 of NUREG-0654]. The evacuation time function is fairly smooth for large homogeneous population segments, such as the general public. Special facilities, such as hospitals and industrial centers, produce less smooth functions, or discontinuous ones. The assessment of evacuation time may be easily updated should further analyses be conducted, assumptions changed, or new plans developed.

[**Reviewer's notes**: If the site's PAR logic does not evacuate all sectors simultaneously, (**i.e. a staged evacuation method**) then additional estimates/scenarios that support the staged evacuation logic should be included.]

a. Comment: The methodology employed in the analysis is the summation of distribution functions. Section 5 describes the time distributions developed for commuters departing place of work, commuters arriving home, residents with commuters leaving home to begin the evacuation trip, and residents without commuters returning home to begin the evacuation trip. Figure 5-3, "Comparison of Trip Generation Distributions," provides the trip generation distributions for employees and transients, residents with commuters, residents without commuters, residents with no commuters with snow, and residents with commuters with snow. Figure 5-3 is in the form of an S-shape curve and indicates that the trip generation time for residents with commuters is the longest at about 6 hours.

b. **RAI**: No RAIs identified

When distributions are used, distribution functions for notification of the various categories of the evacuee population shall be developed. The distribution functions for the action stages after notification predict what fraction of the population will complete a particular action within a given span of time. There are separate distributions for auto-owning households, school populations, and transit-dependent populations. These distribution functions can be constructed in a variety of ways, depending greatly on the kinds of data available for the actual site being studied. The previously developed conditional distributions are combined to develop the time distributions for the various population segments departing their home or other facility, from which they are being evacuated. For example, for the auto-owning population segment, these vehicles are then loaded onto the roadway network, in order to compute travel times and delays.

a. Comment: Section 5 describes the time distributions and explains the sequence of events considered in the analysis. Section 5 identifies fundamental considerations which are identified as event descriptions including Notification, Aware of Situation, Depart Work, Arrive Home, Depart on Evacuation Trip. Table 5-1, "Event Sequence for Evacuation Activities," shows links these events with activities that include Receive Notification, Prepare to Leave Work, Travel Home, Prepare to Leave to Evacuate, and Snow Clearance for selected scenarios. developed for commuters departing place of work, commuters arriving home, residents with commuters leaving home to begin the evacuation trip, and residents without commuters returning home to begin the evacuation trip. Figure 5.1, "Events and Activities Preceding the Evacuation Trip," shows the relationship and various combinations of these events and activities.

b. **RAI**: No RAIs identified.

Regardless of the means by which the time and amount of traffic to be loaded on the network is determined (i.e., sequentially or using distribution functions), it is necessary to calculate the on-road travel and delay times. In this step, traffic from each sector is assigned to available evacuation routes, and, if assigned volumes

exceed capacity, delay times must be calculated using a queuing analysis. Traffic queue (backup) locations and estimated delay times should be indicated on the area map.

a. Comment: The evacuation model PC-DYNEV was used to calculate on road travel and delay times, and the ETEs are provided for 15 scenarios and 17 regions in Table 7-1D, "Time to Clear the Indicated Area of *100* Percent of the Affected Population." Traffic queuing and congestion areas are depicted in Figure 7-3, "Areas of Traffic Congestion *1 hour* after the Advisory to Evacuate (Scenario 6, Region 03)," through Figure 7-5, "Areas of Traffic Congestion *2 hours and 30 minutes* after the Advisory to Evacuate (Scenario 6, Region 03)." A Level of Service F, which indicates heavy congestion [1] is observed in a few areas dispersed throughout the EPZ. Most of the roadways show little or no congestion throughout the evacuation.

   One area where congestion is identified is within Salem City. Section 7.2, "Patterns of Traffic Congestion During Evacuation," explains that congestion builds quickly around concentrations of population and traffic bottlenecks and states that residents of Salem City are limited to two evacuation routes. Figure 10-2, "Evacuation Route Map for the Northeaster Quadrant of the EPZ (ERPAs 1-5)," shows travel along Route 49 coming into Salem City from the East and shows travel exiting Salem on Route 49 to the north and out of the EPZ. **RAI ETE-5** requested additional information regarding the direction of travel on Route 49. **[Response]**

   b. **RAI ETE-5:** Section 7.2, "Patterns of Traffic Congestion During Evacuation," describes congestion on Route 49 westbound through Salem City, and describes Salem City as limited to two evacuation routes. **Explain why Route 49 was not considered an evacuation route out of Salem City, thereby providing a third evacuation route out of the city. Include this information in the ETE Report.**

An estimate of the time required to evacuate that segment of the non-car-owning population, which is dependent upon public transport, shall be made in a similar manner to that used for the auto-owning population. This estimate shall include consideration of any special services that might be initiated to serve this population subgroup. Such services might include fixed-route departures from designated assembly points.

a. a. Comment: Section 8.1, "Transit Dependent People – Demand Estimate," describes the process used to estimate the portion of the population requiring transit service (e.g., non car owning population) and explains that the telephone survey results were used in the estimation. Section 8.1 explains why it is appropriate to consider that many non car-owning persons will evacuate by ride sharing using the widely studied Mississauga, Ontario evacuation as the basis. During the Mississauga evacuation, which was an urban evacuation, a high number of residents did ride share to evacuate. Section 8.1 then states that other documents report that approximately 70 percent of transit dependent persons were evacuated via ride sharing and references NUREG/CR-6953 Volume 2, "Review of NUREG-0654,

Supplement 3, 'Criteria for Protective Action Recommendations for Severe Accidents' – Focus Groups and Telephone Survey." In review of NUREG/CR-6953, Volume 2, staff found a statement that 72 percent of respondents were likely to provide a ride to individuals, but found no indication of an incident in which 70 percent of transit dependent persons were evacuated using ride-share. In **RAI ETE-6**, staff requested clarification regarding the reference to NUREG/CR-6953. **[Response]**

Table 8-1, "Transit-Dependent Population Estimates," provides an analysis of the population requiring public transit and shows that 2,058 residents may need assistance and estimates that if 50 percent of these rideshare, then 1,029 residents will require public transportation to evacuate. The State of New Jersey Radiological Response Plan for Nuclear Power Plants, Table A-8, "Transit Dependent Population General," identifies the number of persons without autos. The source of the state plan information was the 2000 U.S. Census and is less than, but consistent with the values in the ETE Report. Section 8.1 includes an algorithm used to calculate the estimated number of bus trips to service the transit dependent persons based on a occupancy of 30 persons and identifies the need for 34 bus runs. Section 8.4, "Evacuation Time Estimates for Transit-Dependent People," explains that school buses will be used to service the transit dependent evacuees. These school buses will be deployed to evacuate the transit dependent people beginning approximately 105 minutes after the advisory to evacuate. Section 8.4 describes the analysis for the transit dependent ETE which includes a pickup time of 30 minutes estimated for 30 individual stops. The travel speed was derived from the model and is 14.72 mph at this time during the evacuation due to other vehicles on the roadways.

The bus routes for the transit dependent population are presented in Appendix M, "Transit-Dependent Bus Routes." The routes for Delaware were which were obtained from the Delaware State plan and the New Jersey routes represent the most likely routes to be used. Table 8-8.A, "Transit Dependent Evacuation Time Estimates – Good Weather," provides the ETE for each bus route and shows that the average ETE for a single wave is 3 hours which is less than the ETE for the general public. Table 8-8.B, "Transit Dependent Evacuation Time Estimates – Rain," provides the ETE for each bus route under adverse conditions.

Section 8.5, "Special Needs Population," discusses the resources and activities needed to evacuate homebound special needs persons. There are 16 homebound special needs persons identified within the Delaware portion of the EPZ and 34 people within the New Jersey portion of the EPZ. All of the Delaware special needs residents and 11 of the New Jersey residents require wheelchair van transportation. Two people in New Jersey require an ambulance and 21 require a bus to evacuate. Section 8.5 describes the resources to accommodate the evacuation and provides the calculation for the ETE for this population segment. In the State of New Jersey Radiological Response Plan, Table B-2, "Non-Institutionalized Special Needs Population within the Emergency Planning Zone by Zip Codes," identifies special needs residents that may need assistance evacuating and lists 21 residents in

Lower Alloways Creek, 10 in Elsinboro, 91 in Salem City, 15 in Quinton, 2 in Mannington, and 1 in Pennsville for a total of 140 residents in New Jersey. Table B-2 states that the licensee, in cooperation with State Office of Emergency Management, maintains a computer tracking system of this information provided by annual surveys which are mailed back to the agency. In **RAI ETE-7**, staff requested additional information regarding the special needs population that may need assistance evacuating. **[Response]**

b. **RAI ETE-6**: Section 8.1, "Transit Dependent People – Demand Estimate," describes an example where approximately 70 percent of transit dependent persons were evacuated via ride sharing and references NUREG/CR-6953 Volume 2, "Review of NUREG-0654, Supplement 3, 'Criteria for Protective Action Recommendations for Severe Accidents' – Focus Groups and Telephone Survey." In review of NUREG/CR-6953, Volume 2, staff found a statement that 72 percent of respondents were likely to provide a ride to individuals, but found no indication of an incident in which 70 percent of transit-dependent persons were evacuated via ride-sharing. **Correct the reference to NUREG/CR-6953 to clarify that the study indicates a likely percentage of ride-share based on a telephone survey. Include this information in the ETE Report.**

RAI ETE-7: The State of New Jersey Radiological Response Plan, Table B-2, "Non-Institutionalized Special Needs Population within the Emergency Planning Zone by Zip Codes," identifies 140 special needs residents that may need assistance evacuating. **Explain the reason for the difference between the 34 individuals identified in New Jersey in Section 8.5, "Special Needs Population," of the ETE Report and the 140 identified in the state plan. Include this information in the ETE Report.**

Estimates for special facilities shall be made with consideration for the means of mobilization of equipment and manpower to aid in evacuation. This would include the need for designated persons to delay their evacuation in order to shut down industrial facilities. Each special facility shall be treated on an individual basis. Weather conditions and time of day conditions shall be considered. Consideration shall be given to the impact of peak populations, including behavioral aspects.

[**Reviewer's notes:** Special Facility evacuations that take more than one trip may be subject to slower return speeds and or exit speeds based on roadway congestion. See the "Reviewer's note" for II.C "Special Facility Population" above.]

a. Comment: Section 8.4, "Evacuation Time Estimates for Transit-Dependent People," describes the resources and activities considered in development of the ETE for the school population. Loading time distributions for school and special facility analyses included mobilization of resources and considers the traffic on the roadway at the time that these facilities begin entering the network. Table 8-6.A, "School Evacuation Time Estimates – Good Weather," provides the ETE for each school on an individual basis. Table 8-5.B, "School Evacuation Time Estimates – Rain," provides the ETE under adverse weather conditions. The ETE for this population group does not exceed the ETE for the general

population. Section 8.4 explains that the Appoquinimink School District in Delaware and Salem City Schools in New Jersey do not have sufficient bus resources to evacuate school children in a single wave. It is assumed these schools will be assisted through a Memoranda of Understanding and Mutual Aid Agreements outlined in the State of New Jersey Radiological Emergency Response Plans. The State of Delaware Radiological Emergency Plan identifies a Mutual Aid Agreement with the State of New Jersey and other states adjacent to Delaware. In **RAI ETE-8**, staff requested information regarding whether the mobilization time is the same for buses deployed under the MOU. **[Response]**

A list of special facilities is provided in Table 8-4, "Special Facility Transit Demand." The capacity, current census and types of resource required for residents is provided. Section 8.4 describes the bus operations and logistics as similar to those for school evacuations except that buses are assigned 30 patients to accommodate staff and the passenger loading time is longer. The bus mobilization time, loading time, and travel time are added and an ETE of 3 hours 35 minutes is provided, which is less than the ETE for the general public.

Section 8.6, "Correctional Facilities," identifies two correctional facilities within the EPZ. These facilities are located near each other as indicated on Figure E-2, "Day Care Centers, Medical Facilities, and Correctional Facilities within the PSEG Site EPZ." Both facilities are located immediately beyond the 10 mile boundary, but are within Delaware ERPA B. Section 8.6 states that Standard Operating Procedure 1000-D of the Delaware Radiological Emergency Plan identifies shelter in place as the protective action for these facilities, and this protective action was confirmed in discussions with the Delaware Emergency Management Agency.

b. **RAI ETE-8:** Section 8.4, "Evacuation Time Estimate for Transit Dependent People," explains that the Appoquinimink School District and Salem City Schools do not have sufficient bus resources to evacuate school children in a single wave, and these schools will be assisted through a Memoranda of Understanding (MOU) and Mutual Aid Agreements outlined in the State of New Jersey Radiological Emergency Response Plan. **Explain whether the mobilization time for buses deployed under the MOU is the same as the time for buses that are notified directly. Include this information in the ETE Report.**

All of the results shall be reported in the format previously indicated. This format summarizes the maximum times for each component and for each sector. The components may, or may not, be directly additive, based on the methodology used (and stated) in the report. Where distribution functions are used, the percentage of the population as a function of time should be reported [see Figure 4 in App. 4 of NUREG-0654].

a. Comment: The PSEG ETEs are provided for 15 scenarios and 17 regions in Table 7-1D, "Time to Clear the Indicated Area of *100* Percent of the Affected Population," in an appropriate format. Table 7-1D includes ETEs for good weather, rain and snow and includes ETEs for seasonal and various times of day. Table 7-1C, "Time to

Clear the Indicated Area of *100* Percent of the Affected Population," shows that the time to evacuate the 5 mile ring is less than the time to evacuate the 2 mile ring. In **RAI ETE-9**, staff requested additional information regarding the evacuation time difference between Region 01 and Region 02. **[Response]**

Maximum ETEs are provided for special facilities and schools in Section 8, including the assessment of second waves of evacuation when necessary. The evacuation times for these population groups do not exceed the ETE for the general population.

b. **RAI ETE-9:** Table 7-1C, "Time to Clear the Indicated Area of *100* Percent of the Affected Population," shows that the time to evacuate the 5 mile area is less than the time to evacuate the 2 mile area. **Explain why the time to evacuate the 2 mile area is less than the time to evacuate the 5 mile area. Include this information in the ETE report.**

13.3C.18.6 Other Requirements

V.A. The time required for confirmation of evacuation shall be estimated. Candidate methods include visual confirmation by aircraft or ground vehicles, and telephone confirmation.

a. Comment: Section 12, "Confirmation Time," describes the use of stratified random sample and a telephone survey to confirm the evacuation is complete. Section 12 explains that the confirmation process should start approximately 3 hours after the advisory to evacuate, which is when 90 percent of evacuees would be expected to have completed their mobilization activities. Section 12 states that approximately 7.5 man hours are needed to complete the survey and this could be completed in about 75 minutes if 6 individuals were assigned to the task.

b. **RAI**: No RAIs identified.

V.B. Specific recommendations for actions that could be taken to significantly improve evacuation time shall be given. Where significant costs may be involved, preliminary estimates of the cost of implementing these recommendations shall be given.

[**Reviewer's note**: ETE enhancements are expected to focus on identification of potential methods that would increase existing roadway capacity, intersection through put, etc. Examples of enhancements would include, implementation of traffic control plans that may restrict normal turn lanes in efforts to move more capacity, converting a roadway that is normally one lane in each direction to both lanes in one direction, etc. Although any changes would likely include some cost, which would need to be addressed, the reference to "significant costs" is not intended to imply an ETE enhancement should be something on the order of adding additional travel lanes to the current evacuation roadway.

a. Comment: A sensitivity study was provided in the ETE Report and quantifies the effect on the ETE if an additional lane were added to the site access road. Appendix I, "Evacuation Sensitivity Studies," explains that an ETE was calculated assuming that an additional travel lane would be added to the existing site access road. An analysis was run for the peak construction scenario and the results showed that there was no effect on the ETE.

Section 13, "Observations," explains that examination of the general population ETEs shows that the ETE for 100 percent of the population is generally 3 to 3.5 hours longer than the ETE for the 90 percent population. This time difference is due to the lengthy time that residents expect it will take to pack, secure the home, and ready themselves to evacuate. It is suggested that public outreach should emphasize the need for evacuees to minimize the time needed to prepare to evacuate.

b. **RAI**: No RAIs identified.

Documentation of the review of the recommendations/enhancements with local stakeholders should be documented in the ETE report or describe how the review was documented and where that documentation is located.]

a. Comment: Section 1.1, "Overview of the ETE Process," states that local and state police should review all traffic control plans and Section 13, "Observations," states that the traffic management plan should be reviewed by state and county emergency planners with local and state police. Appendix G, "Traffic Management Plan," identifies intersections where traffic control would be beneficial in the evacuation. Appendix G explains that the State of New Jersey and State of Delaware have existing traffic control plans which would be used in the event of an evacuation. Appendix G also suggests the traffic management plan should be reviewed by state and county emergency planners with local and state police. Additional information was requested in **RAI ETE-10** regarding whether the ETE study has been reviewed by local stakeholders and whether comments received have been addressed. **[Response]**

b. **RAI ETE-10:** Section 1.1, "Overview of the ETE Process," states that local and state police *should* review all traffic control plans. **Explain whether the ETE study has been reviewed by local stakeholders and whether comments received have been addressed. Include this information in the ETE study.**

A review of the draft submittal by the principal (state and local) organizations involved in emergency response for the site shall be solicited, with comments resulting from the review included with the submittal.

a. Comment: Section 1.1, "Overview of the ETE Process," states that local and state police should review all traffic control plans and Section 13, "Observations," states that the traffic management plan should be reviewed by state and county emergency planners with local and state police. Additional information was requested in **RAI ETE-10** regarding whether the ETE study has been reviewed by local stakeholders and whether comments received have been addressed. **[Response]**

b. **RAI**: **Refer to RAI ETE-10.**

13.3C.18.7 Conclusions

[**Reviewer's Note**: Conclusions are not required to be placed within the Template. However, this information should be captured by the reviewer in the SER.]

[1] Transportation Research Board (2000). "Highway Capacity Manual," National Research Council, Washington D.C. (TRB, 2000).

[2] NUREG/CR-4873, "Benchmark Study of the IDYNEV Evacuation Time Estimate Computer Code."

[3] NUREG/CR-4874, "The Sensitivity of Evacuation Time Estimates to Changes in Input Parameters for the IDYNEV Computer Code."

[4] Agarwal, M., et. al. "Impacts of Weather on Urban Freeway Traffic Flow Characteristics and Facility Capacity." 2005 Mid-Continent Transportation Research Symposium. August 2005. (Agarwal, 2005).