

Bruce Musico

From: Keller, Tonya K [Tonya.Keller@pnl.gov]
Sent: Thursday, February 12, 2009 7:06 PM
To: Elinor Cunningham; Bruce Musico; Annette Stang
Cc: Hickey, Eva E; Davis, Adam J; Keller, Tonya K
Subject: JCN Q4007, Task 12, Rev Subtask 4 - North Anna ETE
Attachments: Q4007 T12 Rev Sbt4, Revised Draft TER.pdf

Elinor,

Attached is a revised draft of the TER for North Anna ETE, under JCN Q4007, Task 12, Subtask 4.

Please let me know if you have any questions.

Thanks,

Tonya Keller

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Energy and Environment Directorate

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Pacific Northwest National Laboratory

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February 11, 2009

Ms. Elinor M. Cunningham, Technical Assistance Project Manager
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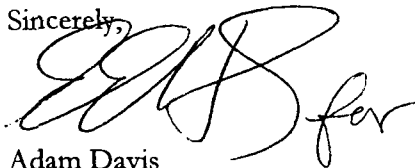
Dear Ms. Cunningham:

Subject: JCN Q-4007, Task 12, Revised Subtask 4, "Technical Assistance in the Review of the Evacuation Time Estimate (ETE) Analysis for North Anna Unit 3 COLA"

Attached is the deliverable for Subtask 4, a draft of the Technical Evaluation Report as revised to reflect the applicant's responses to RAIs.

If you have any questions or comments, please contact Adam Davis at 509-375-2032 or Eva Eckert Hickey at 509-375-2065.

Sincerely,



Adam Davis
Project Team Lead
Radiological Science and Engineering Group
ENVIRONMENT & ENERGY DIRECTORATE

AJD:ll

Attachment

Cc: Bruce Musico
Annette Stang
Eva Hickey

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13.3.1B.R Evacuation Time Estimate (ETE) Analysis

The North Anna Power Station Emergency Response Plan (NAPS Emergency Plan) includes an analysis of the time required to evacuate the plume exposure pathway emergency planning zone (EPZ) and for taking other protective actions for various sectors and distances within the plume exposure pathway EPZ for transient and permanent populations. The report titled "North Anna Power Station Development of Evacuation Time Estimates," dated October 2007, (ETE Report) was provided as a separate document in the COL application, but it is considered to be part of the NAPS Emergency Plan and summarized in the NAPS Emergency Plan in Appendix 4, "Evacuation Time Estimate (Summary)." The ETE Report and the associated Requests for Additional Information (RAI) responses provide the basis for the following discussion and analyses. Textual revisions, corrections, or additions to the ETE report resulting from this review were submitted in September 2008 as Rev. 1 of the ETE report

The staff reviewed the ETE Report against current NRC requirements and guidance for consistency with other parts of the COL Application, including the Final Safety Analysis Report (FSAR). Citations in the report were verified by comparison to the cited document text. General descriptions of the NAPS region, population, and highways were verified using internet searches and aerial photographs. *The designated evacuation routes were driven to observe any impediments to evacuation, shoulder and lane width, and general road condition.*

13.3.1B.R.1 Regulatory Basis for the ETE Analysis

The staff considered the following regulatory requirements and guidance in the review of the evacuation time estimate analysis:

[10 CFR 52.79(a)(21) refers to Appendix E to 10 CFR 50] Section IV. "Content of Emergency Plans," of Appendix E to 10 CFR 50 requires that the nuclear power reactor operating license applicant provide an analysis of the time required to evacuate and for taking other protective actions for various sectors and distances within the plume exposure pathway EPZ for transient and permanent populations.

The staff evaluated the ETE Report against Appendix 4, "Evacuation Time Estimates within the Plume Exposure Pathway Emergency Planning Zone," to NUREG-0654/FEMA-REP-1. Appendix 4 contains detailed guidance that the staff used in determining whether the ETE analysis meets the applicable regulatory requirements in Appendix E to 10 CFR 50.

13.3.1B.R.2 Introductory Materials [10 CFR 50, Appendix E.IV and NUREG-0654, Appendix 4.I]

13.3.1B.R.2.1 Technical Information in Introductory Materials

Section 1, "Introduction," provides a basic description of the process used to estimate the evacuation times. A simple description, with map (Figure 1-1, "North Anna Power Station Site Location"), of the plume exposure pathway EPZ and surrounding area is provided. In **RAI ETE-2** the staff requested surrounding communities be included in Figure 1-1 as stated in the text. The applicant responded by revising the text in Section 1.2 "North Anna Power Station Site Location", with the following statement: "Figure 1-1 displays the area surrounding the North Anna Power Station site including all counties, the major roads and the site location relative to the City of Richmond. A Map showing all communities is shown in Figure 3-1." Figure 3-1 was also revised to include names of communities. The staff requested a detailed map which identifies transportation

networks, topographical features (including elevations), and political boundaries be provided in **RAI ETE-3**. The applicant responded that revised Figure 3-1 and the maps in Section 10 will fulfill the requirements in the guidance. In **RAI ETE-4** the staff also requested clarification for the text in Section J.10.a of the Emergency Plan regarding radiological monitoring locations being included in Figure 3-1 of Appendix 4 of the Emergency Plan. The applicant responded that radiological monitoring locations will be added as Figure II-5. Section J.10.a will also be revised to indicate that evacuation routes, evacuation areas, and locations of assembly areas are presented in Figures 10-1 through 10-4 of the ETE report.

Section 2, "Study Estimates and Assumptions," provides the basis for the population data estimates used in the ETE. Population estimates are based upon GIS shapefiles, address points within each county of the plume exposure pathway EPZ, provided by the Virginia Department of Emergency management. Additional information was requested in **RAI ETE-1(B)** to explain whether population growth was considered beyond 2008. The applicant responded that projections beyond 2008 only had to be made in cases where large population increases are expected. In this case the ETE would be updated. Estimates of employees who commute into the plume exposure pathway EPZ to work are based upon employment data obtained from major employers by Dominion Generation. Population estimates at special facilities are based on available data from county emergency management offices. Auto occupancy factors are based on a statistical analysis of data acquired from a telephone survey.

Additional assumptions regarding the development of population estimates, including pass-through populations and regional employees, are provided in Section 3, "Demand Estimation," and Appendix E, "Special Facility Data." Assumptions about transit-dependent and special populations are in Section 8, "Transit-Dependent and Special Facility Evacuation Time Estimates," and Appendix E. Development of trip generation times from survey responses is described in Section 5, "Estimation of Trip Generation Times."

Twelve study assumptions used as the basis for the ETE report are provided in Section 2.3, "Study Assumptions." The study assumes that everyone will evacuate according to assigned routes. Schools are to be notified in advance of the general population and are given priority for use of transportation resources. Additional information was requested in **RAI ETE-6(A)** with regard to the notification of schools. The applicant responded by removing Assumption 3.a which stated schools would be evacuate prior to notification of the general public. Buses not being used for school evacuation will be used to transport those without access to private vehicles. Fifty-percent of these people are assumed to ride-share with neighbors or friends. Traffic control points and access control points will be establish to aid the flow of traffic out of the plume exposure pathway EPZ. Additional information was requested in **RAI ETE-7** to determine what affect traffic control will have on evacuation time. The applicants clarified that the ETEs do not rely on traffic control points to be manned. Roadway capacity based on methods in Section 4 and survey data was used in the development of the evacuation estimates. Traffic control points could be used to facilitate the movement of traffic and serve as a surveillance point to identify any problems. Voluntary and shadow evacuations are considered as a potential impediment to overall evacuation. Additional information regarding Figure 2-1, "Voluntary Evacuation Methodology," depicting shadow and voluntary evacuation was requested in **RAI ETE-8**. The applicant provided clarification of Figure 2-1 regarding assumption #5. Adverse weather is also considered as part of

this study. Additional information regarding the use of rain and not snow for adverse weather scenarios was requested in **RAI ETE-10**. In response the applicant has revised the ETE to include scenarios that account for snow. A list of affected tables, sections, and figures was provided.

An outline of the approach to estimating evacuation times is presented; with a link-node map (Figure 1-2, "North Anna Link-Node Analysis Network") of the highway network developed through the use of GIS mapping software and field observations. Details of the link-node map are presented in Appendix K, "Evacuation Roadway Network Characteristics." The IDYNEV System was used to analyze the highway network to determine routes used for evacuation and estimate evacuation times. A description of the IDYNEV System and associated sub-models is provided in Section 1.3, "Preliminary Activities." The IDYNEV system consists of several submodels - a macroscopic traffic simulation model, an intersection capacity model, and a dynamic, node-centric routing model that adjusts the "base" routing in the event of an imbalance in the levels of congestion on the outbound links. Another model of the IDYNEV System is the traffic assignment and distribution model, which model integrates an equilibrium assignment model with a trip distribution algorithm to compute origin-destination volumes and paths of travel designed to minimize travel time. Additional information was requested in **RAI ETE-44** regarding the use of computer models to identify bottlenecks in traffic flow and initiating countermeasures. The applicant provided clarification for RAI ETE-44.

A discussion of algorithms used is provided in detail in Section 4, "Estimation of Highway Capacity." Additional information on algorithms used in the estimations was requested in **RAIs ETE-11(A-E)**. The applicant provided clarification for RAIs ETE-11(B), ETE-11(D) and ETE-11(E). The applicant also provided references and clarification for RAIs ETE-11(A) and ETE-11(C).

Further details on the use of traffic models is provided in Appendix C, "Traffic Simulation Model: PC-DYNEV," and Appendix D, "Description of Study Procedure." Because this ETE study supersedes an earlier study performed in 2001 for the existing reactors at the NAPS site, a list of differences in the approaches is provided in Section 1.4, "Comparison with Prior ETE Study."

13.3.1B.R.2.2 Technical Evaluation of Introductory Materials

The ETE Report includes a map showing the proposed site and plume exposure pathway EPZ, as well as transportation networks, topographical features, and political boundaries. The boundaries of the EPZ, in addition to the evacuation subareas within the EPZ, are based on factors such as current and projected demography, topography, land characteristics, access routes, and jurisdictional boundaries.

The ETE Report describes the method of analyzing the evacuation times. A general description of the evacuation model was provided including the assumptions used in the evacuation time estimate analysis.

The staff finds the clarifications provide for RAIs **ETE-1(B)**, **ETE-7**, **ETE-8**, **ETE-11(A-E)**, and **ETE-44** to be acceptable. The staff finds the textual revisions provided in response to RAIs **ETE-2**, **ETE-3**, **ETE-4**, **ETE-6(A)**, and **ETE-10**, to be acceptable. Textual revisions were provided in the applicants September 2008 submittal of Revision 1 of the ETE report.

13.3.1B.R.3 Demand Estimation [10 CFR 50, Appendix E.IV and NUREG-0654, Appendix 4.II]

13.3.1B.R.3.1 Technical Information Related to Demand Estimation

Section 3, "Demand Estimation," states the primary source of population estimates was the 2000 Census. Based on information obtained in a telephone survey, the permanent resident average household size is estimated at 2.57 persons per household with 1.42 vehicles per household. In **RAI ETE-12** the staff requested additional information regarding population estimates by zip code used in the telephone survey (Table F-1, "Survey Sampling Plan,") that did not agree with previous estimates. In response the applicant has revised Table F-1 to show the EPZ population that is within each zip code. GIS shapefiles were used to determine the number of address points in each county. Additional information was requested in **RAIs ETE-1 (C)(D)(E)** regarding the use of GIS Shapefiles. In response the applicant provided an explanation for the use of GIS Shapefiles. These address points were multiplied by 2.57 to determine the population for each county. Based on this estimation, the population in the plume exposure pathway EPZ was predicted to increase from 20, 292 to 33, 423 people. Shapefiles were not available for Caroline County so a growth rate of 3.3%, obtained from the U.S. Census, was applied to project the population out to 2008. Additional information was requested in **RAI ETE-1 (A)** to resolve differences in population estimates between the ETE and the Environmental Report (ER). The applicant responded that the plume exposure pathway EPZ extended beyond the 10-mile radius used in the FEIS including more people. The ETE methodological approach also included vacation homes and small businesses making the estimate higher thus more conservative. Table 3-1, "Permanent Resident Population by [Protective Action Zone] PAZ," lists the 2008 projected population and their associated vehicles. In **RAI ETE-5** the staff requested clarification for the numbering of PAZs in Figure 3-1 that excluded PAZ 1. The applicant provided clarification for RAI ETE-5.

The transient population is defined as those people that are not permanent residents that enter the plume exposure pathway EPZ for a specific purpose. The transient population includes visitors to Lake Anna State Park, surrounding campgrounds, boating facilities, and lodging facilities. Average peak attendance and vehicle occupancy factors are provided for each area. In total, the report estimates that 3,578 transients and 1,489 vehicles are expected to enter the plume exposure pathway EPZ on a given day. This data is presented by PAZ in Table 3-2, "Summary of Transient by PAZ." In **RAIs ETE-17 and ETE-18** the staff requested additional information regarding difference in transient population estimates between the ETE and the Final Environmental Impact Statement for the Early Site Permit (FEIS) presented in Table 3-2. In response the applicant revised Table 3-2 to reflect population estimates provided in the FEIS. Subsequent revisions were also made in Sections 3, 5, 6, Appendix I, and Appendix J to reflect this change. Estimates of the transient population and their vehicles are presented by polar coordinate representation in Figures 3-4, "Transient Population by Sector," and Figure 3-5, "Transient Vehicles by Sector."

Employees who commute to jobs within the EPZ are assumed to evacuate along with the permanent resident and transient populations. Only three major employers, North Anna Power Station, Impac Klearfold, and Trim-Dim Filters, are within the plume exposure pathway EPZ. Vehicle occupancy of 1.03, based on the telephone survey, was used for the employee population. Estimates of the employee population and their

vehicles are presented by polar coordinate representation in Figures 3-6, "Employee Population by Sector," and Figure 3-7, "Employee Vehicles by Sector." In **RAIs ETE-21** and **ETE-22** the staff requested clarification on the estimation of the employee population with regards to FEIS estimates and small businesses. The applicant provided clarification to reconcile differences in employee population estimates between the two documents. The applicant stated that small business owners were considered in the estimation of the permanent population. Additional information on Major Employer employee estimates is provided on page E-5 Appendix E, Special Facility Data." Physical locations of the Facilities are provided in Figures E-1, "North Anna Power Station Major Employers."

Two special event scenarios, Scenarios 11 and 12 are included in the estimation of evacuation times. Scenario 11 represents the construction period for Unit 3 during a typical summer, midweek, midday, under good weather conditions. The construction period is estimated by Dominion to begin in 2011 and run through 2014. Workers are expected to travel into the plume exposure pathway EPZ from neighboring cities and work from 7:00 am till 5:00pm. An estimated 3,000 workers using 2,913 vehicles (vehicle occupancy of 1.03) are expected to enter the plume exposure pathway EPZ during this time. Scenario 12 represents the operation of Unit 3 with refueling during a typical summer, midweek, midday, under good weather conditions. An additional 500 workers were included in the estimate during the refueling process. Population estimates for permanent residents and transients were extrapolated out to 2013 for both scenarios. In **RAI ETE-9** the staff requested additional information regarding the use of peak transient populations as a special scenario. The applicant responded that the sensitivity study in Appendix I showed that increasing the transient population in Lake Anna State Park had little effect on evacuation times. The transient influx is variable depending on weather making it impossible to predict the outcome. Memorial Day weekend usually initiates the period of transient influx but the average transient population remains consistent through Labor Day. Additional information on transient facility population estimates is provided on page E-7, E-9, and E-11 of Appendix E, Special Facility Data." Physical locations of the Facilities are provided in Figures E-2, "North Anna Power Station Recreational Areas," Figure E-3, "North Anna Power Station Lodging Facilities," and Figure E-4, "North Anna Power Station Marinas & Boat Launches."

Permanent residents, transients, and employees make up the general population. Vehicles traveling through the EPZ (external-external trips) at the time of an accident are assumed to continue to enter the EPZ during the first 90 minutes at a rate of 300 vehicles per lane per hour (6000 vehicles total). Subsequently none enter and those remaining also evacuate with the general population.

Population Estimates for special facilities and people without personal vehicles are provided in Section 8, "Transit-Dependent and Special Facility Evacuation Time Estimates." The report indicates the only special facilities in the plume exposure pathway EPZ are a preschool, 3 elementary schools, 2 middle schools, and 2 high schools. The plume exposure pathway EPZ does not contain any hospitals, jails, or other special care facilities. The estimated student population and their transportation needs, based on student to bus ratios, are provided in Table 8-2, "School Population Demand Estimates." Additional information regarding the estimation of school children in each household presented in Figure F-5, "School Children in Households," was requested in **RAI ETE-37**. In response the applicant revised Figure F-5. Additional

information on school populations estimates is provided on page E-2 of Appendix E, Special Facility Data.”

Telephone survey results (reported in Appendix F, “Telephone Survey”) are used to estimate the portion of the population requiring transit service, including persons in households that do not have a vehicle and persons in households whose vehicles would not be available at the time the evacuation is ordered for commuter use. In **RAI ETE-15** the staff requested clarification of equations used to estimate the transit-dependent population. In response the applicant provided clarification for the equation. In **RAIs ETE-13 and ETE-23** the staff requested additional information regarding population groups that make up the transit dependent population. Specifically, if transients, employees, or special needs people are factored into the estimate. In response to special needs individuals, the applicant clarified that special needs individuals are addressed in the county plans. The ETE concluded their time to evacuate lies within that identified in Tables 7-1A through 7-1D. In response to transients and employees, the applicant revised the first paragraph in Section 8 to read, “This section details the analysis and the results obtained in the form of evacuation time estimates for transit vehicle (buses). The demand for transit service reflects the needs of two population groups: (1) resident with no vehicles available; and (2) residents of special facilities such as schools and child-care facilities.” The study assumes that 50% of the transit-dependent population will ride-share with neighbors. According to Table 8-1, “Transit Dependent Population Estimates,” a residual 478 people will require transportation assistance.

The estimated number of evacuees and their vehicles is discussed in Section 6, “Demand Estimation for Evacuation Scenarios.” Evacuation will be performed by regions that include multiple PAZs. A scenario is defined as a combination of circumstances, including time of day, day of week, season, and weather conditions. Scenarios define the number of people in each of the affected population groups and their respective mobilization time distributions. A region is defined as a grouping of contiguous evacuation PAZs, which forms either a “keyhole” sector-based area, or a circular area within the plume exposure pathway EPZ. A total of 12 scenarios and 27 regions are defined. The NAPS plume exposure pathway EPZ has been defined to contain 25 PAZs. The boundary definitions are provided in Appendix L, “Protective Action Zone Boundaries.” A description of the evacuation regions and their associated PAZs can be found in Table 6-1, “Description of Evacuation Regions.” A map of the orientation of PAZs within the plume exposure pathway EPZ is provided in Figure 6-1, “NAPS Protective Action Zones.” Physical boundaries of each PAZ are detailed in Appendix L, “Protective Action Zone Boundaries.” Additional information was requested in **RAI ETE-38** regarding voluntary evacuees in Table 6-3, “Percent of Population Groups Evacuating for Various Scenarios” (page 6-5). The applicant provided clarification for RAI ETE-38.

13.3.1B.R.3.2 Technical Evaluation of Information Related to Demand Estimation

The ETE Report provides an estimate of the number of people who may need to evacuate. Three population segments are considered: permanent residents, transients, and persons in special facilities. The permanent population is adjusted for growth, and the population data is translated into two groups: those using automobiles and those without automobiles. The number of vehicles used by permanent residents is estimated using an appropriate automobile occupancy factor. In addition, evacuation time

estimates for simultaneous evacuation of the entire plume exposure pathway EPZ were determined.

Estimates of transient populations are developed using local data including peak tourist volumes and employment data. Estimates for special facility populations are also provided.

The subareas, for which evacuation time estimates were determined, encompass the entire area within the plume exposure EPZ. The maps are generally adequate for the purpose, and the level of detail is approximately the same as United States Geological Survey (USGS) quadrant maps. The assumptions on evacuation are based on simultaneous evacuation of inner and outer sectors.

The staff finds the clarifications provide for RAIs **ETE-1(A)(C)(D)(E)**, **ETE-5**, **ETE-9**, **ETE-13**, **ETE-15**, **ETE-21**, **ETE-22**, and **ETE-38** to be acceptable. The staff finds the textual revisions provided in response to **RAIs ETE-12**, **ETE-17**, **ETE-18**, **ETE-23**, and **ETE-37**, to be acceptable. Textual revisions were provided in the applicants September 2008 submittal of Revision 1 of the ETE report.

13.3.1B.R.4 Traffic Capacity [10 CFR 50, Appendix E.IV and NUREG-0654, Appendix 4.III]

13.3.1B.R.4.1 Technical Information Related to Traffic Capacity

Section 4, "Estimation of Highway Capacity," describes estimation of highway capacity. The methods used are generally taken from the Highway Capacity Manual published by the Transportation Research Board of the National Research Council. A map of the transportation network is provided in Figure 1-2, "North Anna Link-Node Analysis Network." Appendix K, "Evacuation Roadway Network Characteristics," identifies all evacuation route segments and their characteristics, including capacity. The staff requested additional information for Figure 1-2 that would include a cross-reference to Appendix K in **RAI ETE-28 (A)**. In response to RAI ETE-28(A) the applicant revised Figure 1-2 to include references to Appendix K. Additional information describing the road network used for evacuation routes was requested in **RAI ETE-28 (B-G)**. The applicant provided clarification for RAIs ETE-28 (B-G). In **RAIs ETE-33 (A-C)** the staff requested additional information regarding unusual roadway characteristic and highway lane widths. The applicant provided clarification for RAI ETE-33.

Section 9, "Traffic Management Strategy," presents a traffic control and management strategy that is designed to expedite the movement of evacuating traffic. The traffic management strategy is based on a field survey of critical locations and consultation with emergency management and enforcement personnel. Appendix G, "Traffic Management," provides a description of Traffic control Points (TCPs) and Access control Points (ACPs) and provides maps of their location within the plume exposure pathway EPZ (FigureG-1, "North Anna Power Station Traffic Control Points" and figure G-2, "North Anna Power Station Access Control Points"). Additional information regarding the use of the traffic management strategy was requested in **RAI ETE-30**. The applicant provided clarification for RAI ETE-30.

Section 10, "Evacuation Routes," illustrates the emergency evacuation routes for the four counties surrounding the VCSNS site. Evacuation routes provide for evacuation first

to the EPZ boundary and then to reception centers. The TRAD model was used to determine routes that would minimize exposure to risk by balancing traffic demand relative to road capacity. Evacuation routes were also developed to minimize travel outside the EPZ and relate traffic volume to reception center capacity. Section 7.2, "Patterns of Congestion," identifies areas of traffic congestion that arise for the case when the entire EPZ (Region R3) is advised to evacuate during the summer, weekend, and midday period under good weather conditions, in Figures 7-3, "Congestion Patterns at 1 Hour after the Evacuation Advisory," Figures 7-4, "Congestion Patterns at 2 Hours after the Evacuation Advisory," Figures 7-5, "Congestion Patterns at 3 Hours after the Evacuation Advisory," and Figure 7-6, "Congestion Patterns at 3 Hours and 30 Minutes after the Evacuation Advisory." Additional information regarding congestion points and bottlenecks depicted in figures 7-3 through 7-6 was requested in **RAIs ETE-32 and ETE-39**. In response the applicant added a table to Page 7-7 that identifies the location of the congestion paths shown in Figures 7-3 through 7-6. These figures have also been revised to include location numbers that can be cross referenced with the new table.

13.3.1B.R.4.2 Technical Evaluation of Information Related to Traffic Capacity

The ETE Report provides a complete review of the evacuation road network. Analyses are made of travel times and potential locations for congestion. The evacuation time estimates are not dependent on the establishment of traffic control points and access control points. Therefore, manpower and equipment shortages have no effect on the evacuation time estimate calculations. In addition, all evacuation route segments and their characteristics, including capacity are described.

A traffic control and management strategy that is designed to expedite the movement of evacuating traffic is described. The traffic management strategy is based on a field survey of critical locations and consultation with emergency management and enforcement personnel. The applicant also analyzed travel times and potential locations for serious congestion along the evacuation routes.

The staff finds the clarifications provide for RAIs **ETE-28(B-G)**, **ETE-30**, and **ETE-33(A-C)**, to be acceptable. The staff finds the textual revisions provided in response to RAIs **ETE-28(A)**, **ETE-32**, and **ETE-39**, to be acceptable. Textual revisions were provided in the applicants September 2008 submittal of Revision 1 of the ETE report.

13.3.1B.R.5 Analysis of Evacuation Times [10 CFR 50, Appendix E.IV and NUREG-0654, Appendix 4.IV]

13.3.1B.R.5.1 Technical Information Related to Analysis of Evacuation Times

Sections 4, 5, and 6 of the ETE Report describe the methods used to estimate the evacuation times. Section 4, "Estimation of Highway Capacity," describes how data collected during field surveys of the transportation network were combined with methods suggested in the 2000 HCM. Section 5, "Estimation of Trip generation Time," provides estimates of the four different distributions of elapsed times associated with mobilization activities undertaken by the public to prepare for the evacuation trip. The elapsed time associated with each activity is represented as a statistical distribution reflecting differences between members of the public. Additional information regarding evacuation activity distributions was requested in RAIs **ETE-19**, **ETE-20**, **ETE-35**, and **ETE-36**. The applicant provided clarification for RAIs ETE-19, ETE-20, and ETE-35. In Response to RAI ETE-36 the applicant revised Table 5-6 to include correct values for cumulative percentages of employees evacuating at 65 minutes. The quantification of these

activity-based distributions relies largely on the results of a telephone survey contained in Appendix F, "Telephone Survey."

Section 6, "Demand Estimation for Evacuation Scenarios," defines the various evacuation cases for which time estimates were made; a case is a combination of a scenario and a region. A scenario is defined as a combination of circumstances, including time of day, day of week, season, and weather conditions. Scenarios define the number of people in each of the affected population groups and their respective mobilization time distributions. As noted above, a total of 12 scenarios and 27 regions containing 25 PAZs have been defined. The assumptions on evacuation are based on simultaneous evacuation of inner and outer sectors. A description of the evacuation scenarios used for this study can be found in Table 6-2, "Evacuation Scenario Definitions." The percentage of the population groups expected to evacuate for each scenario is described in Table 6-3, "Percentage of Population Groups for Various Scenarios." Additional information on Table 6-3 regarding the shadow population voluntary evacuees and the use of school buses was requested in **RAI ETE-25**. The applicant provided clarification for RAI ETE-25. The number of vehicles expected to be used during evacuation are listed in Table 6-4, "Vehicle Estimates by Scenario."

A summary of the ETE is provided in Section 7, "General Population Evacuation Time Estimates (ETE)." These results cover 27 regions within the NAPS plume exposure pathway EPZ and the 12 evacuation scenarios discussed in Section 6. The evacuation times are presented in Appendix J, "Evacuation Time Estimates for All Evacuation Regions and Scenarios and Evacuation Time Graphs for Region R03, for all Scenarios." Results are presented for 50%, 90%, 95%, and 100% of vehicles. Additional information on separate evacuation times for resident and transients was requested in **RAIs ETE-34**. The applicant provided clarification for RAI ETE-34. Additional information on evacuation times was requested in **RAIs ETE-27**. The applicant provided clarification for RAI ETE-27. Results are provided for good and adverse conditions. Times are reported separately for general population (Section 7 and Appendix J), schools (Section 8), and transit-dependent population (Section 8). The methodology for the general population uses distribution functions; figures describing the time distribution of evacuating vehicles follow the format of NUREG-0654, App. 4, Figure 4. Additional information on the format used to report evacuation times was requested in **RAI ETE-42**. The applicant provided clarification for RAI ETE-42.

A series of sensitivity tests are documented in Appendix I, "Evacuation Sensitivity Studies," regarding the sensitivity of the results to trip generation time (directly related to time-dependent traffic loading) and to the amount of shadow evacuation. Additional information was requested in **RAI ETE-26** to clarify assumptions regarding the size of the "shadow" population that is expected to evacuate and the numbers of vehicles that were proposed to be used. The applicant responded Table I-2 contained incorrect values and was revised to contain correct values. The shadow population was estimated the same as the resident population (GIS shapefiles and 2.57 people per household) resulting in a total of 34,028.

Section 8, "Transit-Dependent and Special Facility Evacuation Time Estimates," discusses evacuation plans for schools, residents without vehicles, and special care facilities. These groups are expected to merge with general evacuation traffic following notification and mobilization. Additional information on mobilization of buses was

requested in **RAI ETE-6**. The applicant provided clarification for RAI ETE-6. Separate estimates of population size and necessary transportation were made for schools, special facilities and the transit-dependent populations.

Schools are to be given priority for transportation resources (buses) and advanced notification, if possible, in order to determine transportation needs. Transportation resources should be adequate to evacuate schools in one wave. In the event of a shortfall, buses are expected to return for a second wave. Additional information regarding evacuation resources and evacuation waves was requested in **RAIs ETE-16 and ETE-41**. The applicant provided clarification for RAIs ETE-16 and ETE-41. Mobilization of drivers and students has been built into the total evacuation times. Additional information regarding loading of buses was requested in **RAI ETE-24**. The applicant provided clarification for RAI ETE-24.

Remaining transportation resources and those that become available following the evacuation of schools will be used to evacuate the portion of the population without vehicles. The report estimates 478 people needing transportation can be evacuated in 16 bus runs. These individuals will be picked up along routes depicted in Figure 8-2, "Proposed Transit Dependent Bus Routes." Additional information regarding how transit dependent people will get to proposed bus routes was requested in **RAIs ETE-14**. The applicant provided clarification for RAIs ETE-14. Additional information was also requested in **RAIs ETE-29 and ETE-40** regarding bus stops and travel times. The applicant provided clarification for RAIs ETE-29 and ETE-40.

13.3.1B.R.5.2 Technical Evaluation of Information Related to Evacuation Times

A total of 324 evacuation time estimates are computed for the evacuation of the general public. Each evacuation time estimate quantifies the aggregate evacuation time estimated for the population within one of the 27 Evacuation Regions to completely evacuate from that Region, under the circumstances defined for one of twelve Evacuation Scenarios ($27 \times 12 = 324$). Separate evacuation time estimates are calculated for transit-dependent evacuees, including school children. An acceptable variant of the NUREG-0654 format is used for the presentation of the evacuation times in Appendix J.

Distribution functions for notification of the various categories of evacuees were 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 population, and transit-dependent populations. These times are combined to form the trip generation distributions.

There are separate distributions for auto-owning households, school population, and transit-dependent populations.

On-road travel and delay times are calculated. An estimate of the time required to evacuate a particular segment of the non-auto-owning population dependent upon public transportation is developed, in a manner similar to that used for the auto-owning population.

The staff finds the clarifications provide for RAIs **ETE-6, ETE-14, ETE-16, ETE-19, ETE-20, ETE-24, ETE-25, ETE-27, ETE-29, ETE-34, ETE-35, ETE-40, ETE-41, and ETE-42**, to be acceptable. The staff finds the textual revisions provided in response to RAIs **ETE-26 and ETE-36**, to be acceptable. Textual revisions were provided in the applicants September 2008 submittal of Revision 1 of the ETE report.

13.3.1B.R.6 Other Requirements [10 CFR 50, Appendix E.IV and NUREG-0654, Appendix 4.V]

13.3.1B.R.6.1 Technical Information Related to Analysis of Other Requirements

Section 12, "Confirmation Time," suggests a possible alternative procedure to confirm that the evacuation process is effective in the sense that the public is complying with the Advisory to Evacuate. The suggested procedure employs a stratified random sample and a telephone survey. Based on calculations it would be necessary to make 300 random phone calls to confirm that 20% of the population has not yet evacuated. It is estimated that this process could be completed within about 75 minutes if six people are assigned to the task. Since confirmation begins three hours after the advisory, confirmation should be made when the evacuation area is clear. If more than 20% of the population is determined to have not yet evacuated, the telephone survey will be repeated after an hour interval until evacuation is complete. Additional information was requested in **RAI ETE-43(A-C)** to confirm the use of this evacuation confirmation plan by surrounding counties; the use of automated dialers; and resources needed to support the confirmation effort. The applicant provided clarification for RAIs ETE43 (A-C).

The development of the ETE Report was coordinated with emergency planners from the State of South Carolina and Fairfield, Lexington, Newberry, and Richland County who are involved in emergency response for the site. In **RAI ETE-31 and ETE-45** information was requested regarding the review of the ETE Report by state and local organizations involved with emergency response and whether their comments had been included in the ETE Report. The applicant provided clarification for RAI ETE-31. In Response to RAI ETE-45 the ETE was forwarded on two occasions to appropriate state and local authorities. Comments from VDOT with Dominion responses have been provided with response to RAI ETE-45. The applicant stated that there are no non-concurring agencies.

13.3.1B.R.6.2 Technical Evaluation of Information Related to Other Requirements

The time required for confirmation of evacuation was estimated. In addition, the development of the ETE Report was coordinated with emergency planners from the Commonwealth of Virginia, Louisa, Spotsylvania, Orange, Hanover, and Caroline Counties who are involved in emergency response for the site.

The staff finds the clarifications provide for RAIs **ETE-31, ETE-43(A-C), and ETE-45**, to be acceptable.

13.3.1B.R.7 Conclusion for the NAPS ETE Report

On the basis of its review of the onsite emergency plan as described above, the NRC staff concludes that the information provided in the report titled "North Anna Power Station Development of Evacuation Time Estimates," dated October 2007 and revisions provided in the September 2008 submittal of Rev 1, consistent with those portions of Section 13.3 of NUREG-0800 related to the evacuation time estimate analysis.

Therefore, the ETE Report is acceptable and meets the applicable requirements of 10 CFR 50, Appendix E.IV.