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SCE&G®
A SCANA COMPANY

February 5, 2009
NND-09-0020

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

ATTN: Document Control Desk

Subject: Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3 Combined License Application (COLA) - Docket Numbers 52-027 and 52-028 Response to NRC Request for Additional Information (RAI) Letter No. 013

Reference: Letter from Brian C. Anderson (NRC) to Alfred M. Paglia (SCE&G), Request for Additional Information Letter No. 013 Related to SRP Section 13.03 for the Virgil C. Summer Nuclear Station Units 2 and 3 Combined License Application, dated January 6, 2009.

The enclosure to this letter provides the South Carolina Electric & Gas Company (SCE&G) response to the RAI items included in the above referenced letter. The enclosure also identifies any associated changes that will be incorporated in a future revision of the VCSNS Units 2 and 3 COLA.

Should you have any questions, please contact Mr. Al Paglia by telephone at (803) 345-4191, or by email at apaglia@scana.com.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 5th day of February, 2009.

Sincerely,

Ronald B Clary

Ronald B. Clary
General Manager
New Nuclear Deployment

AMM/RBC/am

Enclosure

D083
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NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-2

ETE-1: Estimated Population Growth

SRP Chapter 13.3, Acceptance Criterion 11

Basis: Regulatory Guide 1.206, Appendix 4 to NUREG-0654 Section II.A

A. Table 1-1, "ETE [Evacuation Time Estimate] Study Comparisons," states the resident population estimated for 2007 is 11,826 people. Estimates made by South Carolina Electric and Gas (SCE&G) in the Environmental Report (ER) Section 2.5.1.1, "Population Data by Sector," and the Final Safety Analysis Report (FSAR) Section 2.1.3.1, "Resident Population within 10 Miles," states the population in 2000 was 12,209 persons (includes 76 transients). This would make the estimate in the ETE for 2007 lower than those in the ER and the FSAR estimated for the year 2000. Clarify which population estimate is correct and provide the correct value in the ETE.

B. Section 3, "Demand Estimation," states that population data were extrapolated out to 2014, which is the year that construction will begin, based on SCE&G plans. The estimated population at the start of construction is not provided in the report. Provide the estimated value of the resident, transient, and shadow populations that were extrapolated to 2014.

C. Note #1 on the bottom of page 3-4 provides the annual population growth rates for each county from 2000 through 2007 as being; Fairfield-3.33%, Richland-8.0%, Newberry-4.67%, and Lexington-11.87%. According to U.S. Census data, the population growth rate for Fairfield County decreased 0.5% and increased by 12% for Richland County between 2000 and 2007. Clarify what data were used to obtain the growth rates shown in Note #1 on page 3-4.

D. Explain the difference between population estimates in county plans and the ETE for the following sections:

1. Section K.5.a, "Evacuation," of the Richland Emergency Response Plan (Sector D-1, 1430 people).
2. Section L.5.a, "Evacuation," of the Lexington County Radiological Emergency Response Plan (Sector D-2, 1,130 people), and the map of the plume exposure pathway Emergency Planning Zone (EPZ) with populations listed by

Sector (same as Protective Action Zones in ETE) in Attachment 12, "Population Distribution." that includes a map of the EPZ with populations listed by Sector (same as PAZs in ETE).

3. Populations for Sectors A, B, and C, listed in Annex Q to the Fairfield County Emergency Operations Plan, "Fixed Nuclear Facility Radiological Response Plan."

4. Attachment 4 to Annex Q, "Population Distribution Map, 10-Mile EPZ, VC Summer Nuclear Station."

VCSNS RESPONSE:

A. The Environmental Report (ER) section 2.5.1.1, "Population Data by Sector," uses a 10 mile radius centered at the midpoint of the proposed new units (Units 2 and 3) at the VCSNS site. The ETE report, however, uses a 10 mile radius centered at the existing unit (Unit 1) at the VCSNS site. The ETE only reports the population within the 13 Protective Area Zones (PAZ) which in aggregate comprise the EPZ. The existing EPZ was defined using Unit 1 as the centerpoint. Considering the ETE focuses on the EPZ population as opposed to the 10-mile population, the use of Unit 1 as the centerpoint was deemed appropriate. As shown in Figure 3-1 of the ETE report, there are several areas within 10 miles that are not within the EPZ (i.e. to the east of PAZ B-2). There are also several areas outside of 10 miles which are within the EPZ (i.e. the southern portion of PAZ D-2). Table 1 summarizes the permanent resident population for year 2000:

Table 1. Permanent Resident Population (Year 2000)				
County	**Within 10 Mile Ring**	**Within EPZ**	**Within EPZ & outside 10 mile ring**	**Within 10 mile ring & outside EPZ**
Fairfield	3,816	3,836	221	201
Newberry	3,958	3,928	301	331
Lexington	1,145	1,648	732	229
Richland	1,699	1,765	148	82
Total:	**10,618**	**11,177**	**1,402**	**843**

As shown in Table 1, there are 1,402 people living within the VCSNS EPZ who are more than 10 miles from Unit 1, while there are 843 people who live within 10 miles of Unit 1, but are not within the EPZ.

Table 2.5-1 (Sheet 5 of 5) reports a total (residents plus transients) population for Year 2000 of 12,209 persons and 13,311 persons for Year 2010. The ETE report considers transients and employees who commute into the EPZ to work separately. The ETE report indicates a total of 12,675 persons for Year 2007:

11,826 permanent residents (Table 3-1) + 76 transients (Figure 3-4) + 773 employees (Figure 3-6, see response to RAI 13.03-7, part B)

The estimated population of 12,675 persons for Year 2007 compares with the Year 2000 estimate of 12,209 persons and the Year 2010 estimate of 13,311 persons provided in the ER.

In summary, any difference in population between the ER and the ETE is explained by the following factors:

- The use of different centerpoints for the analysis.
- The use of a 10-mile radius for the ER versus the use of the EPZ boundary for the ETE.

B. As noted in the "New Plant Construction" section on page 3-2 and in the footnote to Table 6-4 on page 6-6, only the permanent resident and shadow populations were extrapolated to 2014 for the construction scenario. As shown in Table 6-4, the transients and employees constitute about 4% (743 ÷ 18,323) of the total evacuation demand. It was assumed that no major transient attractions or major employers would be introduced in the EPZ between 2007 and 2014; thus, these population groups were not extrapolated.

The estimated resident population extrapolated to year 2014 is 12,470, while the estimated shadow population for year 2014 is 44,096. These figures were extrapolated using the county-specific growth rates in Note #1 on page 3-4 of the ETE report.

C. The resident and shadow populations were extrapolated using growth rates estimated from data provided by the U.S. Census bureau website (http://quickfacts.census.gov), accessed on November 1, 2006. The populations for Lexington, Fairfield, Richland and Newberry counties are provided in Table 1, along with their annual growth rates, calculated from the given populations. See Note #2 on page 3-4 of the ETE report for the calculation of the growth rates.

Table 1. Census Population Estimates for Year 2005

County	Population 2000	Population 2005 (estimated)	Annual Growth Rate
Lexington	216,014	235,272	1.70%
Fairfield	23,454	24,047	0.48%
Richland	320,667	340,078	1.14%
Newberry	36,108	37,250	0.67%

The population from the U.S. Census bureau was accessed again on December 12, 2008; Table 2 summarizes the data obtained. The data include 2006 population estimates and the annual growth rates calculated based on these estimates.

Table 2. Census Population Estimates for Year 2006

County	Population 2000	Population 2006 (estimated)	Annual Growth Rate
Lexington	216,014	240,160	1.79%
Fairfield	23,454	23,810	0.24%
Richland	320,667	348,226	1.38%
Newberry	36,108	37,762	0.78%

As shown in Tables 1 and 2, the Census data indicate population growth in each of the EPZ counties.

Section 2.5.1.2 of the Environmental Report (ER) provides the following annual growth rates:

Table 3. County-Specific Annual Growth Rates Provided in ER

County	Annual Growth Rate
Lexington	1.43%
Fairfield	0.58%
Richland	0.80%
Newberry	0.63%

Comparison of the growth rates used in the ETE report (Table 1) with those used in the ER (Table 3) indicates that the values are in agreement. Neither the ETE nor the ER show declining population for any of the EPZ counties.

D. The population calculated in the ETE uses the 2000 US Census "blockpop" Geographical Information Systems (GIS) point shapefile. The "blockpop" shapefile divides census blocks up into a series of points with a Year 2000 population value assigned to each point. These points are located in neighborhoods and other populated areas. Thus, the shapefile provides a level of Census detail which is finer than the block level. These "blockpop" points were then summed for each PAZ using GIS software to provide a Year 2000 permanent resident population estimate. The attached Figure 1 provides a screen capture of the blockpop shapefile and its use in determining the population of a PAZ. As shown, all of the blockpop points in PAZ B-2 have been selected. The GIS software was used to sum these points providing a 2000 Population of 414, which matches the entry for PAZ B-2 in Table 3-1 of the ETE report.

As noted in the "Permanent Residents" sub-heading of Section 3 of the ETE report, county-specific growth rates were calculated by comparing Year 2005 Census population estimates and Year 2000 Census data. The footnotes to Table 3-1 of the ETE report document this procedure. The county-specific growth rates were then used to extrapolate the Year 2000 PAZ population estimates to Year 2007.

1. Section L.5.a (page 25) of the Richland County Radiological Emergency Response Plan reports the population of PAZ D-1 as 1,430 persons. Table 3-1 of the ETE report shows a Year 2007 population of 1,907 permanent residents for PAZ D-1. The original ETE study for the VC Summer Nuclear Station was performed in 1981 using 1970 Census data. A subsequent study was done in January 1993 to update the EPZ population using 1990 Census data; Table 3-1 (page 3-3) of the 1993 study provides the 1990 population estimates for each PAZ. The population identified for PAZ D-1 in that table is 1,430 persons. Therefore, the population reported in the Richland County Plan is a 1990 population estimate.

2. Section L.5.a (page 25a-12) of the Lexington County Radiological Emergency Response Plan reports a permanent resident population of 1,130 persons for PAZ D-2. Table 3-1 of the ETE report shows a Year 2007 population of 1,842 permanent residents for PAZ D-2. Table 3-1 of the 1993 ETE study reports a 1990 population of 1,130 persons for PAZ D-2. Therefore, the population reported in the Lexington County Plan is a 1990 population estimate.

3. Table 4 summarizes the PAZ populations provided in Section L.5.a (page Q-20) of Annex Q of the Fairfield County Emergency Operations Plan and in Table 3-1 of the ETE report.

Table 4. Fairfield County – PAZ Population

PAZ	Permanent Resident Population Estimates		
	County Plan	1993 ETE Report	2007 ETE Report
A-0	246	240	246
A-1	259	250	384
A-2	936	910	653
B-1	277	270	320
B-2	679	660	429
C-1	463	450	434
C-2	1,389	1,350	1,499
TOTAL:	4,249	4,130	3,965

There is no reference to another report and no methodology for estimating the population provided in the county plan. The numbers look similar to those provided in the 1993 ETE report. It is not reported in the county plan what the base year for the estimates is. It is likely that the population estimates are outdated, similar to the Richland and Lexington County plans.

4. Attachment 4 to Annex Q of the Fairfield County Emergency Operations Plan is a map of the EPZ with the population annotated for each PAZ. The numbers shown in Attachment 4 are not in agreement with the numbers provided in Section L.5.a of Annex Q (see Table 4). The numbers in Attachment 4 do match the numbers provided in the 1993 ETE Report.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

No COLA revision is required as a result of this RAI response.

ASSOCIATED ATTACHMENTS:

Figure 1: "Screen Capture of Census Blockpop Shapefile"

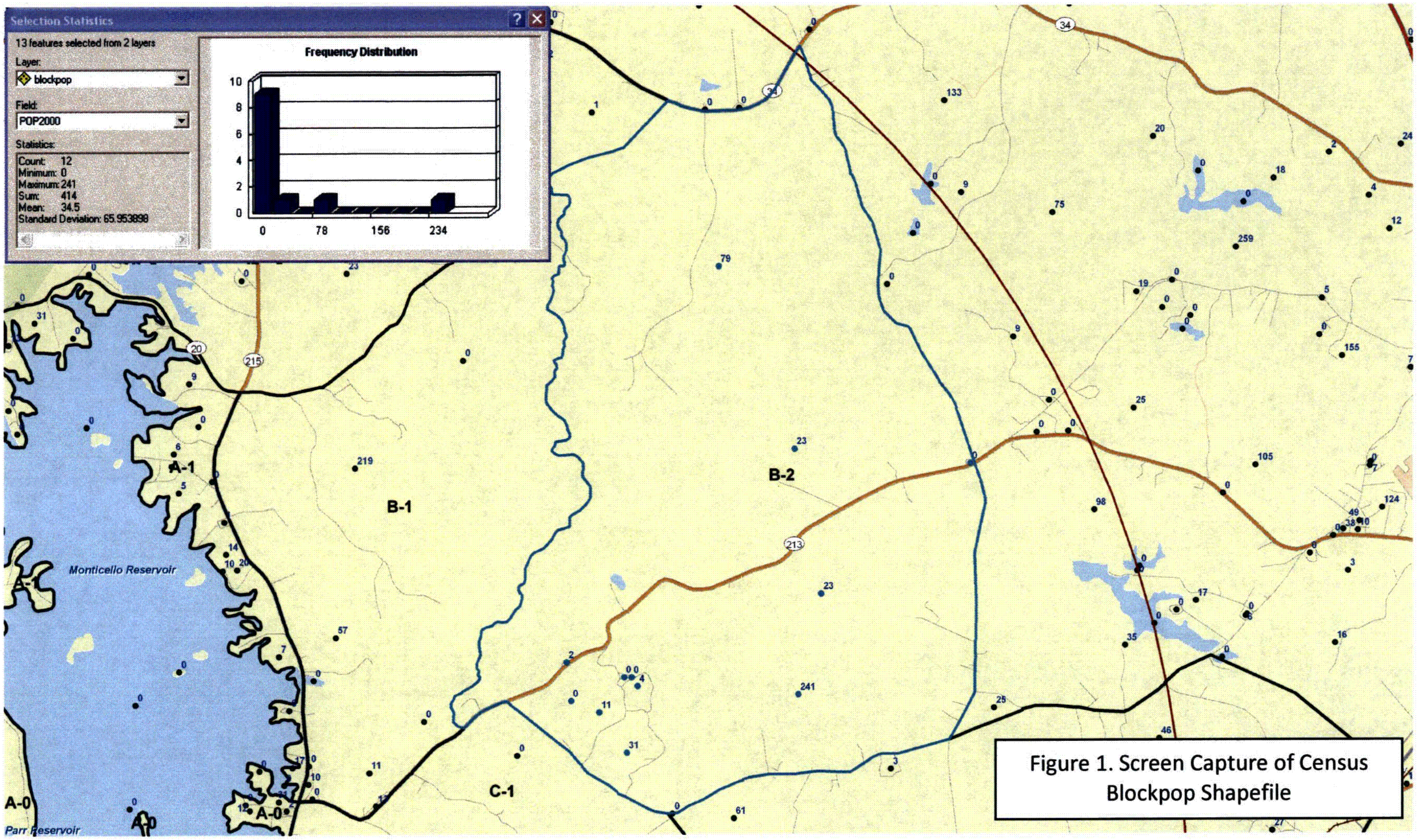


Figure 1. Screen Capture of Census Blockpop Shapefile

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-3

ETE-2: Site Location and Emergency Planning Zone

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: 10 CFR 50, Appendix E.IV (Introductory Paragraph); Appendix 4 to NUREG-0654 Section I.A.

Figure 1-1, "VC Summer Nuclear Station [VCSNS] Site Location," shows the plant with associated Protective Action Zone (PAZ) boundaries within the plume exposure pathway Emergency Planning Zone (EPZ). The text on page 1-3 states that the figure identifies communities in the area, but only Newberry and Winnsboro are identified on the map. Fairfield County, Lexington County, and Richland County are not labeled. The county boundaries are not clearly defined in Figure 1-2, "VC Summer Link-Node Analysis Network," and Figure 3-1, "VCSNS Protective Action Zones." Information on elevation or land formations other than water body locations is also not provided. Provide a topographical map that includes elevations, surrounding communities, county boundaries, and political boundaries.

VCSNS RESPONSE:

Labels have been added to Figure 1-1 for the lakes, rivers, and the communities in the area. County boundaries have also been added and labeled in Figure 1-1. The revised Figure 1-1 is attached and will be included in a future revision of the ETE report.

A large scale (3 ft by 4 ft) PDF file of the revised Figure 1-2 is submitted electronically. Sector, quadrant and county boundaries are delineated on the map. Major roadways, communities, lakes, and rivers are labeled in the map.

County boundaries have been added and labeled in Figures 3-1 and 6-1. The revised figures are attached and will be included in a future revision of the ETE report.

NUREG-0654/FEMA REP-1 (Rev 1) Appendix 4, Evacuation Time Estimates Within the Plume Exposure Pathway Emergency Planning Zone, Section I.A states that "[t]he map shall be legible and identify transportation networks, topographical features and political boundaries. (See planning element J.10.a.)" NUREG-0654/FEMA REP-1 (Rev 1) Section II.J.10 states "[t]he organization's plans to implement protective measures for the plume exposure pathway shall include: a. Maps showing evacuation routes, evacuation areas, preselected radiological sampling and monitoring points, relocation centers in host areas, and shelter areas; ...." Neither of these statements suggests the need for elevations. The reference to "topographical features" in the guidance is interpreted as those features that could affect evacuation planning.

To satisfy this guidance, the ETE report includes Figure 1-1, Figure 3-1 and the various figures in Section 10 that appropriately depict the highway network, topographical features, and political boundaries. Specifically:

- Transportation routes (i.e., evacuation routes) are displayed in several figures (e.g., Figure, 1-2, "VC Summer Link-Node Analysis Network", Figures 10-2, 10-3 and 10-4, Evacuation Route for ... County(ies)).
- Relocation centers in host areas (i.e., Evacuation Assembly Centers) are displayed in Figure 10-1, "General Population Reception Centers".

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

Figures 1-1, 3-1 and 6-1 are revised as attached and will be included in a future revision of the ETE report.

A large scale version of Figure 1-2 is provided.

ASSOCIATED ATTACHMENTS:

1. Figure 1-1: "VC Summer Nuclear Station Site Location"
2. Figure 1-2: "VC Summer Link-Node Analysis Network" (on CD)
3. Figure 3-1: "VCSNS Protective Action Zones"
4. Figure 6-1: "VC Summer Protective Action Zones"

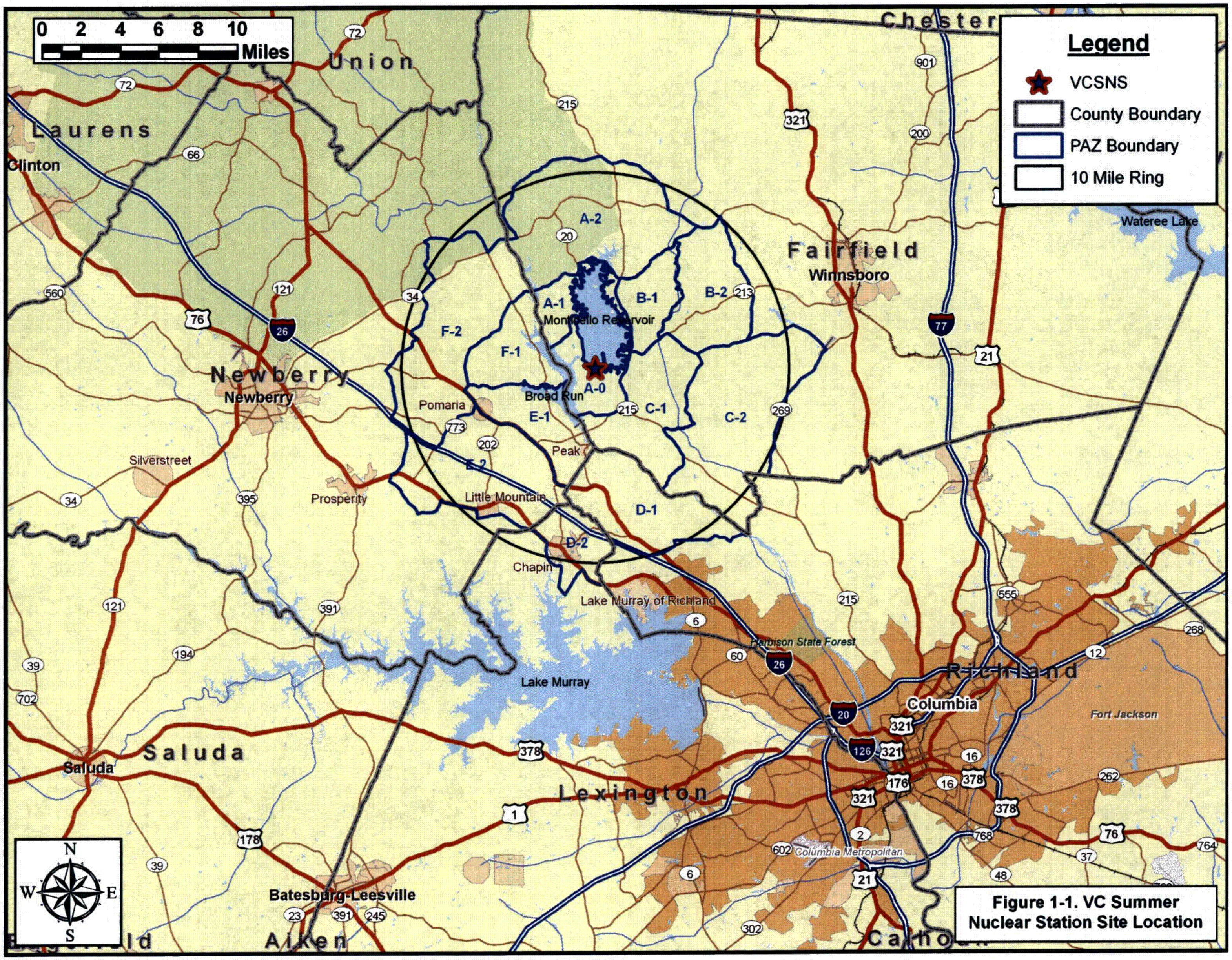


Figure 1-1. VC Summer Nuclear Station Site Location

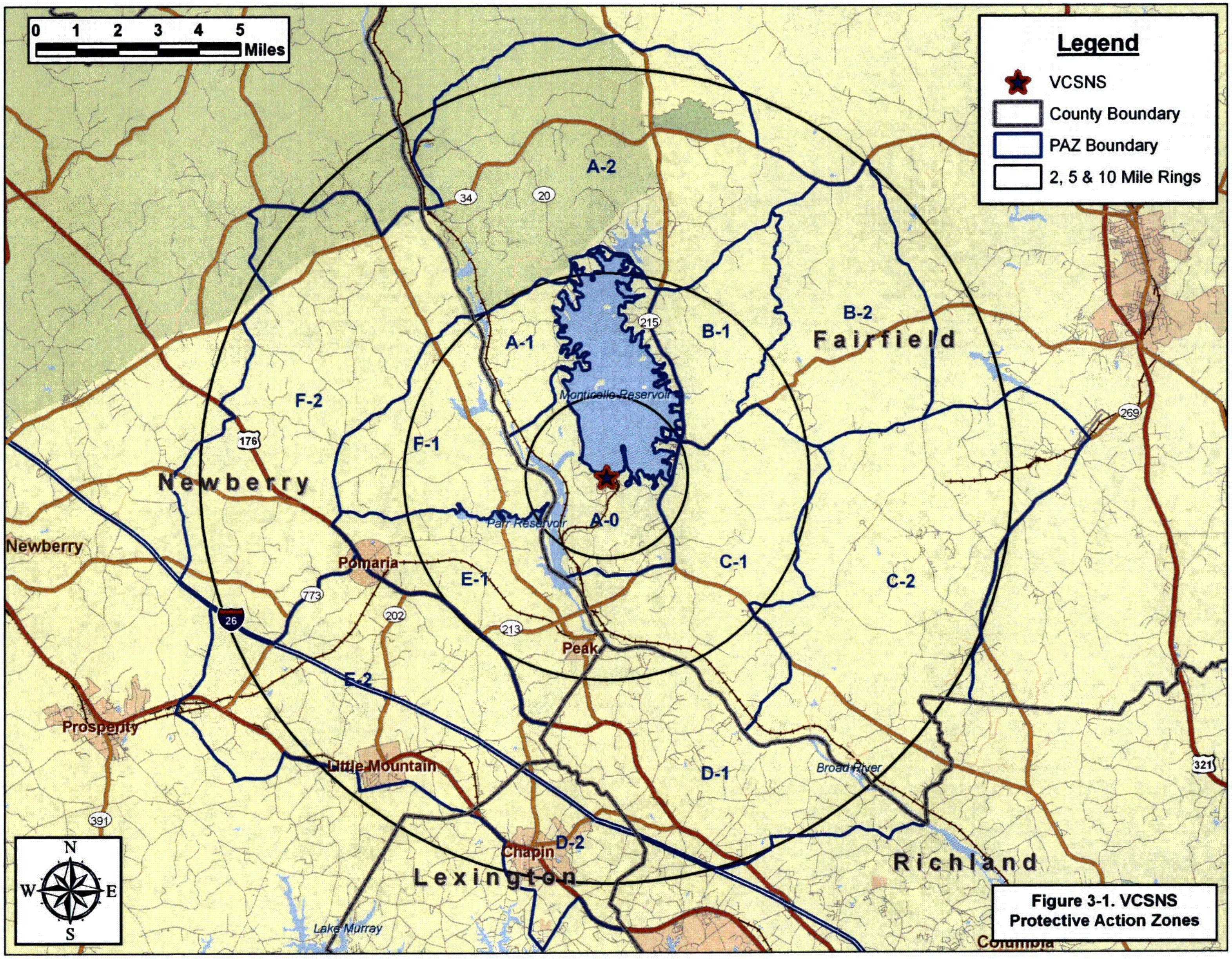


Figure 3-1. VCSNS Protective Action Zones

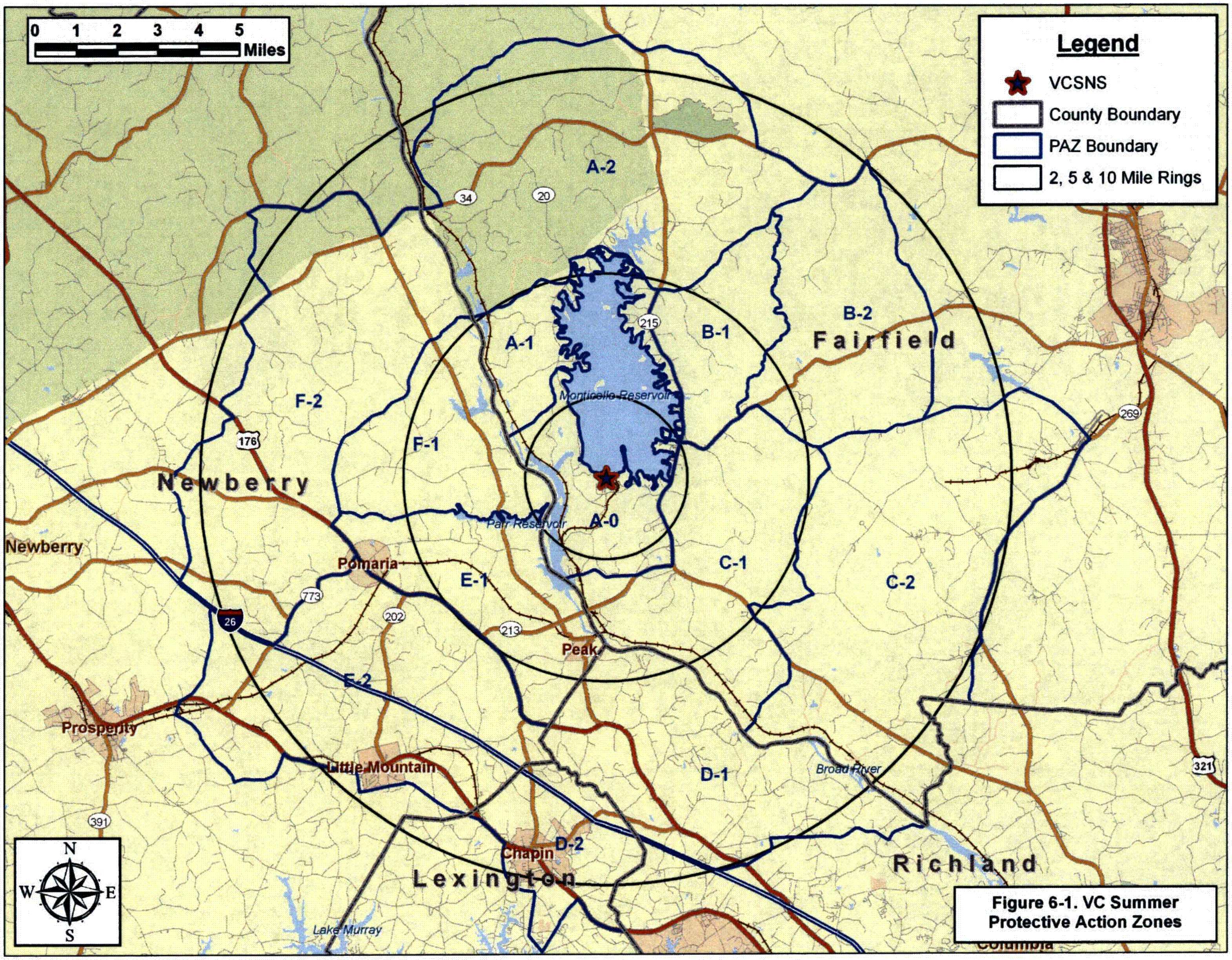


Figure 6-1. VC Summer Protective Action Zones

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-4

ETE-3: ETE General Assumptions

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: 10 CFR 50, Appendix E.IV (Introductory Paragraph); Appendix 4 to NUREG-0654 Sections I.B, Section II.C, Section III.A, IV.A.1

A. Section 2.3,"Study Assumptions," Assumption #3, states schools may be evacuated prior to notification of the general public. Table 8-5A, "School Evacuation Time Estimates-Good Weather," estimates that it will take on average of 1 hour and 56 minutes to evacuate the schools in the plume exposure pathway Emergency Planning Zone. If the assumption is correct, then the general public would not be notified until 2 hours after the emergency is declared. Provide clarification of Assumption #3.

B. Section 2.3, "Study Assumptions," Assumption #7 states the number and location of Traffic Control Points (TCPs) depend on personnel resources and region being evacuated. Discuss the impact on evacuation times if all TCPs are not staffed.

C. Section 2.3, "Study Assumptions," Assumption #8, states that Traffic Control Points should be established outside the EPZ. Describe how the ETE will be affected if these control points are not established.

D. According to Section 2.3, "Study Assumptions," Assumption #11, rain and ice were used as adverse weather conditions. Section 8.4, "Evacuation Time Estimates for Transit Dependent People," does include additional mobilization time due to adverse weather. Describe how and to what extent mobilization times are affected by adverse weather.

VCSNS RESPONSE:

A. Assumption 3.a in Section 2.3 does not influence the ETE calculations or results. As noted in the RAI, this option is not feasible under this ETE planning basis and this assumption will be removed in a future revision of the ETE report.

B. Conservatively, the ETE calculations do not rely upon any of the traffic control measures identified in Appendix G. The estimates of capacity, which are used by the I-DYNEV model and are documented in Appendix K, are based upon the factors described in Section 4 and upon the observations made during the road survey (see response to RAI 13.03-5, Part B (ETE-4B). It is assumed that these capacity estimates are not enhanced nor compromised by the establishment of a TCP at an intersection. As detailed in Section 9, the functions to be performed in the field at TCPs are to (1) facilitate evacuating traffic movements; and (2) discourage those movements that would move travelers closer to the VCSNS. The personnel manning these TCPs will also serve a surveillance function to inform the EOC of any problems that occur in the vicinity or are reported to them by evacuees.

The attached Figure 1 illustrates that the ETE for the VCSNS EPZ is dictated by the mobilization time. The horizontal distance between the trip generation curve and the ETE curve represents the travel time to the EPZ boundary. The short travel times indicate there is not pronounced traffic congestion within the EPZ delaying the departure of evacuees from the EPZ. Therefore, the establishment of TCPs strictly to manage traffic congestion is not necessary; however, the establishment of TCPs is recommended to provide guidance and reassurance to evacuees, and fixed point surveillance as noted above.

There would be no effect on ETE if traffic control points were not established. Thus, no changes to the ETE are needed due to lack of resources or the regions being evacuated.

C. See the response to Part B above.

D. The “No Effect” in the table on page 2-5 refers to the mobilization time for the general population. The name of the final column in the table will be changed to “Mobilization Time of the General Population” for clarification. As discussed in Section 5 of the ETE report, the mobilization of the general public consists of notification time, time to prepare to leave work, time to return home (if not already home), and the time to prepare the home. The only portion of this mobilization that involves driving is the time to return home. Travel home generally occurs prior to the onset of congestion; any reduction in free speed due to weather would not materially increase this travel time.

The mobilization times discussed in Section 8 are for that portion of the population which is dependent on transit resources – schoolchildren, special facility populations and those people who do not have access to a private vehicle. The mobilization time for the transit resources is defined on page 8-1 as the elapsed time from the advisory to evacuate to when the bus arrives at the facility to be evacuated. This mobilization process consists of alerting the bus drivers, the travel time of the bus drivers from home to the depot, the briefing of the bus driver and the travel time from the depot to the facility to be evacuated. The majority of this mobilization time is spent driving; as a result, the reductions of 10% in capacity and in speed for rain are assumed to add a total of 10 minutes to the mobilization time, as discussed on page 8-5.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

Assumption 3.a of Section 2.3 will be revised as follows:

> It is ~~further~~ assumed that~~:~~ 67 percent of households in the EPZ have at least one commuter, 78 percent of which await the return of a commuter before beginning their evacuation trip, based on the telephone survey results.
>
> ~~a. Schools may be evacuated prior to notification of the general public.~~
>
> ~~b. 33 percent of households in the EPZ will await the return of a commuter before beginning their evacuation trip, based on the telephone survey results.~~

The heading in the final column of the table on page 2-5 will be revised as follows:

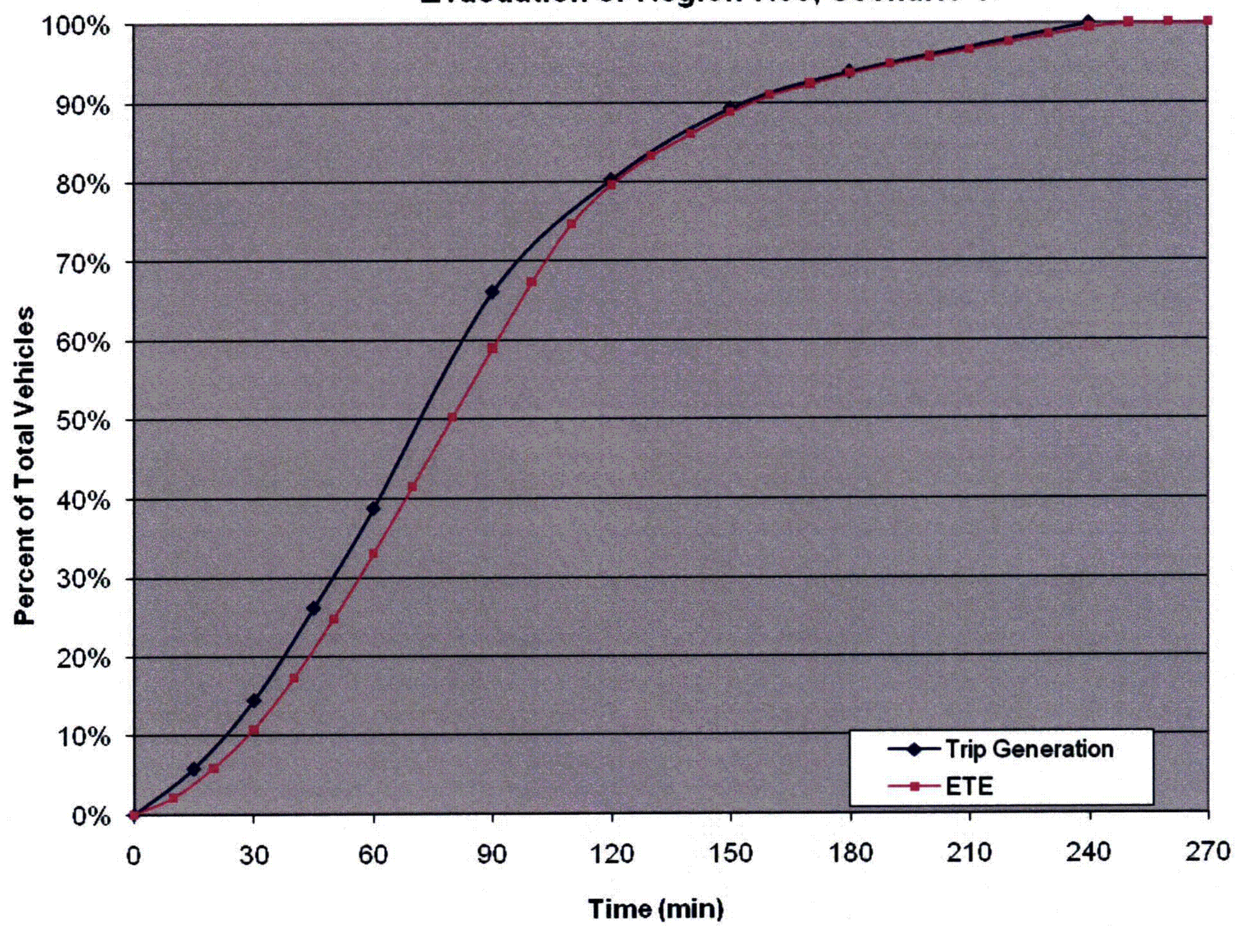
Scenario	Highway Capacity*	Free Flow Speed*	Mobilization Time of the General Population
Rain	90%	90%	No Effect
Ice	85%	85%	No Effect
*Adverse weather capacity and speed values are given as a percentage of good weather conditions. Roads are assumed to be passable.			

NOTE – This table is subsequently further modified in response to RAI 13.03-12.

ASSOCIATED ATTACHMENTS:

Figure 1 – "Comparison of ETE and Trip Generation Time"

Figure 1. Comparison of ETE and Trip Generation Time
VC Summer Nuclear Station
Evacuation of Region R03, Scenario 1



NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-5

ETE-4: ETE Methodology

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: Appendix 4 to NUREG-0654 Section I.C.

A. Section 4, "Estimation of Highway Capacity," describes the process used to determine the capacity of the roadways on the network. The algorithm for intersections is provided along with a description of variables on pages 4-1 and 2. Are there any other algorithms used to generate input for the models? If so, provide a general description of the algorithms.

B. Section 4, "Estimation of Highway Capacity," does not describe how values for variables used in the equation were derived. For example, on page 4-2, the variables F_1 and F_2 are defined as the various known factors that influence the turn-movement-specific mean discharge headway h_m. Discuss whether these various known factors mentioned on page 4-2, which includes items such as lane width, grade, percent heavy vehicles, etc., were based on field observations or measurements.

C. Section 4, "Estimation of Highway Capacity," states certain intersections will be controlled by traffic control personnel and their direction may supersede traffic control devices.

1. Explain how this may affect the variable in the equation and/or intersection capacity.
2. Explain any effect this may also have on the PC-DYNEV traffic simulation model.

VCSNS RESPONSE:

A. The "Analytical Tools" sub-heading on page 1-6 of the ETE report describes the I-DYNEV system used in this ETE study. Appendices B through D of the ETE report provide additional detail on the I-DYNEV system and its use in computing ETEs. Traffic routing is computed by the TRAD model described in Appendix B. Discussion of traffic control is presented below in the response to Parts B and C of this question. Further detail of the PC-DYNEV simulation model is found in NUREG/CR-4873, "Benchmark Study of the I-DYNEV Evacuation Time Estimate Computer Code", and NUREG/CR-4874, "The Sensitivity of Evacuation Time Estimates to Changes in Input Parameters for the I-DYNEV Computer Code". These two reports document studies undertaken to assess the validity of the DYNEV model for use in calculating ETEs. The discussions in the two cited references are at a level of technical detail and complexity which we believe lies outside the needs of an ETE document. Additional references to papers describing other algorithms are provided as a footnote on page 4-2.

B. KLD personnel drove the entire highway system within the EPZ and the Shadow Region. A tablet personal computer equipped with Geographical Information Systems (GIS) software was used during the road survey to acquire and record data. The characteristics of each section of highway were recorded. These characteristics include: number and estimated width of lanes, shoulder type and estimated width, intersection configuration, lane channelization, roadway geometrics, posted speed, actual free speed, abutting land use, traffic control devices, street parking and signage.

In addition, video and audio recording equipment were used to capture a permanent record of the highway infrastructure. No attempt was made to meticulously measure such attributes as lane width and shoulder width; estimates of these measures based on visual observation and recorded images were considered appropriate for the purpose of estimating the capacity of highway sections. For example, Exhibit 20-5 in the Highway Capacity Manual (HCM) indicates that a reduction in lane width from 12 feet (the "base" value) to 10 feet at any shoulder width greater than 6 feet can reduce free flow speed (FFS) by 1.1 mph – not a material difference – for two lane highways. Exhibit 20-5 also indicates that a reduction in lane width from 12 feet to 10 feet coupled with a reduction in shoulder width from 6 feet to less than 2 feet can reduce FFS by 5.3 mph.

Several points must be considered:

1. The FFS estimates presented in Appendix K reflect *observed* FFS during the field study undertaken on the *existing* highway conditions. Thus, any discussion of what the FFS would have been if the pavement and shoulder widths were different than they actually are currently is of academic interest but not relevant to the current need to describe the existing travel environment.
2. As a practical matter, the FFS plays a minor role in influencing ETE for the population within a 10-mile EPZ. For low population density EPZs, evacuees would be able to attain FFS since any congestion would likely impact only a few locations and be brief. As shown in Appendix K, FFS ranges from 30 to 70 mph for the roadways in the study area. The PC-DYNEV output indicates that the network wide average speed for an evacuation of the entire EPZ (Region R03) under Scenario 1 conditions (summer, midweek, midday with good weather) is 55.9 mph. Thus, a 10-mile evacuation trip would require 10.7 minutes. A reduction in FFS of 5.3 mph would result in a 10-mile evacuation trip time of 11.9

minutes – a difference of 1.2 minutes. Since the ETE are rounded to the nearest 5 minutes, the difference of 1.2 minutes would not likely be noticeable. Thus, while a difference in FFS of 5.3 mph is material, the impact of this difference on ETE is not.

3. The ETE for congested environments primarily reflect the ratio of demand (v) to capacity (c): the (v/c) ratio. Capacity is sensitive to the number of lanes available, the effective GREEN:TOTAL time ratio at intersections and the saturation flow rate, none of which is FFS-dependent. The ETE for uncongested environments reflect mobilization time.

The findings of NUREG/CR-4874 support this conclusion: "Free-flow velocity appears to have minimal effect on the evacuation time estimates." Exhibit 12-15 shows no sensitivity for the estimates of service volumes at LOS E (near capacity), with respect to FFS. The topography of the highway (level, rolling, mountainous) which influences saturation flow rate, is a far more important factor than lane and shoulder width when estimating capacity.

The data from the audio and video recordings were used to create detailed GIS shapefiles and databases of the roadway characteristics and of the traffic control devices observed during the road survey; this information was referenced while preparing the input stream for the I-DYNEV system. All of the information obtained during the road survey was input for the links and nodes shown in Figure 1-2 in order to ensure that the link-node analysis network replicates the actual roadway network surrounding the plant.

As indicated in the response to RAI 13.03-03 and RAI 13.03-10, Part A (ETE-10A), a large-scale version of Figure 1-2 with the nodes labeled is provided (see Attachment to RAI 13.03-03). The table of link characteristics provided in Appendix K should be cross-referenced with this large-scale map.

The values of the variables in the intersection algorithm in Section 4 were derived by applying the I-DYNEV system as an analysis tool rather than as a single "pass-through" calculation of an ETE. This tool was used to identify points of congestion and locations where traffic control points (TCPs) could be helpful to the evacuating public. Detailed results of the simulation were analyzed to identify locations where the green time was specified to realistically service the competing traffic volumes under evacuation conditions. The model was executed iteratively to provide assurance that the allocation of "effective green time" appropriately represents the operating conditions of an evacuation, as discussed below. The mean queue discharge headway, h_m, in seconds per vehicle is equal to 3600 sec/hr ÷ saturation flow rate, expressed in veh/hr. Saturation flow rates are presented in Appendix K, based on the field survey and the HCM guidance.

As documented on page 20-3 of the HCM2000, the capacity of a two-lane highway is 1700 passenger cars per hour for each direction of travel. For freeway sections, a value of 2250 vehicles per hour per lane (veh/hr/ln) is assigned. Inspection of Appendix K of the ETE report indicates that several high speed (free speed = 55mph) two-lane (1 "full lane" in each direction) highway links have a saturation flow rate of 1895 veh/hr/ln, exceeding the 1700 veh/hr/ln suggested by the HCM2000. A sensitivity study was run reducing the capacity of these links to the suggested value of 1700 veh/hr/ln. The attached Figure 1 indicates that the ETE is unaffected by this change, further supporting the response to RAI 13.03-4, part B, which indicates that ETE is dictated by mobilization time and not by capacity constraints.

The road survey has identified several segments which are characterized by adverse geometrics which are reflected in reduced values for both capacity and speed. These estimates reflect the service volumes for LOS E presented in HCM Exhibit 12-15. These links with reduced estimates of saturation flow rates may be identified by reviewing Appendix K. Link capacity is an input to I-DYNEV which calculates the ETE. The locations of these sections may be identified by reference to the large-scale map showing the link-node diagram with the nodes identified.

The variables F1 and F2 formally represent the factors that influence the turn movement specific flow rates through an intersection. These factors are detailed in Chapters 16 and 17 of the 2000 Highway Capacity Manual (HCM); Exhibit 16-7 summarizes the factors influencing saturation flow rate. A further (overlapping) list of factors is presented and identified in Equation 16-4 on page 16-9. These two chapters contain detailed technical discussions which extend over more than 250 pages. This level of detail is not appropriate for inclusion in an ETE report.

The following adjustment factors from Exhibit 16-7 were not considered; that is, no adjustment was made to the "base" estimated mean discharge headway due to these factors:

- Adjustment factor for heavy vehicles in traffic stream;
- Adjustment factor for approach grade;
- Adjustment factor for existence of a parking lane and parking activity adjacent to lane group
- Adjustment factor for blocking effect of local buses that stop within intersection area;
- Adjustment factor for area type;
- Pedestrian adjustment factor for left-turn movements; and pedestrian-bicycle adjustment factor for right-turn movements.

Heavy vehicles in the traffic stream were taken into account by expanding the estimated number of passenger car vehicles to reflect their presence. Specifically, instead of adjusting the mean discharge headway as indicated by the formula in Exhibit 16-7 to account for the presence of heavy vehicles, KLD represented each heavy vehicle as 2 passenger vehicles. This is an equivalent treatment since the above mentioned formula uses a "passenger-car-equivalent (E_T)" of 2.0.

The estimates of saturation flow rate presented in Appendix K take into account observed geometric factors such as grade and lane width. Therefore, no additional factors can subsequently be applied. As noted on page 10-25 of HCM, "the approach grade becomes important only when it is significantly steeper than 4 percent". For this area, grades significantly steeper than 4 percent were not observed.

The remaining factors listed above for parking, local buses, area type (CBD), pedestrians and bicycles do not apply for an evacuation environment.

Other factors are expressly accounted for by the simulation model and its input stream:

- Number of lanes in lane group
- Lane utilization
- Left-turns in lane group
- Right-turns in lane group

The PC-DYNEV model includes formulation designed expressly to represent traffic operations including the four factors listed above. These formulations are presented in the references given in the footnote on page 4-2 of the ETE report. The PC-DYNEV input stream specifies: (1) number of lanes on each link; (2) lane channelization and length; (3) turn percentages obtained from the TRAD model, and adjusted by PC-DYNEV logic if congestion so dictates; (4) effective green time for each approach.

A default value of 2.0 seconds is generally used for intersection "lost time", t_L (see Exhibit 10-9, HCM), but may be specified by the analyst for each approach to an intersection.

Delays experienced by turning vehicles are accounted for by the software logic:

- Right-turners and left-turners must slow on the approach to an intersection to execute the turn movement.
- Their headways are longer than those of the through movement, reflecting these lower speeds.

Chapter 31 of the HCM provides further discussion of simulation models and their relationship with the HCM. Note that models such as DYNEV are described as "operational simulation models" in the sense that they do not replicate the procedures of the HCM, but describe the operational performance of traffic in a manner that is consistent with the HCM analysis. Thus, there is no facility-specific Level of Service (LOS) calculation embodied within such simulation models which describe the flow process throughout the analysis network over time and compute flow statistics known as "measures of effectiveness." It is the calibration of these operational models (and of DYNEV, in particular) that relates to the procedures of the HCM. As stated on page 31-2 of the HCM, traffic simulation models use numerical techniques on a digital computer to create a description of how traffic behaves over extended periods of time for a given transportation facility or system. A listing of simulation model inputs is presented in Exhibit 31-4 of the HCM.

C. The equation presented on page 4-1 of the ETE report applies to signalized and to manually-controlled intersections. The iterative procedure described above does not attempt to "optimize" traffic operations at an intersection, but rather represents a reasonably efficient operation under evacuation conditions. The establishment of a TCP at an intersection could well provide greater operational performance than is represented by the calibrated DYNEV model. Thus, if all TCPs are manned in a timely manner by experienced personnel, it is possible that the ETEs predicted by the model might be somewhat longer than achievable in the real world under these ideal circumstances. It is our belief that ETEs should represent reasonable, but not optimal expectations. Therefore, no allowance is made for TCP operations. For the VCSNS EPZ, Figure 1, submitted with the response to RAI 13.03-4, ETE-3 (Part B), shows that the mobilization time distribution, not congestion or traffic control, dictates evacuation time.

When there are competing traffic movements at an intersection or juncture, the real estate within the intersection must be time shared by these competing movements in order to afford safe passage. This is the situation during normal conditions as well. This process is implemented in the simulation model by the analyst determining the allocation of effective green time as described above. Thus, depending upon circumstances, one or more of the competing traffic flows may be delayed at the intersection as it would be in the real world, thereby influencing the travel time of evacuees. Figure 7-4 illustrates the resulting queuing that can take place as a result of this time sharing process when the traffic demand exceeds the intersection capacity at the indicated locations and times.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

The saturation flow rates for all links with 1 full lane and a saturation of 1895 veh/hr/ln will be revised to 1714 veh/hr/ln. For example, the first page of the table in Appendix K is revised as follows:

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
1	3	24	1	~~1895~~ 1714	55
1	87	36	1	~~1895~~ 1714	55
2	126	40	1	~~1895~~ 1714	55
3	33	39	1	~~1895~~ 1714	55
4	5	29	1	1714	45
4	6	34	1	~~1895~~ 1714	55
5	1	107	1	1714	45
6	7	76	1	~~1895~~ 1714	55
7	8	75	1	1714	45
8	14	15	1	~~1895~~ 1714	55
9	4	24	1	1714	45
10	9	22	1	1500	40
11	10	37	1	1500	40
12	11	41	1	1500	40
13	12	34	1	1500	40
13	832	36	1	1714	40
14	15	60	1	~~1895~~ 1714	55
15	16	103	1	~~1895~~ 1714	55
16	17	38	1	~~1895~~ 1714	55
17	18	44	1	~~1895~~ 1714	55
18	19	25	1	~~1895~~ 1714	55
19	20	117	1	~~1895~~ 1714	55
20	21	88	1	~~1895~~ 1714	55
21	22	76	1	~~1895~~ 1714	55
22	23	157	1	~~1895~~ 1714	55
23	24	134	1	~~1895~~ 1714	55
24	25	155	1	~~1895~~ 1714	55
25	27	65	1	~~1895~~ 1714	55
26	85	58	1	~~1895~~ 1714	55
26	27	34	1	1714	40
27	28	42	1	~~1895~~ 1714	55
27	26	34	1	~~1895~~ 1714	55
28	29	131	1	~~1895~~ 1714	55
29	30	38	1	~~1895~~ 1714	55
30	31	36	1	~~1895~~ 1714	55
31	32	34	1	~~1895~~ 1714	55
33	34	98	1	~~1895~~ 1714	55
34	35	73	1	~~1895~~ 1714	55
35	36	41	1	~~1895~~ 1714	55
35	803	99	1	1500	45
36	37	44	1	~~1895~~ 1714	55

ASSOCIATED ATTACHMENTS:

Figure 1: "VC Summer Nuclear Station Comparison of ETE"

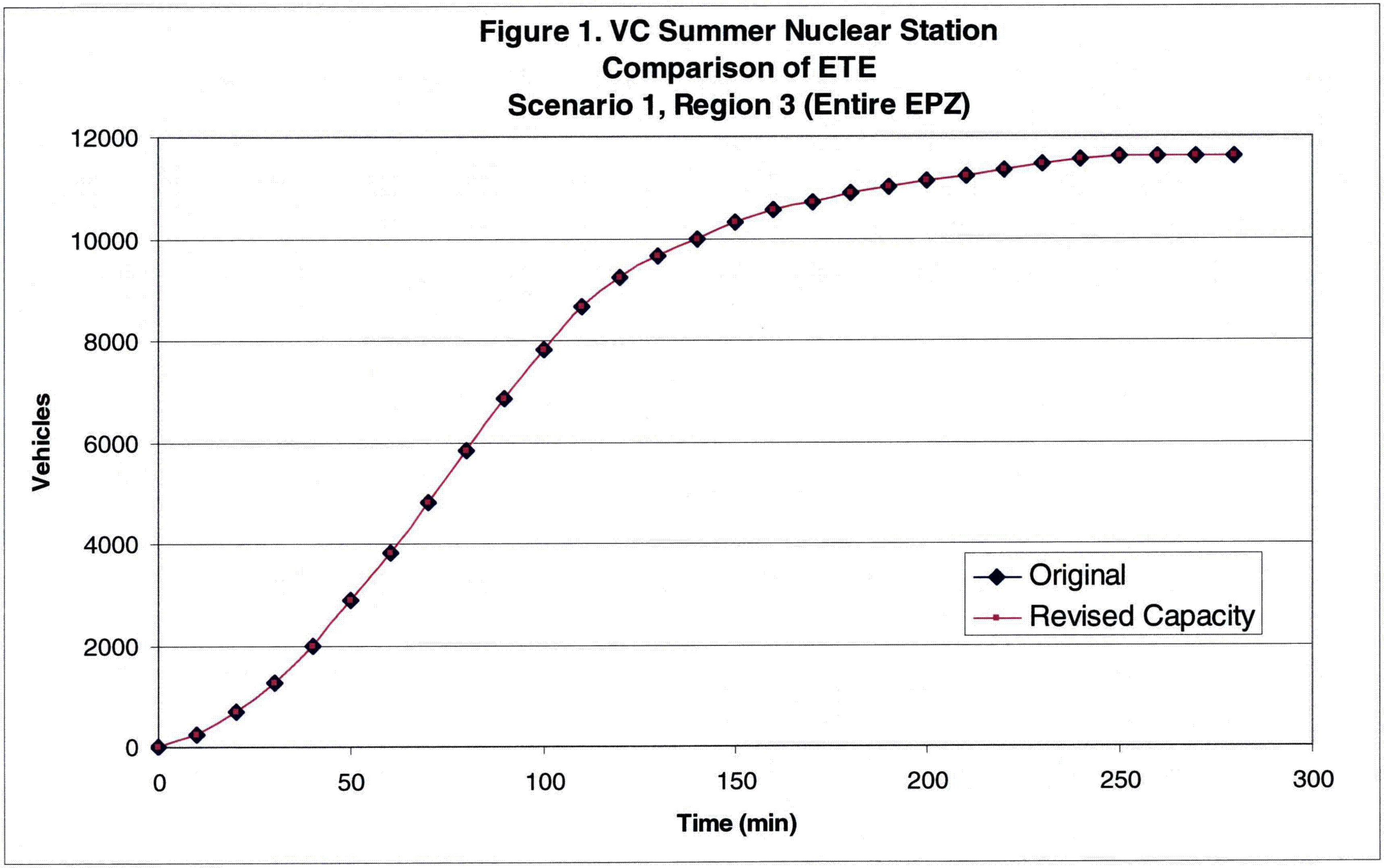


Figure 1. VC Summer Nuclear Station
Comparison of ETE
Scenario 1, Region 3 (Entire EPZ)
12000
10000
8000
6000
4000
2000
0
Vehicles
0
50
100
150
200
250
300
Time (min)
Original
Revised Capacity

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-6

ETE-5: Demand Estimation, Permanent Residents

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: Appendix 4 to NUREG-0654 Section II.A.

Section 2.3, "Study Assumptions," states that 33% of households would await the return of a commuter. Table 6-3, "Percent of Population Groups for Various Scenarios," (page 6-5) indicates that 67% of households have a commuter. Appendix F, "Telephone Survey," indicates that 78% would await the return of a family member prior to evacuating. Clarify which value was used in modeling for the percent of households that would await the return of commuters and make necessary changes.

VCSNS RESPONSE:

The results of the telephone survey indicate that 67% of households have at least one commuter (see Figure F-6 of the ETE report). The value of 33% indicated in Assumption 3 of Section 2.3 is the number of households that do not have a commuter (100%-67%) as indicated in column 3 of Table 6-3 in the ETE report. This is a conservative assessment of those who will not await the return of a commuter before departing on the evacuation trip.

The results of the telephone survey further indicate that 78% of those households with a commuter will await the return of the commuter prior to evacuating (see page F-7 of the ETE report). Thus, the number of households with a commuter who will not await the return of the commuter is 22% (100% - 78%). This value was used to estimate the number of transit dependent persons in the EPZ, as shown in the formula on Section 8.1 of the ETE report.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

Assumption 3.a of Section 2.3 will be revised as follows:

It is ~~further~~ assumed that~~:~~ 67 percent of households in the EPZ have at least one commuter, 78 percent of which await the return of a commuter before beginning their evacuation trip, based on the telephone survey results.

~~c. Schools may be evacuated prior to notification of the general public.~~

~~d. 33 percent of households in the EPZ will await the return of a commuter before beginning their evacuation trip, based on the telephone survey results.~~

ASSOCIATED ATTACHMENTS:

None

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-7

ETE-6: Demand Estimation, Transient Populations

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: Appendix 4 to NUREG-0654 Sections II.B, II.E, IV.B.5

A. Information regarding the transient population can be found in Section 3, "Demand Estimation." These values agree with those in Final Safety Analysis Report (FSAR) Section 2.1.3.3.1, "Transient Population within 10 Miles." However, it has been determined that Chapin, South Carolina has a Labor Day Festival which draws a large number of visitors. Peak tourist volumes for this event, and others like it that may occur during the year, are not discussed. Discuss why peak tourist volumes were not considered for events such as the Chapin South Carolina Labor Day festival.

B. The text in Section 3, "Demand Estimation," states Figures 3-6, "Employee Population by Sector," and 3-7, "Employee Vehicles by Sector," present non-EPZ resident employee data by sector. Figure 3-6 is not provided. It has been replaced by a duplicate of Figure 3-4, "Transient Population by Sector." Provide Figure 3-6, "Employee Population by Sector."

C. No information is provided regarding logistics involved in evacuating the Monticello Reservoir area. Discuss the logistics that were considered for evacuating the lake area.

D. Figure 5-1, "Events and Activities Preceding the Evacuation Trip," shows that transients will be notified, become aware of the incident, and then evacuate the area. The figure suggests that transients would not be returning to their "residence" prior to evacuation. Explain why the possibility for transients returning to a location to gather belongings was not considered in the evacuation time estimate.

VCSNS RESPONSE:

A. A sensitivity study was conducted to assess the impact on ETE of the influx of transients for the Chapin Labor Day Festival. There are 10,000 people present during peak times at the festival. Of these 10,000 people, approximately 20% are traveling into the EPZ from outside (mostly from the north Columbia area). The results of the sensitivity study indicate that the ETE for the Entire EPZ (Region R03) is not affected by the influx of transients for the festival (see "COLA Revisions" section below). The results of this study will be added to Appendix I in a future revision of the ETE report.

B. Figure 3-6 will be replaced in a future revision of the ETE report with the attached version of Figure 3-6, which identifies the employee population by sector.

C. The Monticello Reservoir has 3 public boat ramps, two of which are located on the Reservoir, and a third one located on the sub-impoundment to the north of the main body of the reservoir. One boat ramp is located just to the north of Lake Monticello Park on SC 215, and the other boat ramp is located on Meadow Lake Rd. The sub-impoundment allows fishing on Wednesdays and Saturdays only.

As discussed on page 3-8 of the ETE report, the South Carolina Department of Parks, Recreation and Tourism (SCDPRT) estimates that approximately 90% of the people at recreational areas in the EPZ are EPZ residents, while the remaining 10% are transients who commute into the EPZ. Thus, the majority of the people on the reservoir are EPZ residents who are familiar with the evacuation procedures for VCSNS through public information distribution. As stated on page D-19 of the Fairfield County Emergency Operations Plan:

> Public Information support teams will refer to the brochure printed by V.C. Summer Nuclear Station. This brochure will be in the homes of all residents in the ten-mile EPZ as well as posted in the county Emergency Management Department and other open locations for dissemination to transient populations. It will list evacuation routes, reception centers, protective action guidelines, local radio/TV Emergency Alert Stations, means of public warning and other pertinent information.

As stated in the public information brochure, sirens will sound in the event of an emergency. At that time, those people in the EPZ will tune into local radio or TV stations for further instructions. It is assumed that those people on the reservoir will tune into radios if available; if not available, they will likely become aware of the situation by communication with other boaters or observe other boaters return to boat launch sites, trailer their boat and leave the area.

As shown in table 6-3 of the ETE report, the majority of EPZ residents are home during summer weekends when peak populations on the reservoir are expected. Thus, Distribution D of Table 5-1 is applicable; this distribution extends over 4 hours.

It is reasonable to assume that boaters on the reservoir will be able to return to boat launch sites, trailer their boats and begin to evacuate the area within this time frame.

D. If the emergency occurs during the daytime, it is reasonable to expect that at least some of those who stay overnight at lodging facilities or campgrounds will leave their personal belongings in their respective rooms or at their campsite. Others, who want to have access to their belongings during the day (or are on their last day), will have their belongings with them. Those of the former group have two choices:

- Evacuate immediately, leaving their belongings in the room for subsequent retrieval; or
- Return to the lodging facility or campsite to gather up their belongings and then evacuate.

The mobilization distribution for transients extends over a period of 2½ hours, as shown in Table 5-1. Those who elect to return to lodging facilities or campsites to pick up their belongings will be able to do so and then begin their evacuation trip within this time frame.

The existing Figure 5-1 has been reviewed; the diagrams for scenarios (b) and (d) do not include those households with employees who work during the evening or on weekends. Figure 5-1 is revised as attached to clarify its meaning and will be included in a future revision of the ETE report. The final paragraph on page 5-3 (continues on page 5-4) will be revised in a future revision of the ETE report:

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

Replace figure on page 3-12 with Figure 3-6 "Employee Population by Sector".

Replace Figure 5-1 with the attached version of the figure.

Revise the final paragraph on page 5-3 as follows:

> An employee who lives outside the EPZ will follow sequence (~~d~~ c) of Figure 5-1.~~; a resident of the EPZ who is at work, and will return home before beginning the evacuation trip will follow sequence (a) of Figure 5-1. Note that event 5, "Leave to evacuate the area," is conditional either on event 2 or on event 4. That is, activity 2 → 5 by a resident at home can be undertaken in parallel with activities 2 → 3, 3 → 4 and 4 → 5 by a commuter returning to that home, as shown in Figure 5-1 (a). Specifically, one adult member of a household can prepare to leave home (i.e. secure the home, pack clothing, etc.), while others are traveling home from work. In this instance, the household members would be able to evacuate sooner than if such trip preparation were deferred until all household members had returned~~

~~home. For this study, we adopt the conservative posture that all activities will occur in sequence.~~ A household within the EPZ that has one or more commuters at work, and will await their return before beginning the evacuation trip, will follow the first sequence of Figure 5-1(a). A household within the EPZ that has no commuters at work, or that will not await the return of any commuters, will follow the second sequence of Figure 5-1(a), regardless of day of week or time of day. Note that event 5, "Leave to evacuate the area," is conditional either on event 2 or on event 4. For this study, we adopt the conservative posture that all activities will occur in sequence.

Households with no commuters on weekends or in the evening/night-time, will follow the applicable sequence in Figure 5-1(b). Transients will always follow one of the sequences of Figure 5-1(b). Some transients away from their residence could elect to evacuate immediately without returning to the residence, as indicated in the second sequence.

The following text will be added to Appendix I of the ETE report:

Chapin Labor Day Festival

The town of Chapin (in PAZ D-2) hosts an annual Labor Day Festival. There are activities scheduled throughout the weekend, but attendance peaks on Labor Day during the parade on Columbia Avenue from 9:00 to 11:00 in the morning. The other small events that occur at various locations in and around Chapin throughout the weekend are not as heavily attended.

The festival is held at Chapin High School, located at 300 Columbia Avenue. Attendees park their vehicles along the streets around the high school and in the Ellett Brothers, Inc. parking lot across the street from the High School. The street parking does not inhibit vehicle movement along Columbia Avenue.

A sensitivity study was considered to assess the impact on the ETE of the additional transients the festival attracts. This "Special Event" is numbered Scenario 13.

Methodology

Since Labor Day is a Holiday, it is appropriate to use Scenario 3 (summer, weekend, midday, good weather) as the base case for this special event. The number of additional transient vehicles is estimated using the following data provided by South Carolina Electric & Gas:

- Peak daily attendance for the event is estimated as 10,000 persons.
- It is assumed that those traveling to the event from outside the EPZ travel as a family. Thus, the average household (HH) size for the EPZ of 2.68 persons obtained from the telephone survey results (see Figure F-1) is used to estimate the number of families attending.

- One vehicle per family is assumed.
- An estimated 20 percent of the attendees originate their trip 10 or more miles away, most of whom live in the Columbia area.

Thus, the number of additional transient vehicles evacuating = 10,000 People x 20% x (1 Vehicle per HH ÷ 2.68 People per HH) = 746 vehicles

Given that the high school is only one and one quarter miles from Interstate 26, and considering the origin (Columbia) of these transients, it is reasonable to assume that these additional transient vehicles will travel eastbound on Columbia Avenue to access Interstate 26. It is assumed that these transients will begin their evacuation trips within one hour of the advisory to evacuate: 10% will be ready to evacuate within 15 minutes, 50% will be ready to evacuate in the subsequent 15 minutes, 30% in the next 15 minutes and 10% in the final 15 minutes. It is further assumed that any road closures for the parade are temporary in nature such that roads will be re-opened following the advisory to evacuate and traffic evacuating the Chapin area will not be inhibited.

<u>Results</u>

Table I-3 compares the 50^{th}, 90^{th}, 95^{th}, and 100^{th} percentile ETE for this Special Event with the ETE for the base case. The additional transient vehicles do not affect the ETE.

Table I-3: Scenario 3 (Base) and Scenario 13 (Labor Day Festival) ETE for Region 3

Case	ETE (hr:min) for Indicated Percentile			
	50^{th} Percentile	90^{th} Percentile	95^{th} Percentile	100^{th} Percentile
Scenario 3, Region 3	1:00	2:00	2:30	4:10
Scenario 13, Region 3	1:00	2:00	2:30	4:10

Figure I-1 is a plot of the total number of vehicles evacuated over time for Region 3, under Scenario 13 (Labor Day festival) and Scenario 3 (summer, weekend, midday, good weather) conditions. The curves become parallel near the end of the evacuation, with the vertical distance between them equal to the additional transient vehicles present under Scenario 13 conditions (746 vehicles).

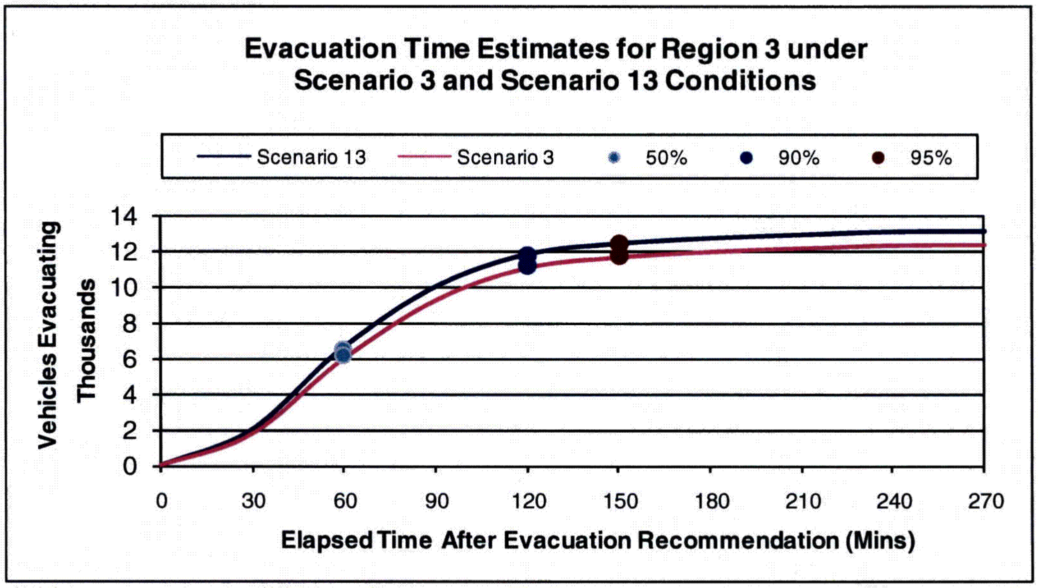
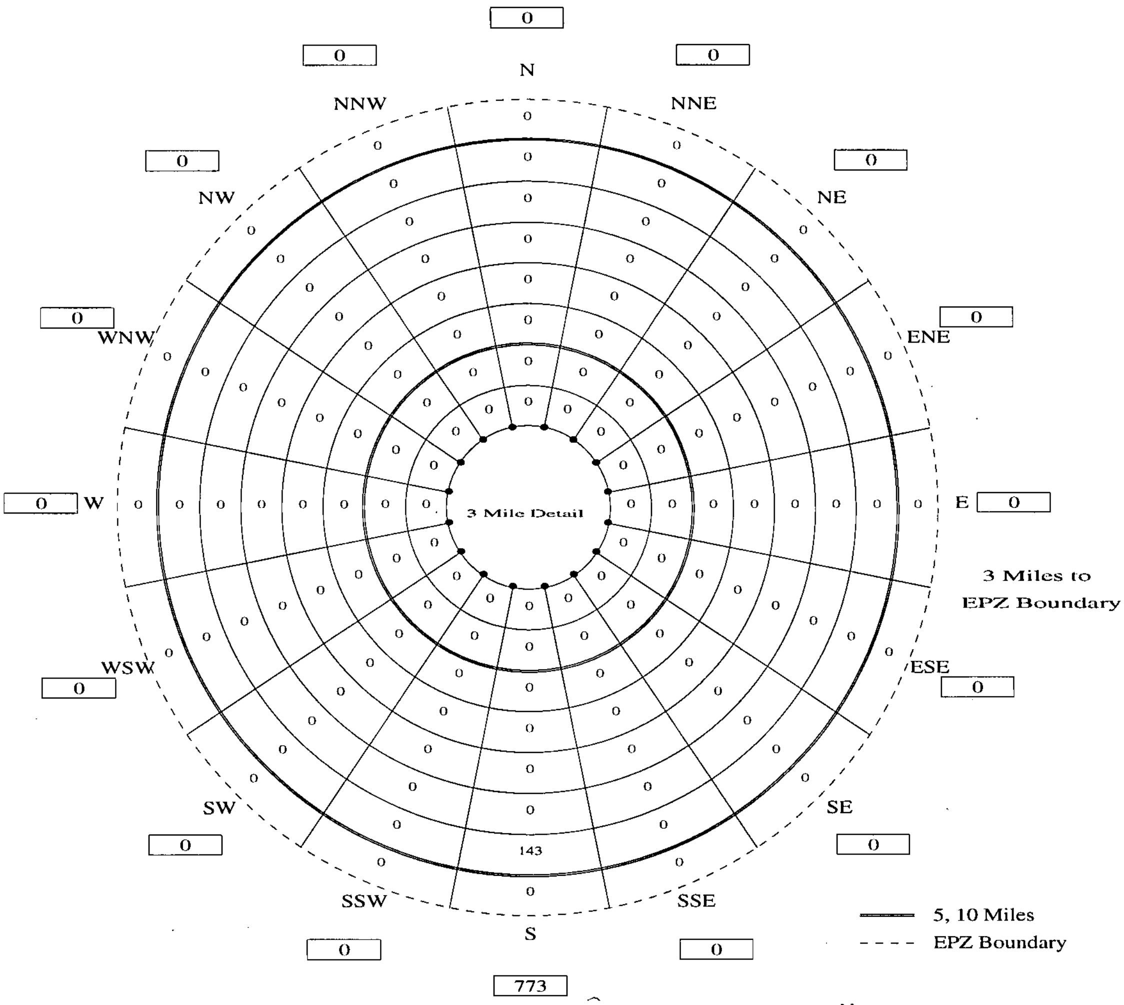


Figure I-1: Evacuation Plots for Scenario 3 (Base) and Scenario 13 (Labor Day Festival) for the Evacuation of the Entire EPZ (Region 3)



Employees			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	630	0-1	630
1-2	0	0-2	630
2-3	0	0-3	630
3-4	0	0-4	630
4-5	0	0-5	630
5-6	0	0-6	630
6-7	0	0-7	630
7-8	0	0-8	630
8-9	0	0-9	630
9-10	143	0-10	773
10-EPZ	0	0-EPZ	773

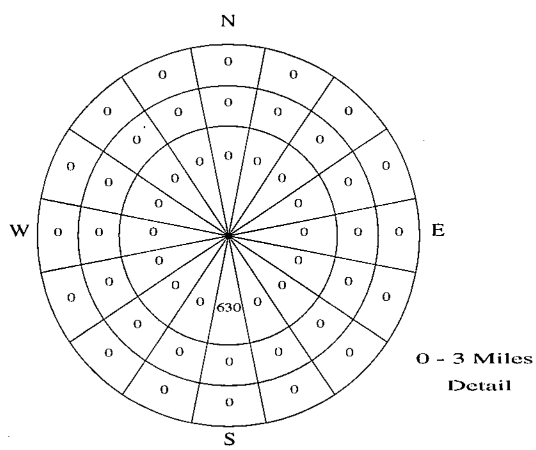
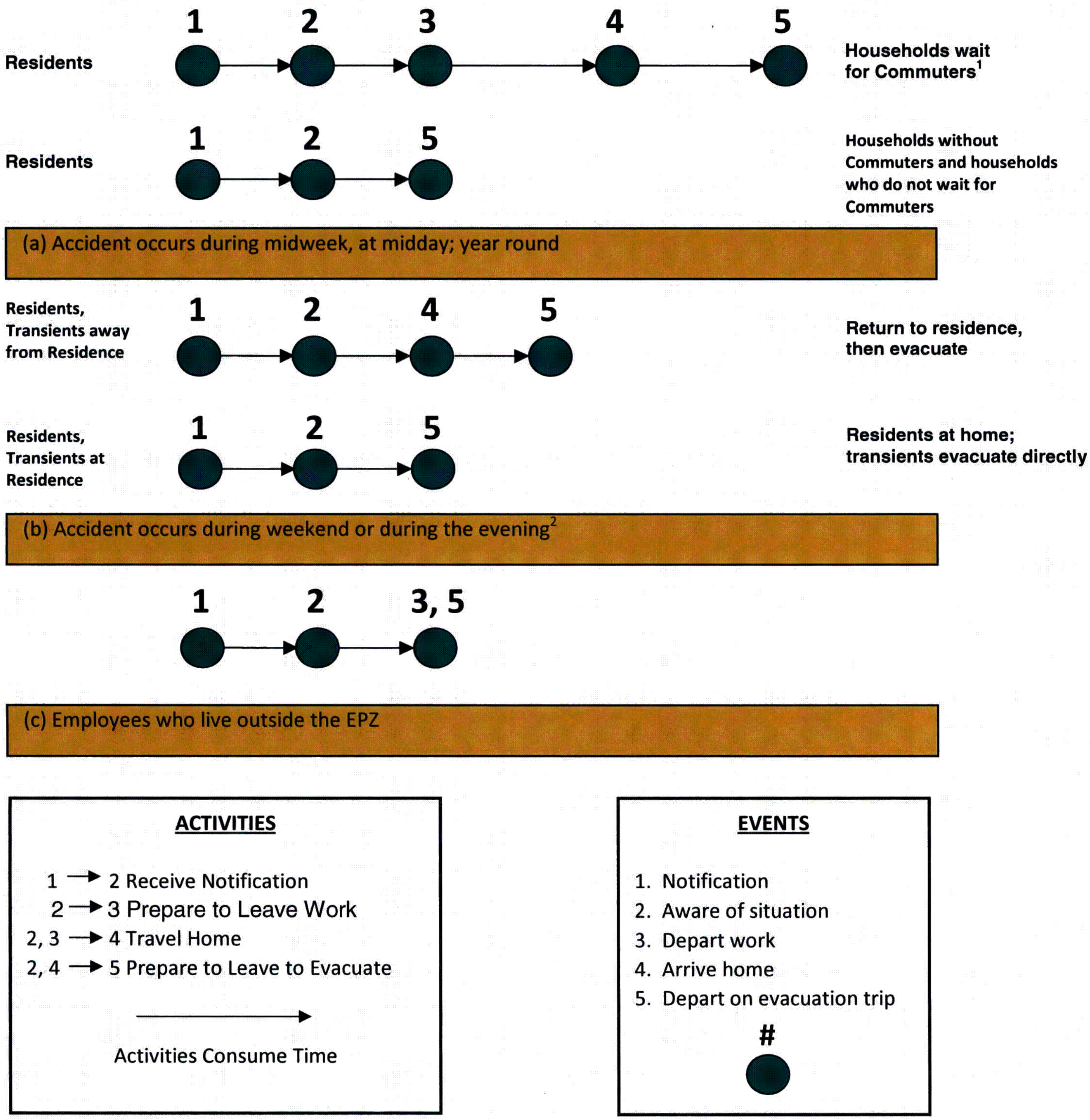


Figure 3-6. Employee Population by Sector



[1] Applies for evening and weekends also if commuters are at work.
[2] Applies throughout the year for transients.

Figure 5-1. Events and Activities Preceding the Evacuation Trip

ASSOCIATED ATTACHMENTS:

None

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-8

ETE-7: Demand Estimation, Special facility population

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: Appendix 4 to NUREG-0654 Sections II.C, II.E, III.A, IV.B.4, IV.B.5

A. Appendix E, "Special Facility Data," lists seven pre-schools that are located inside the plume exposure pathway Emergency Planning Zone (EPZ). These facilities are not listed in any of the tables in Section 8, "Transit-Dependent and Special Facility Evacuation Time Estimates [ETE]," or discussed in the text. Discuss whether pre-school children have been included in the evacuation estimates.

B. The locations of the special facilities discussed in the report are not identified on any of the maps that were provided in Section 8, "Transit-Dependent and Special Facility Evacuation Time Estimates," or Appendix E, "Special Facility Data." Provide a map that includes the locations of the special facilities discussed in the report in relation to the site.

C. The transit-dependent population definition does not include any individuals with special needs that may need assistance during evacuation. Discuss whether the special needs population exists or has been considered.

D. Section 8, "Transit-Dependent and Special Facility Evacuation Time Estimates," states transit service may be needed for residents, employees, and transients. Clarify whether employees and transients are included in the transit dependent population estimate. If not, provide information regarding how the procedure will be modified to include these two population groups.

E. Section 8.1, "Transit Dependent People-Demand Estimation," contains an equation used to calculate the number of persons ("P") requiring public transit or ride-share. According to the equation, 58% or 0.58 of households have 2 vehicles. According to Table 8-1, "Transit Population Estimates," 38.5% of households have 2 vehicles. Clarify which value is correct, and make necessary changes to the number of transit dependent-people and resources used to evacuate them.

F. Section 8.4, "Evacuation Time Estimates for Transit-Dependent People," states based on discussions with South Carolina Electric & Gas and county emergency management offices for counties within the EPZ, additional buses will be provided by neighboring cities to aid in evacuation if necessary.

1. Provide information regarding the process used to request additional resources.
2. Explain how the implementation of this process could affect evacuation times.

G. Section 8.4, "Evacuation Time Estimates for Transit-Dependent People," Activity G-C, states that for the second wave bus evacuation, the bus travel time back to the EPZ (to the start of the route) is estimated to be 15 minutes for good weather and 20 minutes for rain.

1. Clarify whether a time difference associated with other inclement conditions, such as ice, has been considered.
2. Does this estimate consider the necessary time to get through traffic control points?

H. Mobilization times in Section 5, "Estimation of Trip Generation Times," do not include information on transit-dependent people getting to bus routes or waiting for buses. Explain how transit-dependent individuals are expected to get from their residences to the bus routes, and whether this time was factored into the ETE.

I. Section 8, "Transit-Dependent and Special Facility Evacuation Time Estimates," states travel time for each pick-up route is expected to be 30 minutes in good weather and 35 minutes in rain. This section does not discuss the amount of times the buses will be stopping, and the duration stopped, on their proposed routes. Locations for the stops are not mentioned in the text or identified in Figure 8-2, "Proposed Transit Dependent Bus Routes."

1. Provide additional information on bus stop locations.
2. If stops are predetermined, provide maps that show the bus stop locations, and describe their effect on ETE calculations.
3. Clarify whether stopping and dwell time were considered in the estimation of the average route time proposed for transit services.

J. Table 8-2, "School Population Demand Estimates," provides the names, enrollment, and number of buses required to evacuate each school. The table shows that 5,388 students and 657 staff will require 95 buses for evacuation. Table 6-4, "Vehicle Estimates by Scenario," indicates that 200 buses are needed to support evacuation of the schools.

1. Discuss why this value is different than the 95 buses identified in Table 8-2, "School Population Demand Estimates."
2. Provide clarification for the column labeled, "Distance." Is this distance from the

plant or EPZ boundary?

K. In Table 8-2, "School Population Demand Estimates," the number of buses required for Mid-Carolina Middle School was calculated assuming 50 students per bus. The number of buses required for Chapin Middle School was calculated assuming 70 students per bus. Explain why the number of children per bus is different between these two middle schools.

L. Section 8.4, "Evacuation Time Estimates for Transit-Dependent People," states that based on discussions with the county, school evacuation can be accomplished in a single wave, but the number of buses available for school evacuation is never stated in the ETE. Appendix 3 to Annex L, "Transportation Service Resource Newberry County," Newberry County Emergency Operations Plan lists the number of available buses as 98. Appendix 3 to Annex L, "Transportation Service Resources," of the Fairfield County Emergency Operations Plan, lists the transportation resources available for each institution and their capacities. Clarify that there are sufficient resources to evacuate the schools in a single wave.

M. Tab B of Appendix 9 to Annex Q, "Transportation Resources for Fairfield County Schools," lists the resources required to evacuate schools within the county. McCrorey-Liston Elementary School is listed as requiring 5 buses to evacuate students. The ETE states that the same school will only require 4 buses to evacuate the school. Clarify how many buses will be necessary to evacuate students from McCrorey-Liston Elementary School.

VCSNS RESPONSE:

A. Day care centers are neighborhood facilities that service local children that are dropped off in the morning and picked up subsequently by parents or designees. Since the estimated resident vehicle population is based on household size and on vehicles per household, the vehicles used to pick up these children for evacuation have already been included in the estimate of evacuating vehicles. The mobilization time estimates (Section 5 of the ETE) are based on the telephone survey which reflects the daily activities of EPZ residents, including picking up children at day care centers.

Table 1 summarizes the transportation assets for each day care center in the EPZ, based on a survey of these facilities. As the table indicates, some of the larger day care centers have vans or buses. While this transport is not capable of servicing all children at these facilities, they can be used to evacuate any children not picked up in a timely manner. The addition of these relatively few vehicles to evacuating traffic will not impact the ETE of the general population. Discussion of day care facilities will be added to Section 8.3 in a future revision of the ETE report.

Table 1. Transportation Assets of Day Care Centers in the VCSNS EPZ		
Day Care Center	**Enrollment**	**Transportation Assets**
Little Angels Daycare	40	1 Van
Sara's Little Darlings	23	None
Livingston Daycare	15	None
Mt. Horeb Lutheran Church	80	None
Inez's Childcare Center	39	1 Bus
Chapin Baptist Child Development Center	213	3 Buses
Chapin Children's Center	130	2 Buses

B. The figure on page E-8 of the ETE report will be renamed "Figure E-1. Recreational Areas within the VCSNS EPZ." This revised figure is updated to include the names of the recreational areas and is enclosed with this response.

Figure E-2 "Schools within the VCSNS EPZ" and Figure E-3 "Major Employers, Medical Facilities and Day Care Centers within the VCSNS EPZ" are included in this response and will be added to Appendix E in a future revision of the ETE report.

Figures E-1, E-2 and E-3 collectively provide the locations of all special facilities relative to the location of the VC Summer Nuclear Station.

C. Recent communication with the counties has yielded the following data concerning registered homebound special needs population within the VCSNS EPZ:

Table 2. Registered Special Needs Population within the VCSNS EPZ					
Within EPZ	Fairfield	Lexington	Newberry	Richland	**Total**
Registered Special Needs Population	18	11	25	16	**70**
Bed-ridden	9	4	7	0	**20**
Wheelchair bound	0	4	3	8	**15**
Ambulatory	4	3	2	0	**9**
Total Population Requiring	**13**	**11**	**12**	**8**	**44**

It is assumed that buses can transport 30 ambulatory persons per trip, wheelchair buses can transport 15 persons per trip, wheelchair vans can transport 4 persons per trip, and ambulances can transport 2 bed-ridden persons per trip. Based on these capacities, the following transportation resources are needed to evacuate the homebound special needs population residing within the VCSNS EPZ:

Table 3. Transportation Needs for Evacuation of Special Needs Population within the VCSNS EPZ					
Within EPZ	Fairfield	Lexington	Newberry	Richland	Total
Ambulances	5	2	4	0	11
Wheelchair Vans	0	1	1	2	4
Buses	2*				

*See discussion in "Buses" section below

The EPZ counties are parties to the South Carolina state-wide mutual aid agreement which outlines consistent procedures and policies regarding the delivery of local mutual aid resources, including ambulances, wheelchair vans and buses. In the event one of the EPZ counties lacks sufficient transportation resources, those resources will be provided through this state-wide agreement. It is reasonable to expect that the requisite transportation resources would be available within a 90 minute mobilization time. Note that approximately 63% (44 ÷ 70) of special needs persons require transportation assistance – see Table 2. Other special needs persons living at home have their transport needs provided by other members of the household and would not require assistance from the county.

<u>ETE for Special Needs Persons</u>

<u>Buses</u>

It is assumed that school buses will be used to evacuate those homebound special needs persons whom are ambulatory. Assuming no more than one ambulatory special needs person per household implies that 9 households (HH) need to be serviced. While less than 1 bus is needed from a capacity perspective, if 2 buses are deployed to service these special needs HH, then each would require about 5 stops. The following outlines the ETE calculations:

1. Assume 2 buses are deployed, each with about 5 stops, to service a total of 9 HH.
2. The ETE is calculated as follows:
    a. Buses arrive at the first pickup location: 90 minutes
    b. Load HH members at first pickup: 5 minutes
    c. Travel to next pickup locations: 4 @ 6 minutes = 24 minutes
    d. Load HH members at subsequent pickups: 4 @ 5 minutes = 20 minutes
    e. Travel to EPZ boundary (assume 8 miles): 24 minutes.

ETE: 90 + 5 + 24 + 20 + 24 = <u>2:45</u> (hr:min)

Rain ETE: 100 + 5 + (4 x 7) + 20 + 28 = <u>3:00</u>

The estimated travel time between pickups is based on a distance of 2 miles @ 20 mph = 6 minutes. If planned properly, the pickup locations for each bus run should be clustered within the same general area. The estimated travel time to the EPZ boundary is based on a distance of 8 miles @ 20 mph = 24 minutes. It is assumed that mobilization time to first pickup is 10 minutes longer in rain = 100 minutes. It is further assumed that travel speeds are 10% lower in rain – travel time to the EPZ boundary at free speed from last pickup requires 28 minutes (8 miles @ 18 mph) in rain and that travel time between pickups is 7 minutes (2 miles @ 18 mph). All ETE are rounded to nearest 5 minutes.

Assuming all HH members (avg. HH size equals 2.68 persons) travel with the disabled person yields 5 x 2.68 = 14 persons per bus, well below the assumed bus capacity of 30 passengers per bus.

Ambulances

It is estimated that 11 ambulance runs will be needed to evacuate the homebound bed-ridden population within the EPZ – see Table 3. It is assumed that ambulances will be mobilized more quickly than buses; thus, mobilization time is assumed to be 30 minutes. Loading time is assumed to be 30 minutes as additional preparations will be needed for evacuating bed-ridden persons. Each ambulance servicing the homebound bed-ridden population will make 2 stops with an estimated distance of 5 miles between stops and an estimated distance of 5 miles to the EPZ boundary after the final stop. It is conservatively assumed that ambulances will travel at 30 mph within the EPZ. Mobilization time is 5 minutes longer and travel speed is 10% less in rain – 27 mph. All ETE are rounded to nearest 5 minutes.

The ETE are computed as follows:

a. Ambulance arrives at first household: 30 minutes
b. Loading time at first household: 30 minutes
c. Ambulance travels to second household: 5 miles @ 30 mph = 10 minutes
d. Loading time at second household: 30 minutes
e. Travel time to EPZ boundary: 5 miles @ 30 mph = 10 minutes

ETE: 30 + 30 + 10 + 30 + 10 = 1:50

Rain ETE: 35 + 30 + 11 + 30 + 11 = 2:00

Wheel-Chair Vans

Table 2 indicates that there are 15 homebound wheelchair bound persons in the EPZ, while Table 3 indicates that 4 wheelchair vans are needed to evacuate this population. Assuming one special needs person per household, each wheelchair van will service about 4 households. It is conservatively assumed that loading time at each household is 15 minutes, households are spaced 5 miles apart and van speeds approximate those of school buses = 20 mph between households. It is further assumed that vans travel 5 miles to the EPZ boundary after the last pickup. Mobilization time is 10 minutes longer and travel speed is 10% less in rain.

a. Assumed mobilization time for wheelchair van resources to arrive at first household: 90 minutes
b. Loading time at first household: 15 minutes
c. Travel to next household: 3 @ 15 minutes (5 miles @ 20 mph) = 45 minutes
d. Loading time: 3 @ 15 minutes = 45 minutes
e. Travel time to EPZ boundary: 5 miles @ 20 mph = 15 minutes

ETE: 90 + 15 + 45 + 45 + 15 = <u>3:30</u>

Rain ETE: 100 + 15 + 50 + 45 + 17 = <u>3:50</u>

This discussion of special needs population will be added to Section 8 in a future revision of the ETE report.

D. Since there is no mass transit servicing the area (other than taxis), it is reasonable to expect that virtually all transients and employees will have private vehicles available for evacuation. The ETE study therefore assumes that employees and transients will not require transit resources for evacuation. The first paragraph of Section 8 will be revised accordingly in a future revision of the ETE report.

E. The data in Table 8-1 showing that 38.5% of households have 2 vehicles, are accurate. The 58% shown in the calculation on page 8-3 is a typographical error; however, the results of the calculations shown in the second and third lines of the equation are correct. The equation on page 8-3 and the text below the equation will be revised accordingly in a future revision of the ETE report.

F. The "Concept of Operations" section of Appendix L, "Transportation", to the Fairfield County Emergency Operations Plan indicates that transportation operations will be controlled from the County Emergency Operations Center. The Transportation Service Coordinator (TSC) will coordinate all transportation requirements. All county transportation resources will be activated by the TSC. As stated in the plan:

> State and Federal support will be committed, as available, on a mission-type basis upon request to the State. Requests for use of additional transportation resources will be made through the County EOC.

Therefore, if additional transportation resources are needed, they would be requested through the County EOC by the TSC.

As stated in Section 8 of the ETE report, bus mobilization time is estimated to be 90 minutes from the advisory to evacuate. If there should be a shortfall in transportation resources and buses would have to be brought in from neighboring cities or counties, the mobilization time would most likely exceed 90 minutes. As discussed in the response to part L of this RAI, however, there are ample transportation resources available locally to evacuate the special facility and the transit-dependent populations within the EPZ. Therefore, support from neighboring cities and counties are not expected to be needed and the ETE will not be affected.

G.1. Table 8-6C "Transit Dependent Evacuation Time Estimates – Ice" will be added to a future revision of the ETE report. Please see the response to RAI 13.03-12, part C.

G.2. As discussed in Section 9 of the ETE report and in the response to RAI 13.03-4, part B, the primary objectives of traffic control points are to facilitate and guide the flow of evacuating traffic. It is especially critical that traffic control points facilitate the movements of transit resources (buses and ambulances) which are needed to evacuate the transit-dependent and special facility populations within the EPZ. Therefore, it is reasonable to conclude that the inbound bus speed of 45 mph will be unaffected as buses traverse traffic control points.

Appendix 9 to Annex Q (page Q-63) of the Fairfield County Radiological Emergency Plan states the following:

> Once a bus driver has left the 10-mile EPZ, the bus will be permitted to re-enter the affected area only if driven by an adult driver. Adult bus drivers may re-enter the affected area on a voluntary basis, only if the bus has no student passengers. No buses will be permitted back into the EPZ unless multi-trips are necessary.

Therefore, it is anticipated in the county plans that buses may have to re-enter the EPZ to evacuate others who need transportation assistance. The following statement will be added to the end of Section 9 of the ETE report: "All transit trips and other responders entering the EPZ to support the evacuation are assumed to be unhindered by personnel manning TCP."

H. Given that the evacuees in question have no access to private transportation, it is assumed that transit-dependent persons who are ambulatory will walk to the nearest route and "flag" down a bus traversing the route. As discussed on pages 8-7 and 8-8, and shown in Figure 8-2, the bus routes considered for the transit-dependent ETE analysis have been designed to service the population centers in the EPZ (Peak, Chapin, Pomaria, Jenkinsville, Monticello) where transit-dependent persons are most likely to be residing. As indicated in Table 8-1, we estimate a total of 222 transit dependent people and estimate 8 bus runs (assuming that about 30 persons will board each bus run on average) are needed to service this demand.

As discussed on pages 8-7 and 8-8 and shown in Table 8-6A, it is estimated that the majority of transit dependent buses will arrive at the EPZ route 120 minutes after the advisory to evacuate. The mobilization time estimates indicate that the majority of evacuees will have completed their preparatory activities by 90 minutes (see Distribution D in Table 5-1). Based on the use of "flag" stops and the design of the bus routes to pass through population centers, the walking distance should be less than 1 mile. The 2000 Highway Capacity Manual (pages 16-5 and 18-1) recommends a walking speed of 4.0 ft/sec for pedestrians. Therefore, to walk 1 mile would require:

$$1\ mile \times \frac{5280\ ft}{1\ mile} \div \frac{4\ ft}{1\sec} \times \frac{1\min}{60\sec} = 22\min$$

Therefore, the vast majority of the transit-dependent persons will be able to complete their preparation activities (90 minutes) and walk to the routes (22 minutes) by the time the buses arrive at the routes (120 minutes). Subsequent buses on a route will arrive later to service those who take longer to mobilize. Routes 5 and 6, which travel through the higher population areas, will have some buses dispatched at 90 minutes to service those people who mobilize more quickly. Thus, the time needed for transit-dependent people to walk to the bus routes has been considered in the calculation of the transit-dependent ETE.

See the response to part C for the discussion of those transit-dependent persons who are not able to walk to bus routes.

I. It is assumed that transit-dependent persons will walk to the nearest route and "flag" down a bus traversing the route. Thus, there are no pre-established pickup points for transit-dependent persons.

The time, t, required for a bus to decelerate at a rate, "a", expressed in ft/sec/sec, from a speed, "v", expressed in ft/sec, to a stop, is t = v/a. Assuming the same acceleration rate and final speed following the stop yields a total time, T, to service boarding passengers:

$$T = t + B + t = B + 2t = B + \frac{2v}{a},$$

where B = Dwell time to service passengers. The total distance, "s" in feet, travelled during the deceleration and acceleration activities is: $s = v^2/a$. If the bus had not stopped to service passengers, but had continued to travel at speed, v, then its travel time over the distance, s, would be: s/v, or $(v^2/a)/v = v/a$. Then the total delay (i.e. pickup time, P) to service passengers is:

$$P = T - \frac{v}{a} = B + \frac{v}{a}$$

Assigning reasonable estimates:

- B = 45 seconds: a very generous value for about 2 passengers per stop
- v = 25 mph = 37 ft/sec
- a = 4 ft/sec/sec, a moderate average rate

Then, P ≈ 55 seconds per stop. Allowing 15 minutes pick-up time per bus run implies 16 stops per run. Thus the delay associated with stopping and the dwell time for buses has been considered as the "pickup time".

As mentioned above, an average bus speed of 25 mph is assumed. Based on this assumption, a 30 minute travel time implies an average route length of 12.5 miles - a realistic estimate for a 10-mile EPZ.

J. As indicated in the response to part K, the total number of buses needed to evacuate all schoolchildren in the EPZ is 100 buses. The "School Children and Transit Dependent" footnote to Table 6-3 on page 6-5 of the ETE report indicates that 1 bus is equivalent to 2 passenger vehicles. The second paragraph of Section 8 of the ETE report reiterates this value of passenger-car equivalence. Thus, Table 6-4 indicates that 200 **vehicles** (not buses) are modeled to represent 100 school buses in the simulation. The justification for modeling 1 bus as 2 passenger car equivalents is further discussed in the response to RAI 13.03-5, part B.

The column labeled "distance" in table 8-2 is the radial distance of the school from the existing reactor (Unit 1) at the VC Summer Nuclear Station site. The column heading will be revised to "Distance from VCSNS (miles)" in a future revision of the ETE report.

K. As indicated in assumption 12 of Section 2.3 of the ETE report, bus capacity is assumed to be 50 students per bus for middle and high schools. The number of buses required for Chapin Middle School in Table 8-2 is incorrectly identified as 13 buses. The number of buses should be 18 (878 ÷ 50), resulting in a revised total of 100 buses for Table 8-2. This error was only in documentation: the correct number of buses was input to the evacuation model for Chapin Middle School, as discussed in the response to part J. The revised version of Table 8-2 (attached) will be included in a future revision of the ETE report.

L. Table 4 summarizes the bus resources available in each of the EPZ counties; these data were extracted from the county emergency plans and from discussions with county transportation representatives. Table 5 provides the total enrollment and buses needed, by county, to evacuate the EPZ schools; this table was adapted from the data provided in Table 8-2 of the ETE report. Comparison of Tables 5 and 6 shows that there are more than adequate transportation resources to evacuate the schools within the EPZ.

Table 4. Bus Resources within the VCSNS EPZ

County	Buses	Capacity
Newberry	98	5,488
Lexington/Richland†	96	5,760
Fairfield	46	2,871

† The Lexington and Richland County portions of the EPZ are part of "District Five of Lexington and Richland Counties." The bus resources indicated support schools in both counties.

Table 5. Enrollment and Buses Needed for Schools within the VCSNS EPZ*		
County	**Buses**	**Enrollment**
Newberry	36	1,902
Lexington	55	2,933
Fairfield	9	553
Richland	No schools within EPZ	

*See attached Table 8-2.

M. Data collection forms were submitted to the EPZ counties at the project kickoff meeting in October 2006 to gather data on the special facilities, including schools, within the VC Summer EPZ. The forms were completed and returned in February 2007. The data collection form for McCrorey-Liston Elementary indicated a current (2006) enrollment of 240 students. As stated in Assumption 12 in Section 2.3 of the ETE report, school buses used to transport elementary school students were assumed to have a capacity of 70 students. Therefore, the ETE study indicates that 4 (240 ÷ 70, rounded up) buses are needed to evacuate this school. Tab A to Appendix 9 to Annex Q of the Fairfield County Radiological Emergency Plan identifies an enrollment of 354 students. Tab B indicates that 5 buses are needed to evacuate the school (354 ÷ 70 ≈ 5). Internet searches indicate that the current enrollment for McCrorey-Liston Elementary is 250 students, which supports the data reported in the ETE report. The use of 4 buses to evacuate McCrorey-Liston Elementary in the ETE report is retained.

COLA Revisions:

The first paragraph on page 8-1 will be revised as follows:

> This section details the analyses applied and the results obtained in the form of evacuation time estimates for transit vehicles (buses). The demand for transit service reflects the needs of two population groups: (1) residents~~, employees and transients~~ with no vehicles available who do not ride-share; and (2) residents of special facilities such as schools, health-support facilities, and institutions ~~and child-care facilities~~. Appendix 4 of NUREG-0654 indicates that separate ETE should be generated for special facilities due to their "highly individualized" transportation needs.

The text of page 8-3 will be revised as follows:

> To illustrate this estimation procedure, we calculate the number of persons, P, requiring public transit or ride-share, and the number of buses, B, required for the VC Summer EPZ:

$$P = 4{,}410 \times (0.048 \times 1.38 + 0.224 \times (1.80 - 1) \times 0.67 \times 0.22 + 0.385 \times (2.87 - 2) \times (0.67 \times 0.22)^2)$$

$$P = 4{,}410 * (0.1006) = 444$$

$$B = (0.5 \times P) \div 30 = 8$$

These calculations are explained as follows:

- All members (1.38 avg.) of households (HH) with no vehicles (4.8%) will evacuate by public transit or ride-share. The term 4,410 x 0.048 x 1.38, accounts for these people.
- The members of HH with 1 vehicle away, who are at home, equal (1.80-1). The number of HH where the commuter will not return home is equal to (4,410 x 0.224 x 0.67 x 0.22). The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms.
- The members of HH with 2 vehicles that are away, who are at home, equal (2.87 – 2). The number of HH where neither commuter will return home is equal to 4,410 x ~~0.580~~ 0.385 x $(0.67 \times 0.22)^2$. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms.
- Households with 3 or more vehicles are assumed to have no need for transit vehicles.
- The total number of persons requiring public transit is the sum of such people in HH with no vehicles, or with 1 or 2 vehicles that are away from home.

Discussion of day care facilities will be added to Section 8.3 of the ETE report as follows:

8.3 Special Facility Demand

Table 8-4 presents the census of special facilities in the EPZ as of the end of 2006. There is only one medical facility within the EPZ – the Generations of Chapin nursing home with 64 residents. This data was provided by the South Carolina Department of Health and Environmental Control – Division of Health Licensing. The transportation requirements for this group are also presented. The number of buses needed assumes 30 ambulatory patients per trip.

Day care centers are neighborhood facilities that service local children that are dropped off in the morning and picked up subsequently by parents or designees. Since the estimated resident vehicle population is based on household size and on vehicles per household, the vehicles used to pick up these children for evacuation have already been included in the estimate of evacuating vehicles. The mobilization time estimates (Section 5) are based on the telephone survey which reflects the daily activities of EPZ residents, including the picking up of children. Therefore, separate ETE are not provided for day care centers.

A survey of day care centers within the EPZ was conducted: some of the larger day care centers have vans or buses. While this transport is not capable of servicing all children at these facilities, they can be used to evacuate any children not picked up in a timely manner.

Add a new section 8.4 - "Special Needs Population" to page 8-8 of the ETE report which will consist of the response to part C above.

Revise number of buses required for Chapin Middle School in Table 8-2 from 13 to 18. See attached revised version of Table 8-2.

The following statement will be added to the end of Section 9 of the ETE report:

> All transit trips and other responders entering the EPZ to support the evacuation are assumed to be unhindered by personnel manning TCP.

The title "Figure E-1. Recreational Areas within the VC Summer EPZ" will be added to the figured on page E-8. The recreational areas on Figure E-1 will also be labeled. Figure E-1, as revised, is attached.

The attached Figure E-2 "Schools within the VCSNS EPZ" will be added to page E-9 of the ETE report.

The attached Figure E-3 "Major Employers, Medical Facilities, and Day Care Centers within the VCSNS EPZ" will be added to page E-10 of the ETE report.

Attachments:

"Table 8-2. School Population Demand Estimates"

"Figure E-1. Recreational Areas within the VCSNS EPZ"

"Figure E-2. Schools within the VCSNS EPZ"

"Figure E-3. Major Employers, Medical Facilities and Day Care Centers within the VCSNS EPZ"

Table 8-2. School Population Demand Estimates							
Sector	**Distance from VCSNS (miles)**	**Dire-ction**	**School Name**	**Municipality**	**Enroll-ment**	**Staff**	**# of Buses Req'd**
FAIRFIELD COUNTY							
A-2	10.4	N	McCrorey-Liston Elementary School	Blair	240	40	4
C-2	11.1	E	Kelly Miller Elementary School	Winnsboro	313	54	5
				Fairfield County Total:	553	94	9
NEWBERRY COUNTY							
E-2	9.1	SW	Little Mountain Elementary School	Little Mountain	271	37	4
F-2	6.7	WSW	Pomaria-Garmany Elementary School	Pomaria	411	45	6
E-2	10.9	WSW	Mid-Carolina Middle School	Prosperity	553	66	12
E-2	10.9	WSW	Mid-Carolina High School	Prosperity	667	87	14
				Newberry County Total:	1902	235	36
LEXINGTON COUNTY							
D-2	9.2	S	Chapin High School	Chapin	1200	113	24
D-2	9.3	SSW	Alternative Academy	Chapin	120	15	2
D-2	11.1	S	Chapin Middle School	Chapin	878	100	~~13~~ 18
D-2	11.2	S	Chapin Elementary School	Chapin	735	100	11
				Lexington County Total:	2933	328	~~50~~ 55
				EPZ Total:	**5388**	**657**	**~~95~~ 100**

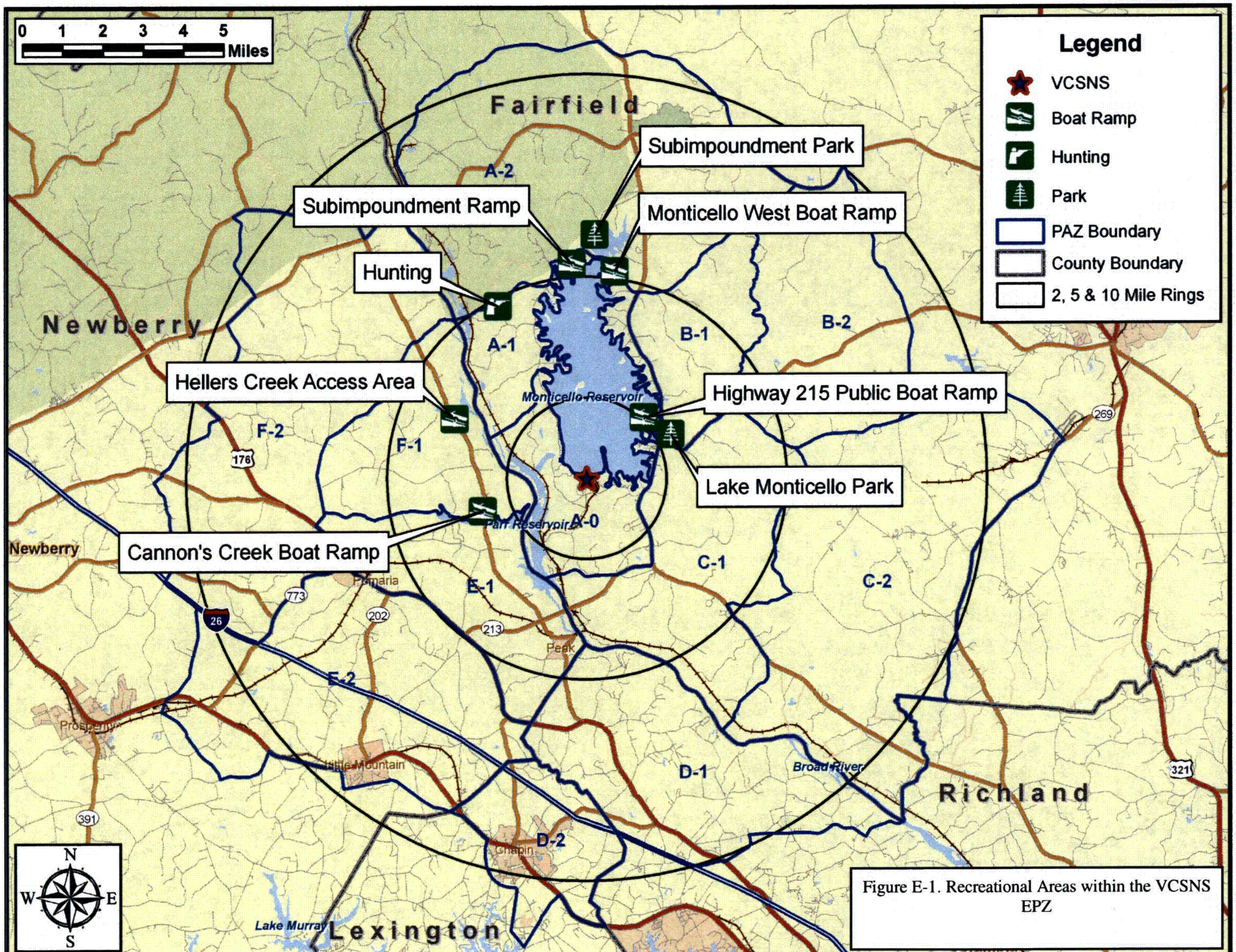


Figure E-1. Recreational Areas within the VCSNS EPZ

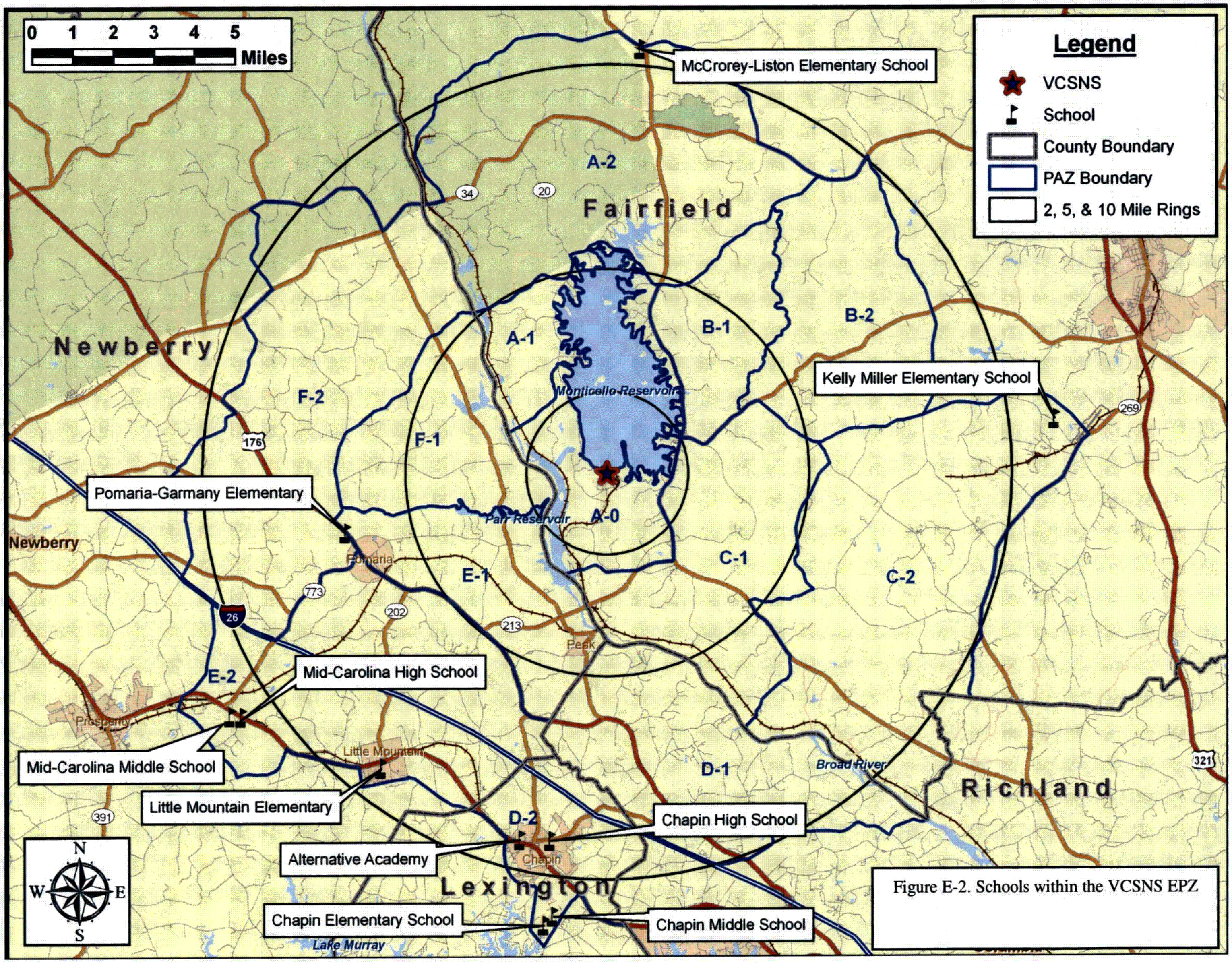


Figure E-2. Schools within the VCSNS EPZ

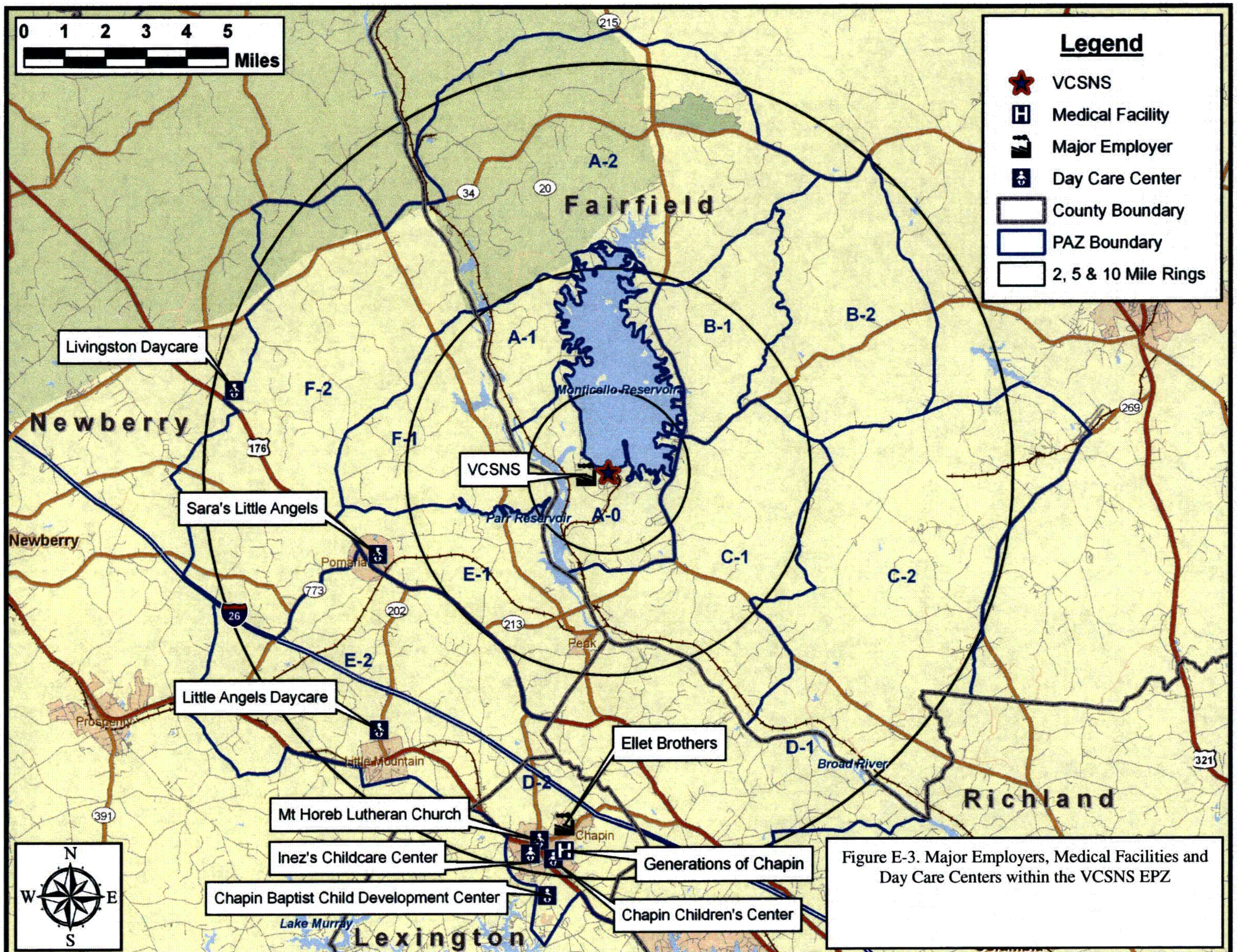


Figure E-3. Major Employers, Medical Facilities and Day Care Centers within the VCSNS EPZ

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-9

ETE-8: Demand Estimation, Emergency planning zone

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: Appendix 4 to NUREG-0654 Section II.D, Section III.B, IV.B.1

A. Intentionally left blank.

B. Table 6-3, "Percent of Population Groups for Various Scenarios," provides an estimate of the percentage of different population groups that are expected to evacuate for each scenario. However, Table 6-3 does not include voluntary evacuees. Clarify how this group has been addressed.

C. The longest evacuation time in 7-1D, "Time to Clear the Indicated Area of 100 Percent of the Affected Population," is 4.1 hours. However, Distribution # 4 in Section 5 indicates that 260 minutes (4.3 hours) is the time for 100% of the population to prepare to leave home.

1. Discuss how the distribution in Section 5 was derived using the telephone survey information.
2. Since the total evacuation time cannot be less than the mobilization time, discuss the difference between the two times.

D. Section 7.4, "Guidance on Using ETE [Evacuation Time Estimate] Tables," states that summer implies that public schools are not in session. In contrast, Table 6-3, "Percent of Population Groups Evacuating for Various Scenarios," shows 10% of school buses are used for evacuation in Scenarios 1 and 2. Table 6-4, "Vehicle Estimates by Scenario," also shows 20 school buses are used for evacuation in scenarios 1 and 2. Discuss the use of school buses in Scenarios 1 and 2 as described in Tables 6-3 and 6-4.

E. Section 7.3, "Evacuation Rates," states there is no significant congestion within the EPZ. However, the last paragraph of Section 7.2, "Patterns of Traffic Congestion During Evacuation," states significant congestion develops along Hwy 215 eastbound, in Scenarios 12, due to the increase in the amount of vehicles during construction. This statement is supported by Figure 7.4, "Congestion Patterns at 2 Hours after the Order to Evacuate (Scenario 12)."

1. Clarify whether congestion is expected to occur during evacuation.
2. Discuss how potential congestion will be managed?
3. What effect, if any, will congestion have on the ETE?

VCSNS RESPONSE:

A. Intentionally left blank.

B. Table H-1 will be added to Appendix H in a future revision of the ETE report; this table identifies the voluntary evacuation percentages for each Protective Action Zone (PAZ) for each Regional configuration.

The maximum vehicle loading is calculated for each link on the network. This loading is characterized by the vehicle types identified in the column headings of Table 6-3. This *maximum* vehicle loading for each link is reduced by a number of factors which provides the time period specific loading for that link. The factors are: (1) trip generation rates shown in Table 5-1; (2) scenario specific percentages provided in Table 6-3; and (3) Region specific voluntary evacuation percentages provided in Table H-1.

The numbers presented in Table 6-4 are for an evacuation of the full EPZ. There are no voluntary evacuation percentages applied in obtaining the numbers in Table 6-4 because all PAZ evacuate 100% for an evacuation of the full EPZ. The vehicle totals for an evacuation of the full EPZ are presented because they represent the upper bound of vehicles evacuating for a given scenario. The vehicle loading on each link is calculated by the I-DYNEV system using the data inputs which include the *maximum* vehicle loading, the trip generation rates, the scenario specific percentages and the voluntary evacuation percentages.

C. As discussed in Section 7.3, the flow rate of evacuating vehicles declines rapidly towards the end of the evacuation such that there is a trickle of vehicles moving towards the EPZ boundary over the last hour. This is seen by the fact that the curves of Figure 7-5 are essentially horizontal past an ETE of 3 hours (zero slope indicates zero flow rate). Consequently, the time to evacuate 100% of the population is indistinct and difficult to quantify.

More to the point, the use of the ETE for 100% of the evacuating population, as a basis for developing a protective action recommendation can be viewed as a biased estimate. In effect, the vast majority of the population within the EPZ could be "penalized" by a protective action based on an ETE that reflects the delayed response by the very few – the case of "the tail wagging the dog." Therefore, in the example presented on pages 7-5 and 7-6, the 95th percentile value of ETE rather than the 100th percentile value is used.

Given these characteristics, a statistical analysis on the mobilization distributions was performed to quantify a "confidence band" about the distribution. This band serves as the basis for establishing the point in time where the long tail should be truncated. In this instance, the mobilization time is estimated to extend over a period of 4 hours, as shown in Figure 5-3. Although a small percentage of the population indicated, via the telephone survey, that their mobilization time may extend out as long as six hours (Figure F-11), the vehicles for this population were loaded into the evacuation network at four hours to provide a conservative estimate of the vehicle flow within the roadway network.

As shown in Figure F-11, about 99 percent of respondents complete the home preparation within 4 hours, with the remaining stragglers requiring another 2 hours. As discussed above, it is essential that the ETE avoid the bias resulting from the behavior of these few stragglers. Specifically, it is important to accurately represent the ETE at the 90th and 95th percentiles of the evacuating public.

To that end, truncating the cited distribution at about 4 hours (see Figure 5-2) ensures that these ETE of interest (i.e. at the 90th and 95th percentiles) are based on a conservative estimate of traffic demand. That is, advancing the departures of the few stragglers in the population to about 4 hours provides assurance that the evacuating traffic demand includes <u>all</u> evacuees over that time frame when congested conditions could arise. Since traffic flow is generally a first-in-first-out (FIFO) process, any "tail truncation" that occurs well after the 90th and 95th percentile ETE, does not influence these values.

As documented in NUREG/CR-6953, Vol. 2, the NRC conducted a telephone survey sampling residents from 63 EPZs surrounding nuclear power plants in the United States[1]. Several questions were asked (Q19 through Q21) to estimate the mobilization time of the EPZ population. It was found that a portion of the population takes longer to prepare, resulting in an "evacuation tail". As stated on page 27 of the reference:

> "The survey data shows that use of 10 percent as an assumption of the evacuation tail would be appropriate for an evacuation during weekday conditions. The evacuation tail may be shorter when people are at home. This data may be used to support development of guidance on trip generation times. "

As noted on page 13-2 of the ETE report and discussed above, it is recommended that the 95th percentile ETE be used by decision makers in preparing recommended protective actions. The attached "Procedure for Estimating Mobilization Curve Based

[1] Jones, J.A, et al, "Review of NUREG-0654, Supplement 3, 'Criteria for Protective Action Recommendations for Severe Accidents': Focus Groups and Telephone Survey", NUREG/CR-6953, Vol.2, 2008.

Upon Survey Data" discusses the methodology for advancing the trip generation times of those relatively few persons who take longer to mobilize.

D. The buses shown for Scenarios 1 and 2 in Tables 6-3 and 6-4 are evacuating summer school students. It is assumed that summer school enrollment is approximately 10% of enrollment for the regular school year.

E.

1. There is no significant traffic congestion during evacuation for all Year 2007 Scenarios – Scenarios 1 through 11; however there is congestion for the Construction Scenario (Scenario 12) due to the large influx of vehicles transporting workers for the construction of Units 2 and 3. The second paragraph on page 7-3 of the ETE report will be revised accordingly.
2. Note that congestion within the EPZ clears by 3 hours and 20 minutes after the advisory to evacuate for Scenario 12; therefore, the ETE for the 100th percentile is still dictated by the mobilization time of 4 hours (see Figure 5-3).

3. The existing plant access road will be used by employees at Unit 1 during the construction of Units 2 and 3. South Lake Access Road will be paved prior to construction; construction workers will use this road during the construction of Units 2 and 3. In the event of an emergency at Unit 1 during the construction of Units 2 and 3, construction workers will evacuate south on S Lake Access Rd, then east on Parr Rd (becomes Jenkinsville Rd) to State Hwy 215 and then proceed south on State Hwy 215 out of the EPZ. At the intersection of Parr Rd/Jenkinsville Rd and State Hwy 213, the vehicles approaching from Parr Rd have a stop sign (Node 169 - see large scale Figure 1-2 providedy in response to RAI 13.03-03 and RAI 13.03-10, part A). At the intersection of Jenkinsville Rd and State Hwy 215, the vehicles approaching from Jenkinsville Rd also have a stop sign (Node 8). This causes congestion to propagate westbound at both of these intersections, as shown in Figure 7-4 (see the response to RAI 13.03-15 for estimates of average vehicle delay at these intersections).

   After the vehicles access State Hwy 215 and travel southbound, they interact with those vehicles evacuating southbound from State Hwy 269 at Node 27. Vehicles approaching from State Hwy 269 have a stop sign at this intersection. Congestion propagates along State Hwy 215 and State Hwy 269 from this intersection, as shown in Figure 7-4 (see the response to RAI 13.03-15 for estimates of average vehicle delay at this intersection).

   Appendix G of the ETE report recommends the implementation of TCP A-0-04 (see page G-8) at the intersection of Parr Rd and State Hwy 213 if an evacuation is ordered during construction. As indicated in the schematic, the traffic guide should facilitate the movement of construction worker vehicles from Parr Rd. Also, the implementation of ACP Q2-01 (see page G-46) is recommended to deal with congestion at the intersection of State Hwy 215 and State Hwy 269 and to discourage vehicles from traveling northbound on State Hwy 215 into the EPZ. The implementation of these control points will help manage the congestion during construction scenarios.

4. As discussed in the response to RAI 13.03-4, part B and RAI 13.03-5, part C, no allowance is made for TCP operations. Therefore, the data presented in Tables 7-1 A through D quantify the effect of congestion on ETE for the construction scenario. Table 1 compares the ETE for Scenarios 1 and 12:

Table 1. ETE (hr:min) for Evacuation of Entire EPZ (Region R03)

Percentile of EPZ Population	Scenario 1	Scenario 12
50%	1:20	1:35
90%	2:40	2:50
95%	3:20	3:10
100%	4:10	4:10

As Table 1 indicates, congestion under Scenario 12 conditions increases the ETE by 15 and 10 minutes for the 50th and 90th percentiles of EPZ population, respectively. The ETE for the 95th percentile is 10 minutes less for Scenario 12 than it is for Scenario 1. The output files were reviewed and the 95th percentile ETE for Scenario 12, Region R03 should be 3:20 (Tables 7-1D and J-1D will be revised accordingly). Therefore, the ETE for the 95th and 100th percentiles are not affected by the congestion caused by construction worker vehicles.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

Add Table H-1 (attached) on page H-2. All subsequent pages will be shifted down by 1 page.

The second paragraph of page 7-3 is revised as follows:

> **There is no significant congestion within the EPZ for all Year 2007 cases (Scenarios 1 through 11); consequently the ETE reflects the mobilization activities of the EPZ population.** There is congestion under Scenario 12 conditions (peak construction – Year 2014); however all congestion within the EPZ is clear by 3 hours and 20 minutes after the advisory to evacuate. Therefore, the 100th percentile ETE for Scenario 12 is also dictated by mobilization time. Specifically, as detailed in Table 7-1D, the ETE for 100 percent of the population approximates the time required for those relatively few persons who need up to 4 hours to mobilize for the evacuation trip. Any decrease in this mobilization time will translate to a

commensurate reduction in ETE. The recommendations in Section 13 address this issue.

Change ETE for Scenario 12, Region R03 from 3:10 to 3:20 in Table 7-1D.

Change ETE for Scenario 12, Region R03 from 3:10 to 3:20 in Table J-1D.

ASSOCIATED ATTACHMENTS:

Table H-1: "Percent of PAZ Population Evacuating for Each Region"

"PROCEDURE FOR ESTIMATING MOBILIZATION CURVE BASED UPON SURVEY DATA"

Table H-1. Percent of PAZ Population Evacuating for Each Region

PAZ	REGION: 2-Mile Ring, 5-Mile Ring, Entire EPZ			2-Mile Radius and Downwind to 5-Miles								5-Mile Radius and Downwind to EPZ Boundary									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
A-0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
A-1	35%	100%	100%	100%	100%	50%	50%	50%	50%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
A-2	35%	35%	100%	35%	35%	35%	35%	35%	35%	35%	35%	100%	100%	50%	50%	50%	50%	50%	50%	50%	100%
B-1	35%	100%	100%	100%	100%	100%	50%	50%	50%	50%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
B-2	35%	35%	100%	35%	35%	35%	35%	35%	35%	35%	35%	50%	100%	100%	50%	50%	50%	50%	50%	50%	50%
C-1	35%	100%	100%	50%	100%	100%	100%	100%	50%	50%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
C-2	35%	35%	100%	35%	35%	35%	35%	35%	35%	35%	35%	50%	50%	100%	100%	100%	50%	50%	50%	50%	50%
D-1	35%	35%	100%	35%	35%	35%	35%	35%	35%	35%	35%	50%	50%	50%	100%	100%	100%	50%	50%	50%	50%
D-2	35%	35%	100%	35%	35%	35%	35%	35%	35%	35%	35%	50%	50%	50%	50%	100%	100%	100%	50%	50%	50%
E-1	35%	100%	100%	50%	50%	50%	50%	100%	100%	100%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
E-2	35%	35%	100%	35%	35%	35%	35%	35%	35%	35%	35%	50%	50%	50%	50%	50%	100%	100%	100%	50%	50%
F-1	35%	100%	100%	50%	50%	50%	50%	50%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
F-2	35%	35%	100%	35%	35%	35%	35%	35%	35%	35%	35%	50%	50%	50%	50%	50%	50%	100%	100%	100%	100%

PROCEDURE FOR ESTIMATING MOBILIZATION

CURVE BASED UPON SURVEY DATA

The mobilization time data is obtained from a telephone survey, often with N = 500 to 1000 samples. The cumulative distribution or cumulative histogram can be plotted from the survey results.

Experience shows that the best fit pattern to the data is often a cumulative exponential distribution, shifted by T_0 minutes. For instance, refer to Figure 1, which shows a hypothetical case in which:

> The population begins to leave only after $t = T_0 = 20$ minutes, and then follows the exponential distribution, and almost all are gone by $T_0 + T_1 = 320$ minutes.

Because this single-regime model is the most common in practice, this procedure addresses this case first. It also lays the basis for the additional cases.

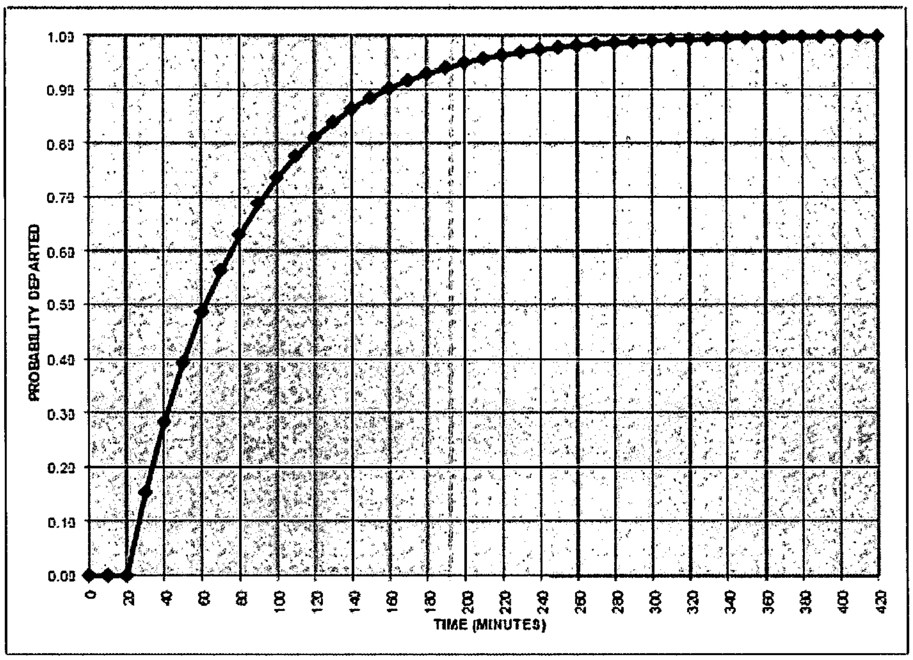


Figure 1: Common Representation of Underlying Behavior

The form of the relation shown in Figure 1 is

$$P_R(\text{departure time} \leq t) = F(t) = \begin{cases} \{1 - e^{-(t-T_0)/\tau}\} & \text{for } t \geq T_0 \\ 0 & \text{for } t < T_0 \end{cases} \quad (1)$$

where P_R indicates the cumulative probability of a departure, "t" is any given time and "τ" is a constant referred to as the "time constant".

The relation can also be read as "the percentage of vehicles departed by time 't'".

The relation can also be expressed as shown in Figure 2, namely as the probability density function of a departure at time "t". In this form, the relation is

$$f(t) = (1 / \tau)\, e^{-(t-T_0)/\tau} \quad \text{for } t \geq T_0\,, = 0 \text{ else} \quad (2)$$

This can be read as "the relative probability of departing at time 't' ". The probability of departing in the interval {t, t + Δt} is approximately $p(t) \simeq f(t)\,\Delta t$.

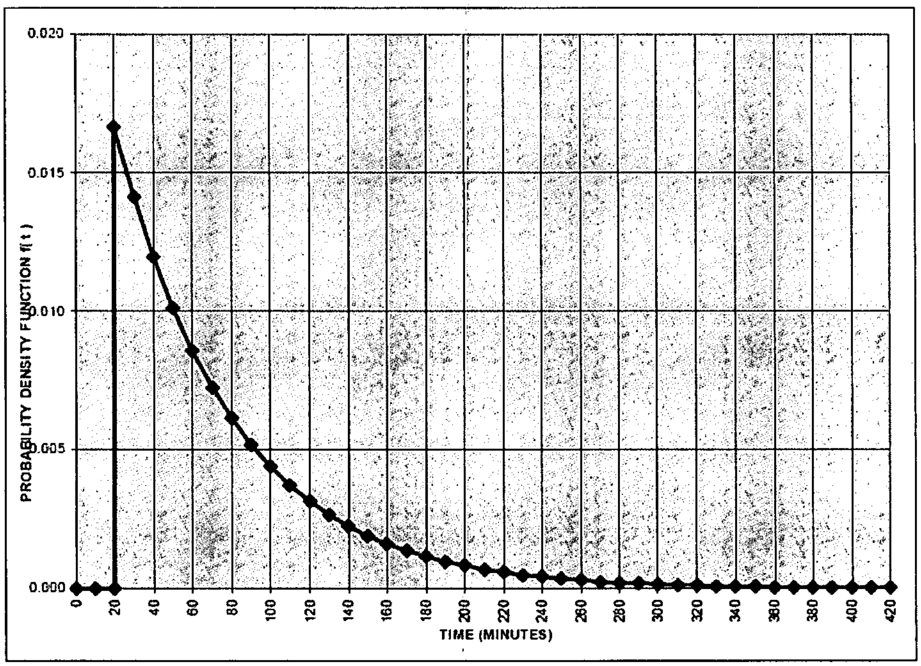


Figure 2: The probability density function f(t) Related to Figure 1

Estimating T_0

The problem of estimating these curves from data is divided into two estimations: (1) estimate the time T_0 and (2) estimate the parameter τ. There are various methods for doing this. Based upon the sample sizes and the number of sampling intervals used in the survey, it has proven effective to

- Select a value of T_0
- Estimate τ based upon methods described in this document
- Iterate as needed

In practice, the choice of T_0 has been clear from the plot of the survey results.

For the remainder of this document, given an initial choice of T_0, you are to shift all the data (or data categories) by subtracting T_0. The net effect of this is to create a version of Figure 2 with the curve starting at $t = 0$ rather than $t = T_0$.

Time Constant and Settling Time

In linear systems, it is common to say that the exponential curve has essentially settled to zero when either four or five time constants have passed. In fact,

$e^{-(4t/\tau)} = e^{-4} = 0.018$ or 1.8% of the original signal strength

$e^{-(5t/\tau)} = e^{-5} = 0.007$ or 0.7% of the original signal strength

Focus on the purpose of the analysis, which is to estimate "τ". The (shifted) Figure 2 curve is idealized. When inspecting data and conceptually sketching a curve through the cumulative plot of the data, it is quite feasible to identify the "4τ" level of 98.2% of the data to the left (i.e. 1.8% remaining) whereas identifying the "5τ" level with 99.3% of the data generally proves elusive due to the presence of outliers in the data. Therefore, while recognizing that the curve truly settles in 5τ, this procedure calibrates τ based upon the 98.2% level.

Therefore, as a key element of this procedure is to identify "τ", you will seek to establish the point at which the 1.8% threshold is passed in plots such as Figure 2, or the 98.2% threshold is passed in plots such as Figure 1 (shifted, in both cases).

The identification may be done by reference to the cumulative data plot (usually aggregated by category, from the survey) or by reference to a smooth exponential curve through that data.

Given that you are working with the curve up to the 4τ time, it can be truncated (brought to 100%) at any point thereafter.

For clarity:

time constant is the constant "τ" shown in Equations 1 and 2. If the exponential relation is written in the form e^{-At}, then $\tau = 1 / A$.

settling time is generally taken as five time constants. If the exponential relation is written in the form e^{-At}, then the settling time to the 1.8% level is $4 / A$.

In either Figures 1 or 2, it is easy to estimate by inspection that the settling time to the 4τ level is about 260 seconds from the graph, including the T_0 component. Therefore, the "time constant" is $\tau = (260\text{-}20)/4 = 60$ and $A = 1/60$. A later section in this document will give guidance by which to estimate "τ", for more difficult cases.

Note that the exponential curve never reaches zero, but approaches zero asymptotically. The concept behind using this curve is that "essentially everyone" has departed by five time constants. In the ETE application, this defines the 100th percentile.

Other percentiles (50th, 90th, 95th) can be found on the basis of entering Figure 1 on the vertical at the desired percentile and reading the corresponding time "t". The same can be achieved by solving Equation 1 for "t", given the percentile set on the left hand side of Equation 1.

From basic probability theory, it is known that the mean of the exponential distribution equals "1 / A" or "τ" (that is, one time constant). Let us formalize the procedure as:

Method 1 is estimating the settling time to the 4τ level by inspection as described above, and arriving at the estimated time constant "τ".

Method 2 for estimating the time constant is making it equal to the

{ (estimated mean mobilization time) - T_0 }

computed from the observations (i.e. samples) obtained. It may be necessary to do this by using the centers of the categories, given the method of data collection and recording.

With the analytic form of the curve thus determined, the curve can be plotted on the same display as the data, and any major anomalies can be identified.

A "major anomaly" would be a cumulative analytic curve that has the data systematically lying to one side or the other of the analytic curve, which is drawn in the form of Equation 1. This would imply that the shifted exponential form is not a satisfactory representation of the data.

As an example, consider the hypothetical data shown in Table 1, along with the computation of the estimated mean and estimated variance contained therein.

Table 1: Estimation of {(Mean Mobilization Time) – T_0}

	minutes CATEGORIES			FROM CATEGORY OBSERVATIONS	
Cat #	FROM	TO	Observed	EST MEAN	EST STD
1	0	30	228	3420	51300
2	30	60	149	6705	301725
3	60	90	88	6600	495000
4	90	120	47	4935	518175
5	120	150	42	5670	765450
6	150	180	12	1980	326700
7	180	210	8	1560	304200
8	210	240	5	1125	253125
9	240	270	6	1530	390150
10	270	END	5	1425	406125
			590	34950	3811950

590 observations	6472 est variance
59.2 deduced mean	80.4 est std
	6.5 for conf bound on mean

With 95% confidence, mean is estimated		
to be between	52.7	minutes
and	65.7	minutes

The estimated time constant is therefore 59.2 minutes, given the particular sample used for this computation.

Note that the 95% confidence bound range on this estimate of the mean is from 52.7 to 65.7 minutes. A hypothesis that the mean is any value in this range would not be rejected[1].

Because the data tends to be aggregated into groups due to the survey (stated ranges are checked by the interviewer, rather than interviewee estimate of minutes, it is not necessarily true that Method 1 is markedly better than Method 2. Rather, the two results should be compared for reasonableness.

Should there be a clear anomaly, one can expect the underlying hypothesis to be rejected in the next section.

A Goodness-of-Fit Test for the Hypothesized Curve

The hypothesis to be tested is that the underlying probability density function (pdf) is as described in Equation 2, with the constant "τ" or "A" determined by

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[1] Indeed, for this illustration within this procedure, the true mean of the distribution that generated the "data" was 60 minutes. Normally, of course, this would not be known and the above estimate would be the best available.

Methods 1 or 2 or an alternative method (described herein). **In practice, one is to use Method 1 as the preferred method.** *Should an analyst recommend another choice, it is to be discussed with the senior analyst and the QC Officer.*

The statistical test to be used is chi-square goodness-of-fit test. A level of significance of $\alpha = 0.05$ will be used.

The procedure calls for the data to be divided into at least 5 categories, generally such that the shape of the curve to be calibrated is retained. More than 5 categories are preferred. The category widths need not be equal.

A number of standard statistical packages (e.g. SPSS, StatGraphics, MiniTab) contain the chi-square goodness of fit test. It can also be done on a spreadsheet.

Refer to Table 2, which shows the results of a hypothetical set of survey data. The KLD spreadsheet accompanying this procedure was used. Note that:

1) There are at least five categories and at least 5 samples per category;
2) The last category is open-ended;
3) The categories are selected such that the "expected" bars do not obscure the fact that they represent the exponential distribution;
4) While the "observed" differs from the "expected", it is within the range of natural variability for the number of samples and categories, so that the conclusion *in this illustration* is "**do not reject the hypothesis**".

With that decision reached, one then proceeds to use the exponential distribution as descriptive of the phenomenon being modeled (e.g. the mobilization times). For the purpose of identifying where the sample distribution may be truncated.

Table 2: Chi-Square Test on the Mobilization Distribution Above T_0

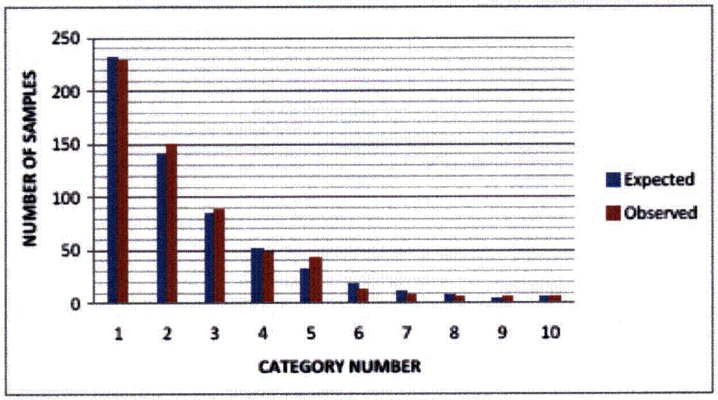
CHI-SQUARE TEST ON EXPONENTIAL DISTRIBUTION OF MOBILIZATION TIMES

time constant = 60 minutes LEVEL OF SIGNIFICANCE = 0.05

	CATEGORIES		PROB WITH
Cat #	FROM	TO	EXP DIST
1	0	30	0.393
2	30	60	0.239
3	60	90	0.145
4	90	120	0.088
5	120	150	0.053
6	150	180	0.032
7	180	210	0.020
8	210	240	0.012
9	240	270	0.007
10	270	END	0.011

	Expected	Observed	CHI-SQ	
1	232	228	0.074	
2	141	149	0.477	
3	85	88	0.079	
4	52	47	0.445	
5	31	42	3.564	
6	19	12	2.613	
7	12	8	1.095	
8	7	5	0.576	
9	4	6	0.719	
10	7	5	0.369	
		590	10.011	COMPUTED

Decision Point = 16.919
with α above and df = {#categories - 1}



HYPOTHESIS: UNDERLYING DISTRIBUTION IS EXPONENTIAL, WITH PARAMETERS SHOWN

CONCLUSION

DO NOT REJECT HYPOTHESIS

implication: use the exponential relation

Notes

1. # categories > 5, # samples per category > 5
2. categories need not be equal span (range)
3. expected distribution should follow hypothesized curve, namely exponential (do not aggregate too much, particularly where curve changes quickly)
4. this spreadsheet starts with 10 categories, with the first nine each 1/2 of a time constant wide. The user can modify the red bold category ends, and can change the number of categories

Another Graphical Display, Involving the Natural Logarithm

It is interesting that if one takes the natural logarithm of both sides of Equation 2, the result is a linear relation, namely

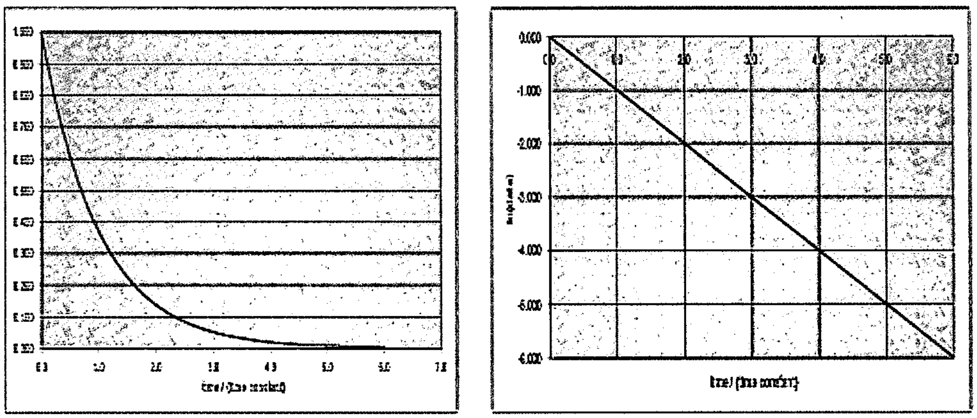
$$\ell n\{ f(t) \} = -\{ t / \tau \} + \ell n \{ 1 / \tau \}$$

or (3)

$$\ell n\{ f(t) \} = a + b\,t$$

where "b" is actually " – A" or " -1 / τ "

Refer to Figure 3 for an illustration of how Equation 2 and 3 would plot, normalized to (t/τ), which is the same as saying plotting for τ = 1 just for illustration[1].



a) f(t) versus t/τ b) ℓn{ f(t) }versus t/τ

Figure 3: Plot of Exponential Function

Figure 4 shows the logarithmic plot of the "data" from Table 1, with the trend line from the data. The "trend line" obtained in Excel is in fact the same as that resulting from a linear regression. If one does the regression using Data Analysis tools in Excel, the result is

Estimated time constant = 60.2 $\pm$ 11.7 minutes

For present purposes, let us define the use of the regression line in this format as **Method 3** for arriving at an estimate of the time constant.

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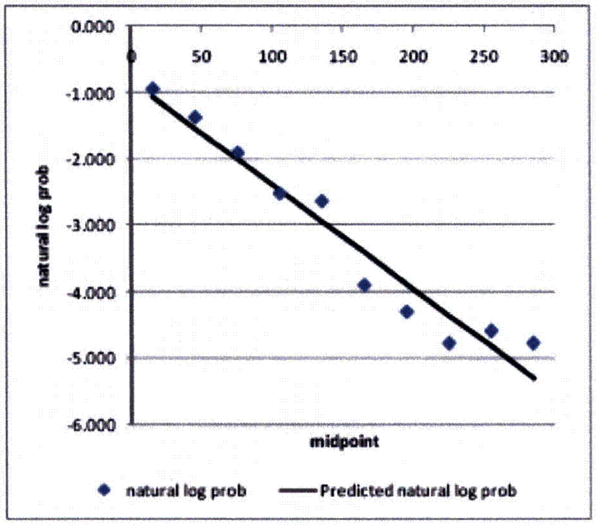
[1] At one time, it was common to use semi-log paper to plot this, with the scale on the paper taking care of the logarithmic conversion.



midpoint	natural log prob
15	-0.951
45	-1.376
75	-1.903
105	-2.530
135	-2.642
165	-3.895
195	-4.301
225	-4.771
255	-4.588
285	-4.771

Figure 4: Plot of the Table 1 "Data" in Logarithm Form for the Percent by Category

This is rather consistent with the Method 2 estimate of 59.2 $\pm$ 6.5 minutes.

Comparing the three "methods" side-by-side, Figure 5 shows a negligible difference in the results, at least on a visual scale. The analyst is to use Method 1, but as this illustration demonstrates, the other methods yield comparable results, with no more than $\pm$ 2% on the 50^{th} percentile and $\pm$ 1% at the 90^{th}, 95^{th}, or 99^{th} percentiles. This is well within the natural variability of the statistics, given the number of samples and the inherent variability in the population. Consider Table 3, as an illustration.

Table 3: Percentile Results, for Different Methods

Percentiles indicated, in minutes			
	Method 1	Method 2	Method 3
50th	42	41	42
90th	138	136	139
95th	180	178	180
99th	271	271	273

Note: Add T_0 = 20 minutes for actual mobilization times

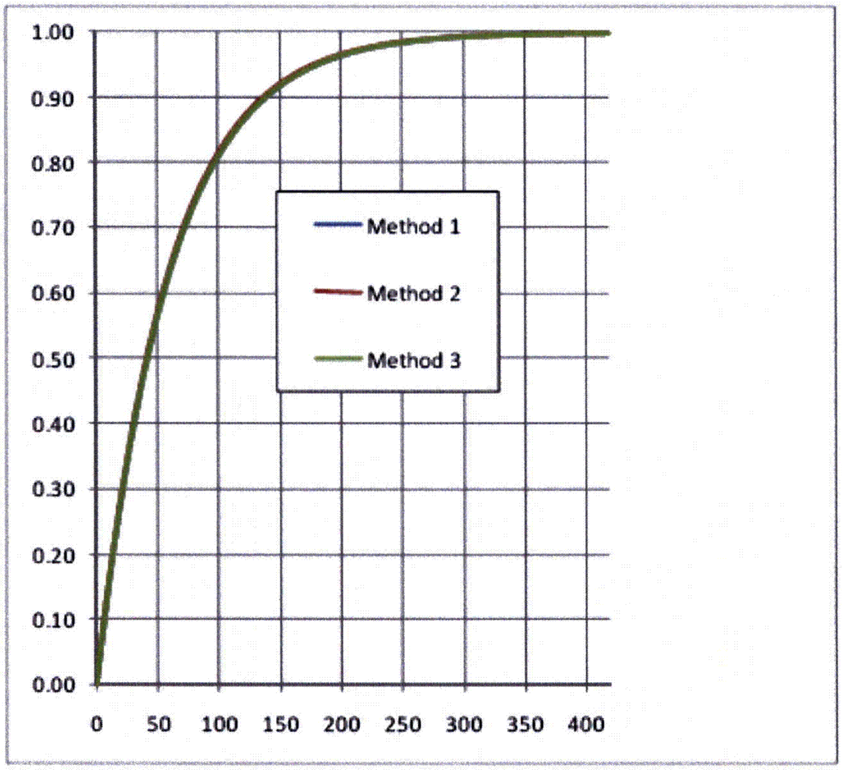


Figure 5: Comparison of Three Methods of Estimating τ

Insights and Guidance for the Analyst

1) Method 1 is to be used as the default method. If another method is considered, it must be discussed with the senior analyst and reviewed by the quality control officer.

2) Given the natural variability in the data and the survey sample sizes, any differences shown herein are within the expected variability of the results.

3) Table 3 illustrates the variability that may arise, in terms of percentile values of the mobilization distribution. As shown in Figure 3, the numbers that appear somewhat different in Table 3 have little practical impact in Figure 5.

4) All of the analysis and methods have focused on the most common model of a homogeneous population mobilizing. If there were more complex models (see the next section), the problem can be subdivided into "regimes" and the above techniques applied within each regime. Because this is not as common, the analyst should review such cases with the senior analyst and quality control officer when they occur.

5) Note that the "outlying" points typical of survey responses may shift the mean somewhat, but not in a major way. The methods used do not depend on the outliers as much as on the 98.2% level or the mean. That is, good estimates of the major percentiles can be obtained from the underlying curve, as illustrated in Figure 5.

6) In reviewing work, the analyst may find that the mobilization curve is not continued past the 95th percentile or that it is sketched unevenly (poorly) past that point. Fortunately, as cited in #5, the time constant τ (whether estimated by Methods 1, 2, or 3) is the prime determinant of the curve and of the key percentiles.

7) The goodness-of-fit test is intended to assure that the hypothesis of an underlying exponential distribution is plausible. If it is not, the analyst can expect the result of "reject hypothesis" in the analysis illustrated in Table 2.

8) Indeed, if the data in the Figure 4 display is done at the time of the goodness-of-fit test, the analyst can then expect the data to <u>not</u> appear randomly distributed about the trend line. In particular, a range that has the values on only one side – notably toward the end – may represent a more complex underlying model.

The conclusion in #8 occurs infrequently, and the senior analyst should then be involved, with a review by the QC officer expected.

Other Model Forms

Three variations may occur, as illustrated in Figures 6, 7, and 8:

- Figure 6 shows a 2-regime model in which there are two distinct groups *that can be discerned* in the data. For instance, Group 1 may start to leave immediately and follow the basic model pattern. Group 2 may start some time later (due to returns home, etc) and then follow a shifted exponential, perhaps with a different time constant. The curve may also be shifted at $t = 0$.
- Figure 7 shows a 3-regime model in which there are three distinct groups *that can be discerned* in the data. The curve may also be shifted at $t = 0$.
- Figure 8 shows a delayed curve with a smooth rise (shown compared to the dashed basic model with $T_0 = 0$).

If and when the data displays these unexpected multi-regime patterns, the senior analyst is to be involved, and a special analysis is to be documented and submitted to the QC officer.

--end--

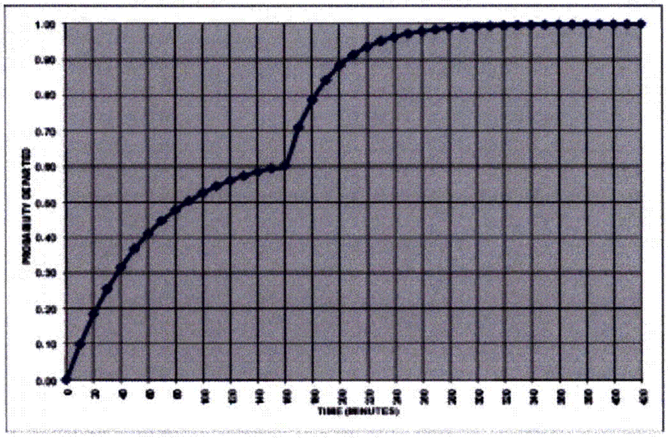


Figure 6: 2-regime model

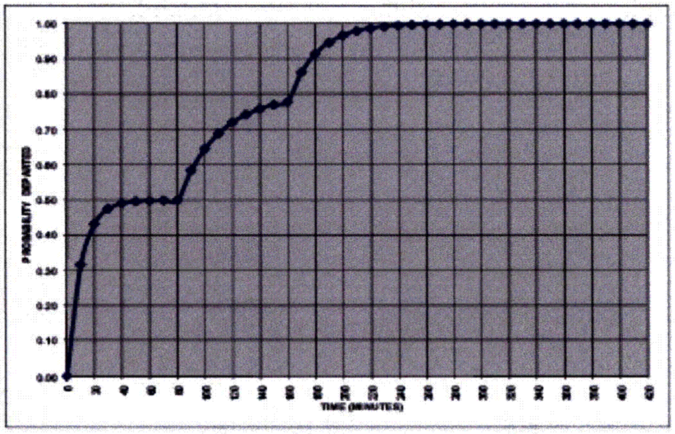


Figure 7: 3-regime model

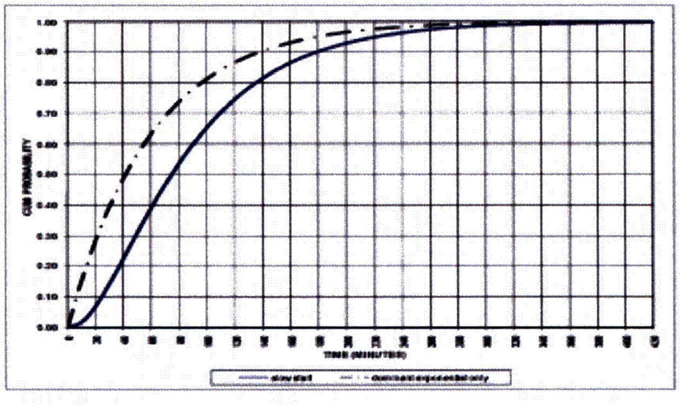


Figure 8: delayed initiation model, compared to basic model

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-10

ETE-10: Traffic Capacity, Evacuation Roadway Network

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: Appendix 4 to NUREG-0654 Sections III.A, Section III.B

A. Appendix K, "Evacuation Roadway Network Characteristics," contains road characteristics for the links and nodes, but there is no reference tying them to the map in Figure 1-2, "Link-Node Analysis Network." The maps also do not contain sector and quadrant boundaries. Provide an annotated map or maps that include the nodes identified in Appendix K, "Evacuation Roadway Network Characteristics," including sector and quadrant boundaries.

B. A traffic management strategy is included in the plan in Section 9, "Traffic Management Strategy." The implementation of this strategy including access control points and traffic control points are included in Appendix G, "Traffic Control." It is not clear how these strategies affect the Evacuation Time Estimate (ETE) or how they are used.

1. Explain how the ETE modeling addresses the movement of vehicles through traffic control intersections.
2. Explain how the traffic management strategy affects ETE calculations.

C. Section K.5.c.6, "Evacuation," of the Richland Emergency Response Plan states that access to the evacuated area will be stringently enforced by local law enforcement, and only predetermined forms of identification will allow entrance to the evacuated area. In ETE Section 9, "Traffic Management Strategy," states that there may be legitimate reasons for people to reenter the EPZ and they will be flexible. Discuss the impact that reentry into the plume exposure pathway EPZ will have on evacuation time estimates.

VCSNS RESPONSE:

A. A 48 inch by 36 inch PDF file of Figure 1-2, exported at a resolution of 350 dpi from the original GIS file, is provided in an electronic format. The node numbers (from Appendix K) are labeled in the map. Sector, quadrant and county boundaries have also been provided in the map.

B. Conservatively, the ETE calculations do not rely upon the manning of any of the traffic control points in Appendix G. The estimates of capacity, which are used by the I-DYNEV system and are documented in Appendix K, are based upon the factors described in Section 4 and upon the observations made during the road survey. It is assumed that these capacity estimates are not enhanced nor compromised by the establishment of a Traffic Control Point (TCP) at an intersection.

As detailed in Section 9, the functions to be performed in the field at TCPs are to (1) facilitate evacuating traffic movements; and (2) discourage those movements that would move travelers closer to the VCSNS. The personnel manning these TCPs will also serve a surveillance function to inform the EOC of any problems that occur in the vicinity or are reported to them by evacuees. Thus, the calculated ETE does not rely upon implementation of the TPCs detailed in ETE Appendix G. See the responses to RAI 13.03-4, Part B (ETE-3B) for more information.

C. Assumption 6 of Section 2.3 of the ETE report indicates that Access Control Points (ACP) are staffed 1 to 2 hours after the advisory to evacuate (ATE). The inputs to the model indicate that traffic stops entering the EPZ at 90 minutes after the ATE. Figure F-10 of the ETE report indicates that approximately 99% of the EPZ population surveyed could travel home from work in 90 minutes or less, justifying the use of 90 minutes after the ATE for the entry of traffic into the EPZ to stop.

One of the primary findings of NUREG/CR-6953, Volume 2 is that, "[t]he public prefers to respond as a family unit." Therefore, it is reasonable to assume that most EPZ residents who work outside of the EPZ would return home to gather with family and evacuate together. In addition, the commuter returning home may have the only household vehicle. If the commuter is not permitted to enter the EPZ, there will likely be a higher transit dependent population within the EPZ, which will require additional transit resources for evacuation.

It will take time to mobilize personnel and equipment before implementing traffic and access control; thus, it is likely that there will be a period of time following the advisory to evacuate when vehicles will continue to enter the area being evacuated. The assumed 90 minute timeframe for allowing entry into the EPZ was reviewed by the EPZ counties as they were presented with the ETE report prior to COLA submittal.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

Assumptions 6 and 7 on page 2-4 will be revised as follows:

6. Access Control Points (ACP) will be staffed within approximately ~~1 - 2 hours following~~ 90 minutes of the siren notifications, to divert traffic attempting to enter the EPZ. Earlier activation of ACP locations could delay returning commuters. It is assumed that no vehicles will enter the EPZ after this ~~1 – 2 hour~~ 90 minute mobilization time period.

7. Traffic Control Points (TCP) within the EPZ will be staffed over time, beginning at the Advisory to Evacuate. Their number and location will depend on the Region to be evacuated and personnel resources available.

The objectives of these TCP are:

- Facilitate the movements of all (mostly evacuating) vehicles at the location.
- Discourage inadvertent vehicle movements toward the VCSNS.
- Provide assurance and guidance to any traveler who is unsure of the appropriate actions or routing.
- Act as a local surveillance and communications center. Provide information to the emergency operations center (EOC) as needed, based on direct observation or on information provided by travelers.

Consistent with these objectives, there is no expectation that the operation of TCP will materially shorten evacuation times. In calculating ETE, i~~I~~t is assumed that drivers will act rationally, travel in the directions identified in the plan (as documented in the public information material), and obey all control devices and traffic guides. Therefore, the TCP are not expected to enhance or impede the flow of traffic. Consequently, any shortfall of personnel or equipment will not influence the ETE results. Also, the time needed to mobilize personnel or equipment will not influence the ETE results.

The "External Through Traffic" footnote on page 6-5 will be revised as follows:

Traffic on local highways and major arterial roads at the start of the evacuation. This traffic is stopped by access control approximately ~~1-2 hours~~ 90 minutes after the evacuation begins.

The following discussion will be added to page 9-2:

As discussed in Section 2.3, these TCPs are not expected to influence the ETE results. Access control points (ACP) are deployed near the periphery of the EPZ to divert "through" trips. The ETE calculations reflect the assumption that all "external-external" trips are interdicted after 90 minutes have elapsed after the advisory to evacuate (ATE).

All transit trips and other responders entering the EPZ to support the evacuation are assumed to be unhindered by personnel manning TCPs.

Study Assumptions 6 and 7 in Section 2.3 discuss ACP and TCP staffing schedules and operations.

ASSOCIATED ATTACHMENTS:

None

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-11

ETE-11: Traffic Capacity, Roadway Segment Characteristics

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: Appendix 4 to NUREG-0654 Section III.B

A. Appendix K, "Evacuation Roadway Network Characteristics," lists lane widths as 1, 2, or 3 inferring two-lane roads, highways, and freeways. The actual width of the lane is not provided. The field survey does not confirm whether lane widths are greater than or equal to 12 feet, shoulder widths are wider than or equal to 6 feet, and whether there are other impediments to through traffic as described in Chapter 12 of the Highway Capacity Manual. Provide information regarding lane widths.

B. Section 1.3, "Preliminary Activities," states that the characteristics of each section of the highway were recorded during field surveys. These included unusual characteristics, such as narrow bridges, sharp curves, poor pavement, flood warning signs, inadequate delineations, etc. In addition, Section 4, "Estimation of Highway Capacity," states that sections of roadway with adverse geometrics are characterized by lower free-flow speeds and lane capacity.

1. Identify the location and nature of the highway sections with unusual characteristics, and describe how this information was reflected in the Evacuation Time Estimate calculations.
2. Identify and discuss, with respect to Appendix K, "Evacuation Roadway Network Characteristics," which segments reflect the narrowest roadway sections within the roadway network.
3. Describe the impact of these narrow road segments on evacuation time estimates.

C. Section 4, "Estimation of Highway Capacity," states a value of R=0.85 was employed based on empirical data collected on freeways. Describe the empirical data that supports the value of R=0.85, including how the value was determined.

VCSNS RESPONSE:

A, B. Appendix K does not list lane widths. The term "full lanes" is used to identify the number of lanes that extend over the entire length of the roadway segment or link. Many network links are widened with additional lanes near the downstream intersection (e.g., left-turn bays, right-turn bays, additional through lanes). These additional lanes are all properly represented in the input stream for the I-DYNEV system. Lane widths vary from one link to the next and even within one link as do shoulder width, grade, and horizontal curvature. In accord with NUREG- 0654, Appendix 4, Section IIIB, the estimation of capacity (expressed as saturation flow rate in the fifth column of the table in Appendix K) is based on the narrowest section of the roadway segment. The free-flow speed shown in Appendix K is based upon observation of traffic movements during the field survey; these estimates do not necessarily comport with the speed advisory signing. Lane widths were observed but not measured during the field survey. See the response to RAI 13.03-5, part B for additional discussion of the field survey. As noted in the response to RAI 13.03-03 and RAI 13.03-10, part A, a large-scale version of Figure 1-2 is provided. The node numbers are provided in the figure and the links can be cross referenced with Appendix K.

The number of bridges, sharp curves, narrow shoulders and other capacity-reducing features on the evacuation network were observed and considered in estimating capacity. Bridges are treated, for ETE purposes, as links in the highway network. Their properties are recorded in Appendix K (with all other links), but are not otherwise delineated.

To represent the changing geometric features along a highway, the modeling process subdivides a highway into sequential links, each with its own reasonably consistent set of attributes, including lane width. The objective is to assign estimated values of saturation flow rates and free speed for each link that are reflective of its features.

Where the "ideal" conditions are not realized, downward adjustments to the capacity estimate of 1,700 pc/hr were made. These adjustments, which can be viewed in Appendix K, are based on the guidance provided in Exhibit 12-15 of the 2000 Highway Capacity Manual (HCM). Note that the base conditions for this exhibit include a 60/40 directional split. This assumption would not be realized during an evacuation where the flow is primarily outbound and the directional split is more likely to be 80/20 or 90/10. There would be limited inbound traffic, particularly after 90 minutes following the advisory to evacuate when evacuating traffic volumes are high. As is shown in Exhibit 12-7(b), a reduced opposing flow rate is associated with a lower percentage of "Time-spent-following," a measure of "[t]he comfort and convenience of travel." [p.12-12, HCM] As shown in Exhibit 20-4, Level of Service (LOS) is related to percent time-spent-following.

As discussed in the responses to RAI 13.03-4, part B and RAI 13.03-5, part B, the mobilization time dictates the ETE. There is excess capacity within the EPZ and the reduced capacities on the narrowest road segments have no effect on ETE.

C. The advisability of such a capacity factor is based upon empirical studies that identified a fall-off in the service flow rate when congestion occurs at "bottlenecks" or "choke points" on a freeway system. Zhang and Levinson[2] describe a research program that collected data from a computer-based surveillance system (loop detectors) installed on the Interstate Highway System, at 27 active bottlenecks in the twin cities metro area in Minnesota over a 7-week period. When flow breakdown occurs, queues are formed which discharge at lower flow rates than the maximum capacity prior to observed breakdown. These queue discharge flow (QDF) rates vary from one location to the next and also vary by day of week and time of day based upon local circumstances. The cited reference presents a mean QDF of 2016 passenger cars per hour per lane (pcphpl). This figure compares with the nominal capacity estimate of 2250 pcphpl that is representative for freeway links. The ratio of these two numbers is 0.896 which translates into a capacity reduction factor of 0.90. The data collected in the cited reference indicates that the variation of QDF at a location is generally in the range of +/- 5% about the average QDF. That is, the lower tail of this distribution would be equivalent to a capacity reduction factor of 0.90 - 0.05 = 0.85 which is the figure applied by DYNEV.

The ETE report takes a conservative view in estimating the capacity at bottlenecks when congestion develops (this capacity is the QDF rate discussed above). One could argue that a more representative value for this capacity reduction factor could be 0.90 as discussed above. Given the emergency conditions, we believed that a conservative stance was justified. Therefore, the software applies a factor of 0.85 *only when flow breaks down*, as determined by the simulation model.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

Page 4-4 of the ETE report will be revised as follows:

> Based on empirical data collected on freeways, we have employed a value of R=0.85[1]. It is important to mention that some investigators, on analyzing data collected on freeways, conclude that little reduction in capacity occurs even when traffic is operating at Level of Service, *F*. While there is conflicting evidence on this subject, we adopt a conservative approach and use a value of

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[1] Lei Zhang and David Levinson, "Some Properties of Flows at Freeway Bottlenecks," Transportation Research Record 1883, 2004.

capacity, V_F, that is applied during LOS F conditions; V_F, is lower than the specified capacity.

ASSOCIATED ATTACHMENTS:

None

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-12

ETE-12: Analysis of Evacuation Times, Report Format

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: Appendix 4 to NUREG-0654 Section IV.A.1

A. According to Table 6-2, "Evacuation Scenario Definitions," ice was only evaluated for winter, midweek, and midday. Explain why ice conditions were not evaluated for the weekends or for the evening when ice conditions could potentially be worse than they are during the day.

B. In Table 7-1A, "Time to Clear Indicated Area of 50 Percent of the Affected Population," and Table 7-1B, "Time to Clear Indicated Area of 90 Percent of the Affected Population," ice only appears to cause a five-minute delay in Regions 12 and 13, respectively. Table 7-1D, "Time to Clear Indicated Area of 100 Percent of the Affected Population," does not appear to show any difference in evacuation time between rain and ice conditions. Explain why only Regions 12 and 13 are affected by ice when evacuating 50% and 90% of the population.

C. Tables 8-5A and B, "School Evacuation Time Estimates-Good Weather/Rain," do not contain estimates for evacuation under icy conditions. Tables 8-6A and B, "Transit Dependent Evacuation Time Estimates-Good Weather/Rain," also do not include estimates for ice conditions. Explain why icy conditions were not considered in the estimates provided for schools and transit dependent people in Tables 8-5A/B and 8-6 A/B.

VCSNS RESPONSE:

A. The failure to include an ice weekend/evening scenario was an oversight: We will renumber Scenarios 11 and 12 as Scenarios 12 and 13, respectively in a future revision of the ETE report and add new Scenario 11 (winter weekend/evening with ice). Thus, Scenarios 9, 10 and 11 (all winter, weekend scenarios) will appear in adjoining columns in the ETE tables (Tables 7-1A through D) so that a rapid assessment of the effect of rain and ice on the ETE can be made.

As documented in the table on page 2-5 of the ETE report (and corrected in the response to part B), rain is estimated to reduce the free speed and capacity of all links in the analysis network by 10%, while ice reduces the free speed and capacity by 20%. The only difference between the weekday and weekend rain scenarios is the number of people evacuating, as shown in Table 6-4. The weekend and the evening scenarios are similar in that most commuters are home, as shown in Table 6-3.

B. The presence of ice reduces capacity and free speed on all network links, as discussed on page 2-5 of the ETE report. The input files were reviewed, and the capacity reduction used was actually 20%, not 15% as indicated in the table on page 2-5. This table will be corrected in a future revision of the ETE report. Tables 7-1A through D indicate that the adverse weather conditions (rain and ice) do not have a significant effect (all changes are 10 minutes or less) on ETE. Rain and ice do not materially influence the ETE because the volume of traffic following the Advisory to Evacuate never attains a level where capacity is a factor in influencing travel time even when capacity is reduced by inclement weather (see the response to RAI 13.03-4, part B).

The effect of the reduction in free flow speed, alone, due to rain or ice is generally not sufficient, by itself, to materially increase the ETE, due to the relatively short trip lengths within the EPZ. The average speeds output by PC-DYNEV are 55.8, 50.2, and 44.7 mph for an evacuation of the entire EPZ (Region R03) under the conditions of Scenarios 6, 7 and 8, respectively. A 10-mile evacuation trip within the EPZ would require travel times at the average speeds of 10.8, 12.0, and 13.4 minutes for Scenarios 6, 7 and 8, respectively. As stated in the second paragraph of Section 7, data are generated by PC-DYNEV at 10 minute intervals and interpolated to round to the nearest 5 minutes. A change of 1.4 minutes in travel time (13.4 – 12.0) between a rain and an ice scenario is less than 5 minutes and would not materially affect ETE.

However, if the interpolation produces ETE results near the midpoint of a 5-minute interval, a small difference in travel time could cause a numerical difference in ETE between a rain and an ice scenario when the interpolation is rounded to the nearest 5 minutes. Table 1 shows the vehicles evacuated output by PC-DYNEV every 10 minutes for an evacuation of Region 13 under Scenario 7 and Scenario 8 conditions. As the table shows, there are 3,235 vehicles evacuating for the Region. Therefore, the 50th percentile of 1,618 vehicles would evacuate between 1:20 (hr:min) and 1:30 after the advisory to evacuate for both scenarios. The interpolation provided in Table 2 indicates that the 50th percentile would evacuate at 1:21.9 for Scenario 7 and 1:23.1 for Scenario 8. As previously noted, ETE are rounded to the nearer 5 minutes: Therefore, the 50th percentile ETE for Scenario 7, Region 13 is output as 1:20, and for Scenario 8, it rounds to 1:25. This interpolation procedure is used for all ETE values and explains the 5 minute difference in the 90th percentile ETE for an evacuation of Region 12 under Scenario 7 and 8 conditions.

Table 1. Vehicles Evacuated - Output by PC-DYNEV		
REGION 13		
Time After Advisory to Evacuate	Sc. 7 (RAIN) Vehicles Evacuated	Sc. 8 (ICE) Vehicles Evacuated
0:10	33	29
0:20	105	89
0:30	256	231
0:40	482	451
0:50	753	719
1:00	1031	999
1:10	1306	1274
1:20	1567	1536
See Interpolation - Table 2		
1:30	1829	1799
1:40	2076	2049
1:50	2291	2265
2:00	2483	2470
2:10	2617	2610
2:20	2722	2716
2:30	2826	2821
2:40	2904	2899
2:50	2956	2955
3:00	3006	3004
3:10	3048	3048
3:20	3080	3081
3:30	3114	3114
3:40	3149	3149
3:50	3181	3182
4:00	3217	3218
4:10	3234	3233
4:20	3235	3235
4:30	3235	3235
4:40	3235	3235
4:50	3235	3235

Table 2. Region 13 ETE Interpolation		
Item	**Sc. 7 (RAIN)**	**Sc. 8 (ICE)**
Lower bound (1:20) vehicles	1567	1536
50th percentile vehicles	1618	1618
Upper bound (1:30) vehicles	1829	1799
Time to reach 50th percentile (min)	121.9	123.1
ETE rounded to nearest 5 minutes	1:20	1:25

C. Table 8-5C "School Evacuation Time Estimates – Ice" and Table 8-6C "Transit Dependent Evacuation Time Estimates – Ice" will be added to a future revision of the ETE report.

As stated in the "School Evacuation" heading (pages 8-5 and 8-6) in Section 8.4 of the ETE report, evacuating vehicles are mostly traveling at free-flow speeds. South Carolina state law, however, restricts school buses to a 45 mph speed limit. Therefore, a 45 mph speed was used to compute the school ETE for good weather. Travel speed was reduced by 10 percent for rain scenarios and will be reduced 20 percent for ice scenarios. A 10 minute increase in mobilization time was assumed for rain conditions to allow for slower travel speeds as the bus driver drives to the depot to pick up the bus and then drives from the depot to the school. A 20 minute increase will be added to the base mobilization time for ice scenarios. The loading time was increased by 5 minutes for rain scenarios to account for students who may be carrying umbrellas who have to close the umbrella before boarding the bus. It is assumed that this loading time is also adequate for ice scenarios. The attached Table 8-5C provides the ETE for schools under icy conditions.

The ETE for the transit dependent population during rain was computed assuming 5 additional minutes of route travel time and of passenger pickup time to account for slower travel times. The ETE for ice will assume 10 additional minutes of route travel time and of passenger pickup time. The attached Table 8-6C provides the ETE for the transit dependent population under icy conditions.

The text of Section 8.4 will be revised accordingly in a future revision of the ETE report.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

The scenario table on page 2-2 will be revised as follows:

Scenario	Season	Day of Week	Time of Day	Weather
1	Summer	Midweek	Midday	Good
2	Summer	Midweek	Midday	Rain
3	Summer	Weekend	Midday	Good
4	Summer	Weekend	Midday	Rain
5	Summer	Midweek, Weekend	Evening	Good
6	Winter	Midweek	Midday	Good
7	Winter	Midweek	Midday	Rain
8	Winter	Midweek	Midday	Ice
9	Winter	Weekend	Midday	Good
10	Winter	Weekend	Midday	Rain
11	Winter	Weekend	Evening	Ice
~~11~~ 12	Winter	Midweek, Weekend	Evening	Good
~~12~~ 13	Summer	Midweek	Midday	Good

Table 6-2 "Evacuation Scenario Definitions" will also be revised as shown above.

Tables 7-1A through D will be revised to incorporate the additional scenario shown above.

All references to "12 scenarios" will be changed to "13 scenarios".

The table on page 2-5 will be revised as follows:

Scenario	Highway Capacity*	Free Flow Speed*	Mobilization Time of the General Population
Rain	90%	90%	No Effect
Ice	~~85%~~ 80%	~~85%~~ 80%	No Effect
*Adverse weather capacity and speed values are given as a percentage of good weather conditions. Roads are assumed to be passable.			

Section 8.4 of the ETE report will be revised as follows:

8.4 <u>Evacuation Time Estimates for Transit-Dependent People</u>

Based on discussions with South Carolina Electric & Gas and the county offices of emergency management for the four counties in the EPZ, additional buses needed to evacuate transit-dependent people from the EPZ will be provided by the larger cities neighboring the EPZ – Winnsboro, Newberry, and Columbia. The available resources expressed in terms of bus-seats, are sufficient in each county to service the evacuation demand in a "single-wave", assuming drivers are available for all vehicles. In general, the buses will transport the evacuees to the appropriate reception centers and return to the EPZ for a second trip if needed.

In the event that the allocation of buses dispatched from the depots to the various facilities and to the bus routes is somewhat "inefficient", or if there is a shortfall of available drivers, then there may be a need for some buses to return to the EPZ from the reception center after completing its first evacuation trip, to complete a "second wave" of providing transport service to evacuees. For this reason, the ETE will be calculated for both a one wave transit evacuation and for two waves (Tables 8-6). Of course, if the impacted Evacuation Region is other than R3 (the entire EPZ), then there will likely be ample transit resources relative to demand in the impacted Region and this discussion of a second wave would likely not apply.

For each county, transit resources will be assigned to schools as a first priority. When these needs are satisfied, subsequent assignments of some of these buses to service the transit-dependent after the school children are delivered to the relocation centers would be sensitive to their mobilization time. Clearly, these buses, which are available within two hours after the Advisory to Evacuate (see Table 8-5A), should be dispatched after people have completed their mobilization activities and are in a position to board the buses when they arrive at the pick-up points.

Evacuation Time Estimates for Transit Trips were developed using both good weather and adverse weather conditions. Figure 8-1 presents the chronology of events relevant to transit operations. The elapsed time for each activity will now be discussed with reference to Figure 8-1.

Activity: Mobilize Drivers (A→B→C)

Mobilization is the elapsed time from the Advisory to Evacuate until the time the buses are dispatched from their respective depots. It is assumed that for a rapidly escalating radiological emergency with no observable indication before the fact, drivers would likely require 90 minutes to be contacted, to travel to the depot, be briefed, and to travel to the transit-dependent facilities. Mobilization time is slightly longer during adverse weather to account for slower travel times: ~~– 100 minutes – when raining.~~ 100 minutes during rain and 110 minutes during icy conditions.

Activity: Board Passengers (C→D)

Studies have shown that passengers can board a bus at headways of 2-4 seconds (Ref. HCM2000 Page 27-27). Therefore, the total dwell time to service passengers boarding a bus to capacity at a single stop (e.g., at a school) is about 5 minutes. A loading time of 10 minutes will be used for rain and ice scenarios. For multiple stops along a pick-up route we must allow for the additional delay associated with stopping and starting at each pick-up point. This additional delay to service passengers expands this estimate of boarding time to 15 minutes in good weather, ~~and~~ 20 minutes in rain~~.~~, and 25 minutes during icy conditions.

Activity: Travel to EPZ Boundary (D→E)

School Evacuation

The distance from a school to the EPZ boundary is measured using Geographical Information Systems (GIS) software along the most likely route out of the EPZ. The travel times to the EPZ boundary are based on evacuation speeds computed by the model. The model outputs indicate that evacuating vehicles are traveling at free flow speeds as is to be expected in a low congestion environment. South Carolina state law restricts school buses to a 45 mph speed limit; therefore, this was the speed used to calculate the travel time to the EPZ boundary.

Travel speeds are reduced by 10 percent for rain scenarios and 20 percent for ice scenarios. Tables 8-5A (good weather), ~~and~~ 8-5B (rain) and 8-5C (ice) present the following evacuation time estimates (rounded up to the nearest 5 minutes) for schools in the EPZ: (1) The elapsed time from the Advisory to Evacuate until the bus exits the EPZ; and (2) The elapsed time until the bus reaches the School Reception Center. The evacuation time out of the EPZ can be computed as the sum of travel times associated with Activities A→B→C, C→D, and D→E (For example: 90 min. + 5 + 5 = 1:40 for Chapin High School, with good weather). The evacuation time to the School Reception Center is determined by adding the time associated with Activity E→F (discussed below), to this EPZ evacuation time.

<u>Evacuation of Transit-Dependent Population</u>

The buses dispatched from the depots to service the transit-dependent evacuees will be scheduled so that they arrive at their respective routes after their passengers have completed their mobilization. As indicated in Section 5, about 90 percent of the evacuees will complete their mobilization when the buses will begin their routes, 120 minutes after the Advisory to Evacuate for both good and adverse weather. ~~and rain.~~

Those buses servicing the transit-dependent evacuees will first travel along their pick-up routes, then proceed out of the EPZ; Figure 8-2 maps the proposed bus pick-up routes. Figure 8-2 shows more buses (10 buses) than are estimated (8 buses) in Section 8.1; additional buses have been added to assure that each county has sufficient resources to evacuate transit-dependent persons. The travel time for each route is estimated as 30 minutes for good weather, ~~and~~ 35 minutes for rain and 40 minutes for ice; passenger pickup times are 15 ~~minutes~~, ~~and~~ 20 ~~minutes~~ and 25 minutes for good weather, ~~and~~ rain and ice, respectively.

Tables 8-6A, B and C present~~s~~ the transit-dependent population evacuation time estimates for each route obtained using the above procedures. For example, the ETE for Route 1, Bus 1 is computed as 120 + 30 + 15 = 2:45 hours for good weather. The ETE for a second wave (discussed below) is presented in the event there is a shortfall of available buses or bus drivers.

<u>Activity: Travel to Reception Centers (E→F)</u>

The distances from the EPZ boundary to the reception centers are measured using Geographical Information Systems (GIS) software along the most likely route from the EPZ boundary to the reception center. For a one-wave evacuation, this travel time outside the EPZ does not contribute to the ETE. For a two-wave evacuation, the ETE for buses must be considered separately, since it could exceed the ETE for the general public. There are sufficient bus resources to evacuate the schools in a single wave, based on discussions with the county offices of emergency management; thus, a two-wave evacuation time for schools has not been estimated. Two-wave ETE have been generated for transit-dependent buses. The travel time from the EPZ boundary to the Reception Center (15 minutes) is estimated using the average distance to the Reception Centers (10 miles) measured in GIS and the free-flow inbound travel speeds (45 mph). The travel time to the Reception Center will ~~take slightly~~ be longer for adverse weather:~~,~~ 20 minutes~~,~~ for ~~R~~rain and 25 minutes for ice. ~~scenarios.~~

<u>Activity: Passengers Leave Bus (F→G)</u>

Passengers can deboard within 5 minutes. The bus driver will take a 10 minute break.

<u>Activity: Bus Returns to Route for Second Wave Evacuation (G→C)</u>

The buses assigned to return to the EPZ to perform a "second wave" evacuation of transit-dependent evacuees will be those that evacuated the first wave since the bus drivers will be familiar with the pick-up routes. The time to return to the EPZ (15 minutes) is equal to the travel time to the Reception Center (E→F). The bus then travels its route and picks up transit-dependent evacuees along the route. The return trip will take ~~slightly longer,~~ 20 minutes~~,~~ for Rain scenarios and 25 minutes for Ice scenarios.

ASSOCIATED ATTACHMENTS:

Table 8-5C: "School Evacuation Time Estimates – Ice"

Table 8-6C: "Transit Dependent Evacuation Time Estimates – Ice"

Table 8-5C. School Evacuation Time Estimates - Ice

School	Driver Mobilization Time (min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bndry to R.C. (mi.)	Travel Time EPZ Bdry to RC (min)	ETE to R.C. (hr:min)
Fairfield County Schools								
McCrorey-Liston Elementary School	110	10	8	14	**2:15**	13.8	23	**2:40**
Kelly Miller Elementary School	110	10	2.4	4	**2:05**	13.9	23	**2:30**
Newberry County Schools								
Little Mountain Elementary School	110	10	5.7	10	**2:10**	9	15	**2:25**
Pomaria-Garmany Elementary School	110	10	4.6	8	**2:10**	5.2	9	**2:20**
Mid-Carolina Middle School	110	10	1.8	3	**2:05**	9	15	**2:20**
Mid-Carolina High School	110	10	1.8	3	**2:05**	9	15	**2:20**
Lexington County Schools								
Chapin High School	110	10	3.7	7	**2:10**	12	20	**2:30**
Alternative Academy	110	10	3.5	6	**2:10**	12	20	**2:30**
Chapin Middle School	110	10	2.6	5	**2:05**	12	20	**2:25**
Chapin Elementary School	110	10	3.3	6	**2:10**	12	20	**2:30**
Average for EPZ:					**2:10**	**Average:**		**2:25**

Table 8-6C. Transit Dependent Evacuation Time Estimates - Ice													
		One-Wave				Two-Wave							
Route Number	Bus Number	Mobilization	Route Travel Time	Pickup Time	ETE	Travel Time to Rec. Ctr	Unload	Driver Rest	Return time to EPZ	Route Travel Time	Pickup Time	ETE
1	1	120	40	25	3:05	25	5	10	25	40	25	5:15
	2	120	40	25	3:05	25	5	10	25	40	25	5:15
2	1	120	40	25	3:05	25	5	10	25	40	25	5:15
3	1	120	40	25	3:05	25	5	10	25	40	25	5:15
4	1	120	40	25	3:05	25	5	10	25	40	25	5:15
5	1	90	40	25	2:35	25	5	10	25	40	25	4:45
	2	120	40	25	3:05	25	5	10	25	40	25	5:15
	3	150	40	25	3:35	25	5	10	25	40	25	5:45
6	1	90	40	25	2:35	25	5	10	25	40	25	4:45
	2	120	40	25	3:05	25	5	10	25	40	25	5:15

NOTE: The second wave of transit bus trips on a specific route are only required if there are not sufficient buses to evacuate everyone in the first wave. If bus resources are sufficient, the one-wave ETE should be used.

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-13

ETE-13: Analysis of Evacuation Times, Report Format,

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: Appendix 4 to NUREG-0654 Sections IV.A.2, Section IV.B.1

A. The format of the Evacuation Time Estimate (ETE) is similar to that in Appendix 4 of NUREG-0654 but does not provide separate evacuation times for permanent residents and transients. Provide separate evacuation estimates for residents and transients.

B. In Section 5, "Estimation of Trip Generation Time," the tables included in Distribution No. 2 and Distribution No. 3, include a note, which states: "The survey data was normalized to distribute the "Don't know" response." Explain this note, including the process used to normalize the data.

C. The assumption for the base case for shadow evacuation is stated as 30% in Section 2.2, "Study Methodological Assumptions," Assumption #5 and Figure 2-1, "Voluntary Evacuation Methodology," but Table 6-3, "Percent of Population Groups for Various Scenarios," shows 33% for all scenarios except 5 and 11. Explain what percentage of shadow residents are expected to evacuate.

D. Table I-2, "Evacuation Time Estimates for Shadow Sensitivity Study," identifies 6,908 vehicles for the 30% base case for the shadow evacuation, but Table 6-4, "Vehicle Estimate by Scenario," identifies 6,988 vehicles for the 30% shadow evacuation. Explain which value is being used for shadow resident vehicles. Discuss the timing of the traffic loading onto the network for the shadow population identified in Table 6-4.

VCSNS RESPONSE:

A. NUREG-0654 does not specify that separate ETE be provided for residents and transients. The vehicles evacuating these population groups use the same roadways. The simulation does not distinguish which vehicles belong to which population group. The ETE provided in Section 7 and in Appendix J are for the general population, which includes permanent residents, employees commuting into the EPZ and transients.

Table 2 on page 4-16 of Appendix 4 of NUREG-0654 shows a suggested template for ETE tables. There are entries for "Transient Population", "Transient Pop. Vehicles", "Transient Pop. Response Normal Conditions", and "Transient Pop. Response Adverse Conditions"; however, the only entries in the Table for Evacuation Time Estimates are "General Pop. Evac. Time Normal Conditions", "General Pop. Evac. Time Adverse Conditions", "Special Pop. Evac. Time Normal Conditions" and "Special Pop. Evac. Time Adverse Conditions". Tables 7-1 A through D of the ETE report provide the ETE for the general population in good weather ("normal conditions") and in rain ("adverse conditions"); Tables 8-5 provide ETE for the schools within the EPZ and Tables 8-6 provide ETE for the transit-dependent population. Table 5-1 provides the trip generation ("response") times for the general population and separately for transients. Finally, Figures 3-2, 3-4 and 3-6 summarize the general population within the EPZ. Thus, all of the data requested in Table 2 on page 4-16 of NUREG-0654 are presented within the ETE report.

B. Attachment A in Appendix F of the ETE report is a documentation of the survey instrument used to gather the data that serves as a basis for estimating mobilization times. A review of the survey instrument reveals that several questions have a "don't know" or "refused" entry for a response. It is accepted practice in conducting surveys of this type to accept the answers of a respondent who offers a "don't know" response for a few questions. To address the issue of occasional "don't know" responses from a large sample, the practice is to assume that the distribution of these responses is the same as the underlying distribution of the positive responses. In effect, the "don't know" responses are ignored and the distributions are based upon the positive data that is acquired.

C. Figure 2-1 indicates that 30% of the population within the shadow region will "voluntarily" elect to evacuate as they reside outside the plume exposure pathway of the EPZ. As discussed in the footnote to Table 6-3 entitled "Shadow" on page 6-5, the population within the shadow region is comprised of residents and employees. We estimate the number of employees in the shadow region to have the same proportion relative to residents, as we have determined for the EPZ. This proportion is the ratio of 732 vehicles for employees (shown for Scenarios 1 and 2 in Column 4 of Table 6-4) to the total number of evacuating vehicles used by residents (4,439 + 2,123 = 6,562, listed in Columns 2 and 3 for Scenarios 1 and 2). This ratio is equal to 0.112. Thus, the total population of residents plus employees within the shadow region is 1.112 x the number of residents. Multiplying 1.112 by 0.3 (the percentage assumed to evacuate) yields 0.33 or the 33% figures shown in Column 6 of Table 6-3 for Scenarios 1 and 2. The same methodology applied to the remaining scenarios produces the shadow percentages provided in Column 6 of Table 6-3, and the estimates of evacuating vehicles shown in column 6 entitled "Shadow" of Table 6-4.

D. The sensitivity study presented on page I-2 of the ETE report was for an evacuation of Scenario 1, Region 3. Table 6-4 indicates 7,678 shadow vehicles evacuating for this scenario/region versus the 6,908 evacuating shadow vehicles shown in Table I-2. As noted in the response to part C of this RAI, the shadow vehicles shown in Table 6-4 include a percentage of employees in the shadow region. Table I-2, however, only shows the shadow resident population and shadow resident vehicles evacuating. Applying the formula discussed in the response to part C to the data presented on page I-2 yields:

$$23{,}026 \times \left(1 + \frac{732}{4{,}439 + 2{,}123}\right) \times 30\% = 7{,}678 \; vehicles$$

The text of page I-2 of the ETE report will be revised accordingly.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

Page I-2 of the ETE report will be revised as follows:

> A sensitivity study was conducted to determine the effects on Evacuation Time Estimates (ETE) of changes in the percentage of people who decide to relocate from the Shadow Region. The movement of people in the shadow region has a potential to impede vehicles evacuating from an Evacuation Region within the EPZ. The case considered was Scenario 1, Region 3; a summer, midweek, midday, good weather evacuation for the entire EPZ.
>
> Table I-2 presents the evacuation time estimates for each of these cases. The ETE for all regions remain unchanged as the percentage of people who decide to relocate from areas within the shadow region increase from 15% to 60%. The population density within the shadow region is not sufficient to delay the departure of evacuees from the EPZ. There are a total of 41,439 people (23,026 vehicles) living in the Shadow Region. As discussed in the "Shadow" footnote to Table 6-3, the shadow evacuation demand assumes a 30% relocation of shadow residents along with a proportional percentage of shadow employees. The percentage of shadow employees is computed using the scenario-specific ratio of EPZ employees to residents. Thus, for Scenario 1, with reference to Table 6-4:
>
> $$23{,}026 \times \left(1 + \frac{732}{4{,}439 + 2{,}123}\right) \times 30\% = 7{,}678 \; vehicles$$

Table I-2 of the ETE report will be revised as follows:

Table I-2. Evacuation Time Estimates for Shadow Sensitivity Study						
Shadow Data				**Evacuation Region**		
Percent Shadow Evacuation	~~**Number of Shadow Residents**~~	~~**Number of Shadow Resident Vehicles**~~	**Total Vehicles Evacuation from Shadow Region**	**2-Mile Region (R01)**	**5-Mile Region (R02)**	**Entire EPZ (R03)**
15	~~6,216~~	~~3,454~~	3,839	4:00	4:05	4:10
30 (Base)	~~12,432~~	~~6,908~~	7,678	4:00	4:05	4:10
60	~~24,864~~	~~13,816~~	15,356	4:00	4:05	4:10

ASSOCIATED ATTACHMENTS:

None

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-14

ETE-14: Analysis of Evacuation Times, Methodology, Total Evacuation Times

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: Appendix 4 to NUREG-0654 Section IV.B.1

A. Section 5, "Estimation of Trip Generation," states 85% of the population within the plume exposure pathway Emergency Planning Zone (EPZ) will be aware of the accident within 30 minutes. Provide the basis for the statement that 85% of the population within the EPZ will be aware of the accident within 30 minutes.

B. According to Table 7-1C, "Time to Clear the Indicated Area of 95 Percent of the Affected Population," it takes longer to evacuate 95% of the population from the 2-mile ring during midweek, weekend, good weather (Scenario 5), than all other summer scenarios including the adverse weather conditions for the summer midweek midday adverse condition (Scenario 2). It would appear, from the trip generation data provided in Section 5, "Estimation of Trip Generation Time," that an evening scenario would mobilize more quickly and likely have a lower Evacuation Time Estimate (ETE) for the 95% population. This same effect is shown in Table 7-1B, "Time to Clear the Indicated Area of 90 Percent of the Affected Population," and Table 7-1A, "Time to Clear the Indicated Area of 50 Percent of the Affected Population." Explain the factors that cause the ETE for Scenario 5, in Table 7-1C, to be longer than all other summer scenarios including Scenario 2.

C. Appendix F, Figure F-11, "Time to Prepare Home for Evacuation," indicates that as much as 360 minutes, or 6 hours, are required for the maximum time needed for the last individuals to prepare to evacuate. They must then travel out of the EPZ. Table 7-1D, "Time to Clear the Indicated Area of 100 Percent of the Affected Population," indicates the longest evacuation time is 4 hours and 10 minutes. Explain how the data in Figure F-11 were used in the development of the ETE.

D. The curves in Figure 5-3, "Comparison of Trip Generation Distributions," appear to end at approximately 97% of population evacuating. Discuss whether these curves are intended to approach 100 %, or whether the elapsed time axis should be extended.

VCSNS RESPONSE:

A. The Notification distribution is assumed based on the presence of the siren alert system; the discussion of distribution number 1 on page 5-4 will be revised in a future version of the ETE report to indicate that the distribution is assumed. Page Q-8 of the Fairfield County Emergency Operations Plan provides a design objective for warning the population in the EPZ as follows:

2. The design objective for warning the population shall be as follows:
   a. To provide both an alert signal and an informational or instructional message to the population throughout the ten-mile EPZ, within 15 minutes after initial notification.

   b. To insure that the public alert and notification system will assure direct coverage of essentially 100% of the population within ten miles of VCSNS.

   c. Route alerting will be utilized to assure 100% coverage of the population who may not have received the initial siren notification within 45 minutes of siren sounding.

This design objective is in agreement with the assumed notification distribution provided on page 5-4 of the ETE report.

B. As shown in Table 6-1, only PAZ A-0 evacuates for the 2-mile ring (Region R01). There are 246 residents (137 vehicles – Table 3-2), 6 transients (3 vehicles – Figures 3-4 and 3-5), and 630 employees (622 vehicles – Figures 3-6 and 3-7) in PAZ A-0. As shown in Table 6-3, 10% of employees, 100% of residents and 10% of transients are present in a summer evening scenario (Scenario 5). Therefore, there are 137 resident, 62 employee and 0 transient (0.3 rounded down) vehicles evacuating for Scenario 5. There are 75%, 100% and 100% of employees, residents, and transients, respectively present for a summer, weekend, midday scenario (Scenarios 3 and 4). Therefore, there are 137 resident, 467 employee, and 3 transient vehicles evacuating for Scenarios 3 and 4.

As indicated in the response to RAI 13.03-4, part B, the ETE for all cases are reflective of mobilization time. That is, the time distribution of evacuation time tracks the time distribution of the mobilization (i.e. trip generation) process. The attached Table 1 presents the mobilization time of the evacuating vehicles for each time period for Scenarios 3, 4 and 5. The "Cumulative Vehicles Mobilized" are calculated using the vehicle totals from above and the trip generation rates provided in Table 5-1 of the ETE report. The attached Figure 1 presents the time distribution of mobilized vehicles. As shown, the mobilization curve for Scenarios 3 and 4 is significantly steeper than that of Scenario 5. This difference reflects the fact that the majority of the vehicles evacuating in Scenario 5 are resident vehicles which have longer mobilization times than employees and transients. Scenario 5 has 199 evacuating vehicles, 137 (69%) of which are residents. Scenarios 3 and 4, however, have 607 evacuating vehicles, 137 (23%) of which are residents. Therefore, the ETE time distribution for Scenario 5, which tracks that of the mobilization time, is longer at the 50th, 90th and 95th percentiles than that for Scenarios 3 and 4.

C. Please see the response to RAI 13.03-9, part C. Distribution number 4 on page 5-8 of the ETE report will be revised in a future version of the ETE report to reflect the results of the trip generation truncation procedure identified in the response to RAI 13.03-9. The distribution was input correctly to the simulation model; however the distribution was not properly documented in the ETE report.

D. As indicated in the response to RAI 13.03-9, part C, the 100th percentile of mobilization time is indistinct and difficult to quantify due to the summing of several trip distributions with long tails. As a result, the trip generation time of those relatively few stragglers who take longer to mobilize is advanced so as to provide realistic estimates for the 90th and 95th percentile ETE. The "Procedure for Estimating Mobilization Curve Based upon Survey Data" attached to the response to RAI 13.03-9 discusses this process.

The curves in Figure 5-2 and Figure 5-3 do not reflect the results of this procedure whereby the trip generation of the stragglers is advanced; both figures will be replaced in a future revision of the ETE report with the attached versions. As shown in the attached Figure 5-3, the trip generation process is complete at 4 hours after the advisory to evacuate, which agrees with the tabular distribution shown in Table 5-1 of the ETE report.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

The discussion of time distribution number 1 on page 5-4 is revised as follows:

> It is ~~reasonable to expect~~ assumed that 85 percent of those within the EPZ will be aware of the accident within 30 minutes with the remainder notified within the following 20 minutes.

Distribution No. 4 on page 5-8 is revised as follows:

Elapsed Time (Minutes)	Cumulative Pct. Ready to Evacuate	Elapsed Time (Minutes)	Cumulative Pct. Ready to Evacuate
0	0	135	96
5	9	140	97
10	19	145	97
15	28	150	97
20	38	155	97
25	48	160	97
30	58	165	97
35	61	170	97
40	63	175	97
45	66	180	97
50	71	185	97
55	76	190	98
60	81	195	98
65	83	200	98
70	85	205	98
75	87	210	98
80	88	215	~~98~~ 99
85	89	220	~~98~~ 99
90	89	225	~~98~~ 99
95	89	230	~~98~~ 99
100	90	235	~~98~~ 99
105	90	240	~~99~~ 100
110	91	~~245~~	~~99~~
115	92	~~250~~	~~99~~
120	93	~~255~~	~~99~~
125	94	~~260~~	~~100~~
130	95		

ASSOCIATED ATTACHMENTS:

Table 1: “Comparison of Trip Generation for Scenarios 3, 4 and 5”

Figure 1: “Time Distribution of Mobilized Vehicles

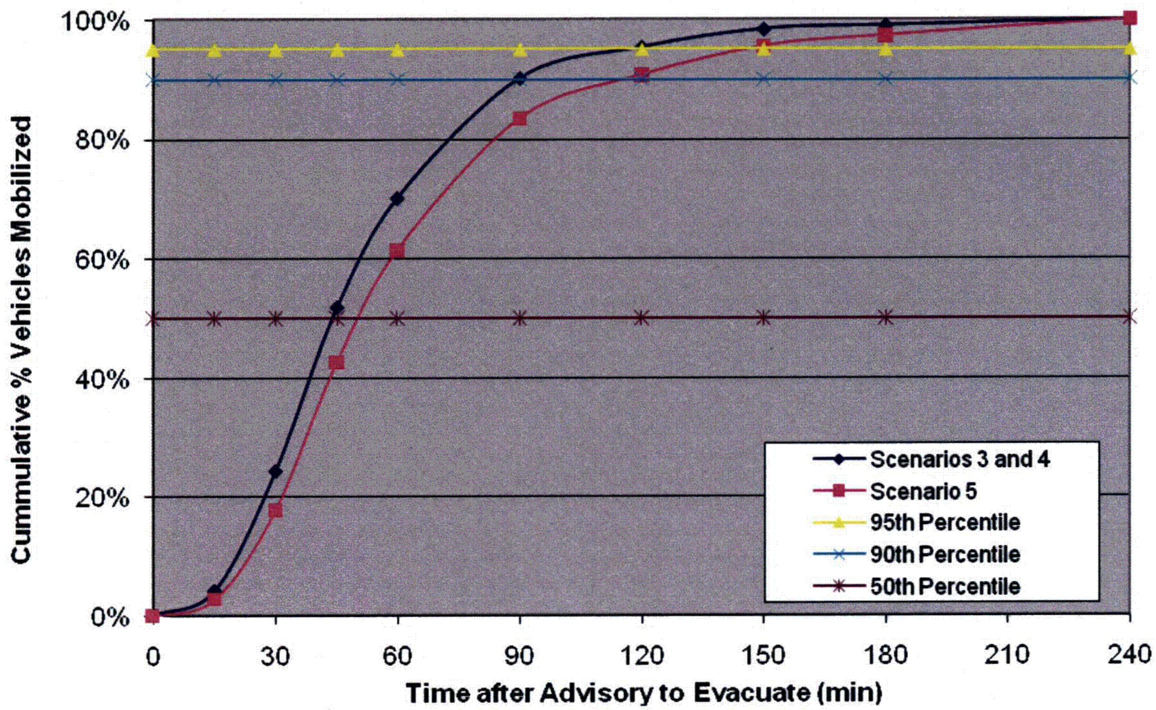
Figure 5-2: “Evacuation Mobilization Activities”

Figure 5-3: “Comparison of Trip Generation Distributions”

Table 1. Comparison of Trip Generation for Scenarios 3, 4 and 5

Scenario	Time Period	Time Period Duration (min)	Percent of Total Trips Generated within Indicated Time Period				Vehicles Mobilized in Time Period	Cumulative Vehicles Mobilized	Cumulative % Vehicles Mobilized	Cumulative Time (hr:min)
			Residents with Commuters	Residents without Commuters	Employees	Transients				
3 and 4	1	15	0	2	5	5	24.3624	24.3624	4%	0:15
	2	15	0	13	23	23	113.4206	137.783	23%	0:30
	3	15	2	25	29	29	148.1026	285.8856	47%	0:45
	4	15	7	20	18	18	99.3606	385.2462	63%	1:00
	5	30	26	23	19	19	124.4214	509.6676	84%	1:30
	6	30	27	7	4	4	48.786	558.4536	92%	2:00
	7	30	17	5	2	2	28.4756	586.9292	96%	2:30
	8	30	9	2	0	0	9.8366	596.7658	98%	3:00
	9	60	12	3	0	0	13.2342	610	100%	4:00
5	1	15	0	2	5	5	3.8124	3.8124	2%	0:15
	2	15	0	13	23	23	18.8906	22.703	11%	0:30
	3	15	2	25	29	29	28.9126	51.6156	26%	0:45
	4	15	7	20	18	18	25.3806	76.9962	39%	1:00
	5	30	26	23	19	19	46.3314	123.3276	62%	1:30
	6	30	27	7	4	4	32.346	155.6736	78%	2:00
	7	30	17	5	2	2	20.2556	175.9292	88%	2:30
	8	30	9	2	0	0	9.8366	185.7658	93%	3:00
	9	60	12	3	0	0	13.2342	199	100%	4:00

Figure 1. Time Distribution of Mobilized Vehicles



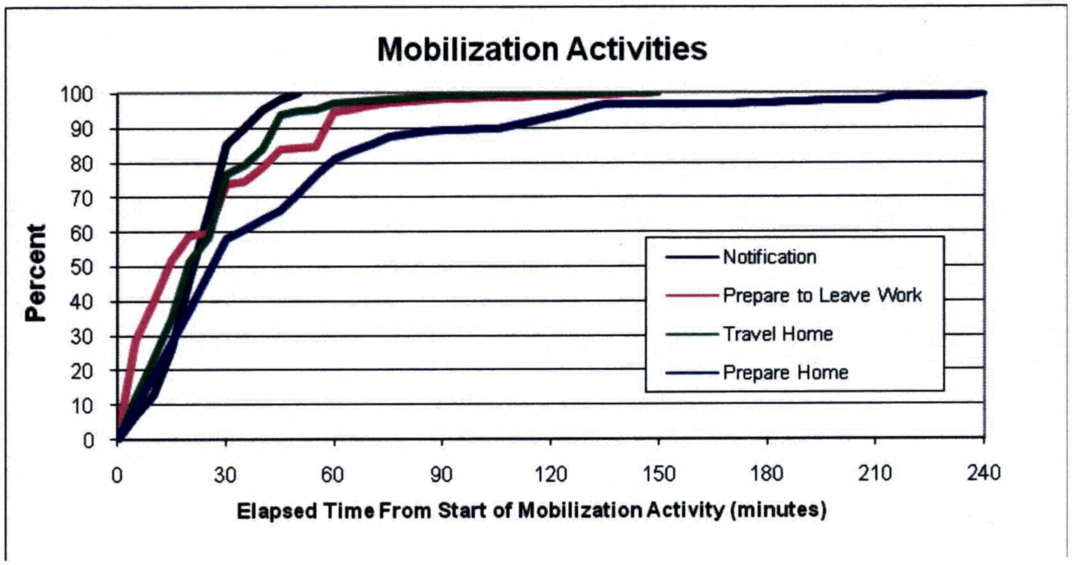


Figure 5-2. Evacuation Mobilization Activities

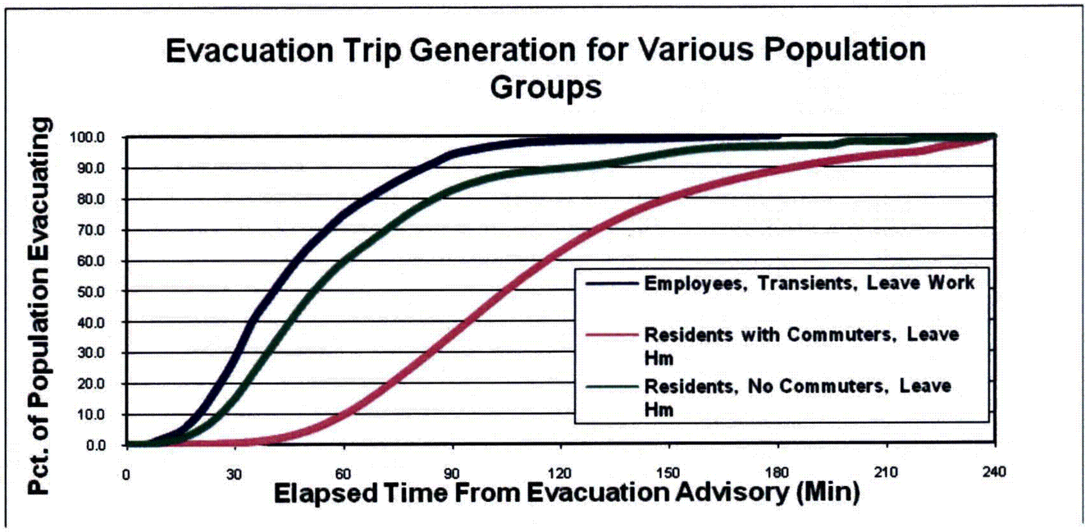


Figure 5-3. Comparison of Trip Generation Distributions

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-15

ETE-15: Analysis of Evacuation Times, Methodology, Traffic Congestion

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: Appendix 4 to NUREG-0654 Section IV.B.3

Queuing and delay times are discussed in Appendix C, "Traffic Simulation Model: PC-DYNEV," but queuing locations and estimated delay times are not indicated on the maps in Figures 7-3, "Congestion Patterns at 2 Hours after the Order to Evacuate (Scenario 1)," and Figure 7-4, "Congestion Patterns at 2 Hours after the Order to Evacuate (Scenario 12)." Provide maps that include queuing locations and estimated delay times.

VCSNS RESPONSE:

Figures 7-3 and 7-4 have been revised as attached and will be included in a future revision of the ETE report. The major roads in the study area have been identified on the map. The major congestion points in the study area have been labeled with an identification number (CP # = Congestion Point #). Table 7-3 (attached) provides a description of each congestion point and the link from Figure 1-2 (RAI 13.03-3) corresponding to that area of congestion. Estimates of the average delay in minutes per vehicle are provided in the Table 7-3 for each of the congestion points. The delay presented is over the previous 10 minutes of simulation. For example, Figure 7-4 shows the congestion patterns at 2 hours after the Advisory to Evacuate for Scenario 12. The average delay for each link provided in the table (column 6) applies to the 10-minute time interval from 110 to 120 minutes after the Advisory to Evacuate. Therefore, the vehicles occupying the link from node 168 to node 8 experience an average delay of 1.8 minutes during this 10-minute interval.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

Figures 7-3 and 7-4 will be replaced with the attached.

Table 7-3 will be added on page 7-16 of the ETE report.

ASSOCIATED ATTACHMENTS:

Figure 7-3: “Congestion Patterns at 2 Hours after the Order to Evacuate (Scenario 1)”

Figure 7-4: “Congestion Patterns at 2 Hours after the Order to Evacuate (Scenario 12)”

Table 7-3: “Description of Congestion Points in Figures 7-3 and 7-4”

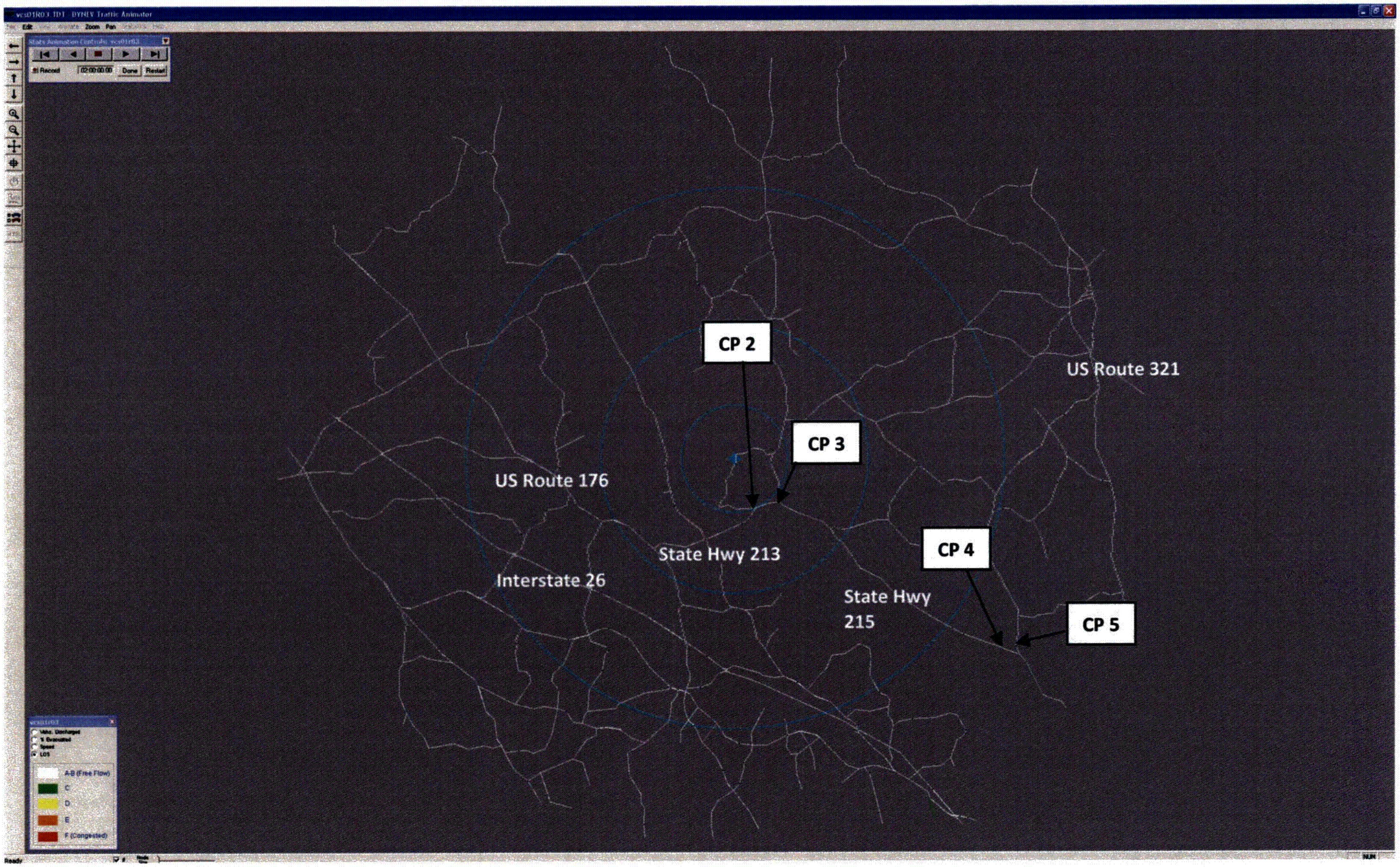


Figure 7-3. Congestion Patterns at 2 Hours after the Order to Evacuate (Scenario 1)

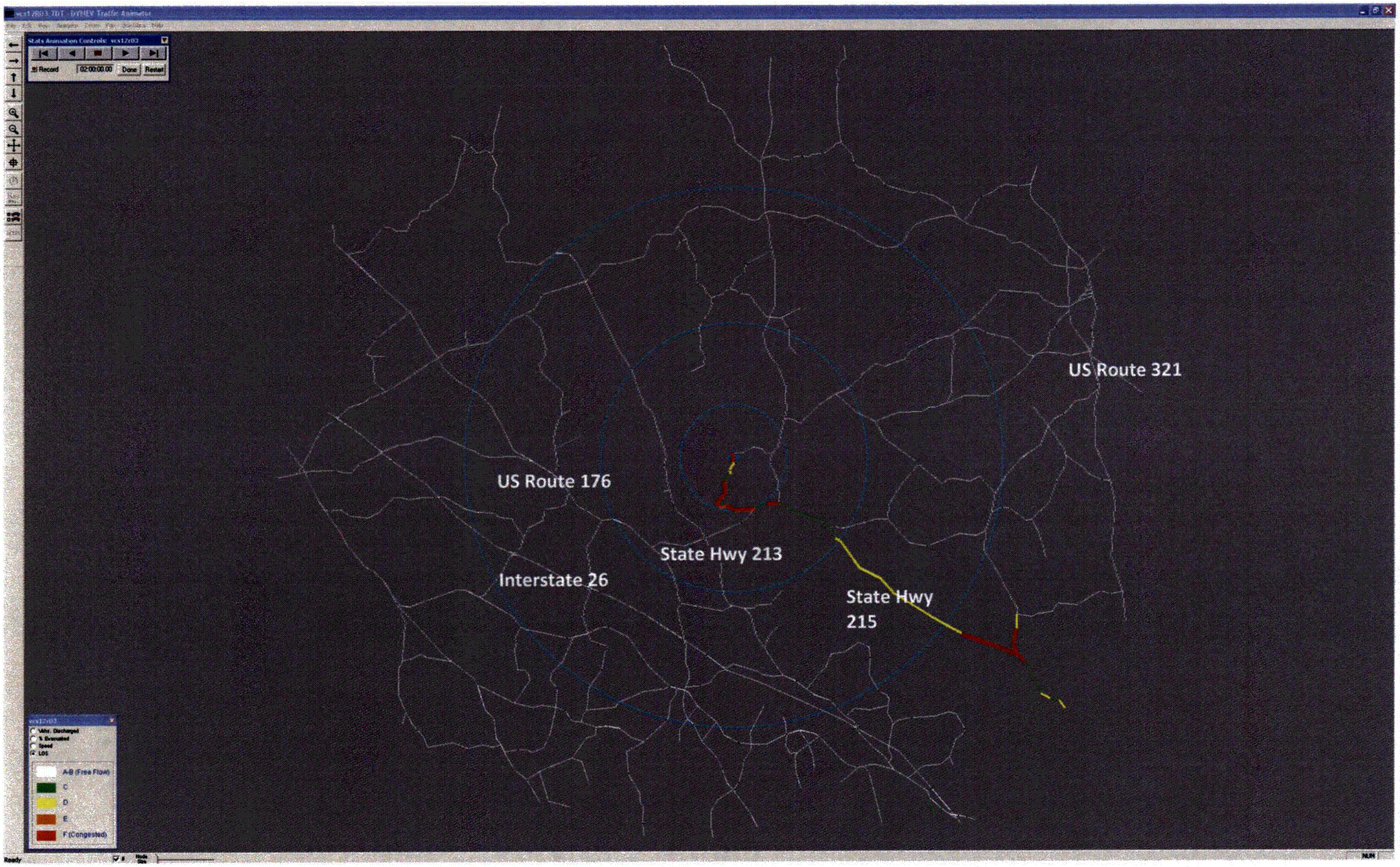


Figure 7-4 Congestion Patterns at 2 Hours after the Order to Evacuate (Scenario 12)

Table 7-3. Description of Congestion Points in Figures 7-3 and 7-4

Congestion Point Number	Link		Description of Congestion Point	Average Delay in Minutes per Vehicle[3] at Two Hours after the Advisory to Evacuate	
	From Node	To Node		Scenario 1	Scenario 12
1	839	840	S Lake Access Rd approach to Parr Rd	Road not in use[4]	1.0
2	471	169	Parr Rd approach to State Hwy 213	0.0	3.3
3	168	8	State Hwy 213 approach to State Hwy 215	0.0	1.8
4	25	27	State Hwy 215 merge with State Hwy 269	0.0	2.5
5	26	27	State Hwy 269 merge with State Hwy 215	0.0	9.8

[3] This delay is measured over the 10 minutes preceding the indicated time, thus it cannot exceed 10 minutes.

[4] This road will be paved and used by construction vehicles once construction begins. Therefore, it is not in use for Scenario 1.

NRC RAI Letter No. 013 Dated January 6, 2009

SRP Section: 13.3 – Emergency Planning

QUESTIONS for Licensing and Inspection Branch (NSIR/DPR/LIB (EP))

NRC RAI Number: 13.03-16

ETE-16: Other Requirements, Confirmation of Evacuation

SRP Chapter 13.3, Requirements A and H; Acceptance Criterion 11

Basis: Appendix 4 to NUREG-0654 Section V.A

A. The time it will take to confirm evacuation is discussed in Section 12, "Confirmation Time." To confirm that the evacuation process is effective, a stratified random sample and a telephone survey are suggested as an alternative for others that may be county specific. Clarify whether there are other confirmation plans being used or whether other counties have agreed to this plan.

B. The mobilization time for the people that will support the confirmation effort is not discussed. This would include the time and resources needed to obtain the telephone numbers for the plume exposure pathway Emergency Planning Zone (EPZ) that are necessary prior to beginning the telephone survey. Provide information regarding mobilization times for people who will be conducting the evacuation confirmation.

VCSNS RESPONSE:

A. The county emergency operations/response plans were reviewed and there is no mention of methodologies to confirm that the advisory to evacuate is being adhered to. All of the county plans discuss the use of route alerting by warning teams as a backup to siren notification in the event sirens fail to operate properly (page 25a-42 of Lexington County plan; page Q-50 of Newbery County plan; page 50 of Richland County plan; and page Q-44 of Fairfield County plan).

Page Q-31 of the Fairfield County Plan does discuss reports on the "Status of Evacuation", including "[l]ocation and number of persons in shelter or congregate care facilities on an hourly basis…" and "[c]ompletion time of evacuation", however it does not indicate how this information will be obtained.

The signed certification letters for each county included in the COLA submittal indicate that the EPZ counties have reviewed the ETE report and will consider its content.

B. Section 12 of the ETE report suggests the use of a telephone survey to confirm evacuation. The use of automated dialing equipment or the use of multiple operators can significantly reduce the 7.5 person hours needed to complete confirmation. For example, the use of 5 operators would reduce the confirmation time to 90 minutes.

If this method is indeed used by the EPZ counties, it is recommended that a list of telephone numbers within the EPZ be available in the EOC at all times. Such a list could be purchased from vendors and should be periodically updated. As indicated in the third paragraph on Page 12-1, the confirmation process should not begin until 3 hours after the Advisory to Evacuate, to ensure that households have had enough time to mobilize. This 3-hour timeframe will enable telephone operators to arrive at their workplace, access the call list and prepare to make the necessary phone calls.

Section 12 of the ETE Report provides a *recommended* methodology for evacuation confirmation to be performed by the EPZ counties. The suggested approach can be reinforced by other methods, such as ground based vehicles with public address systems, but this is a state/local planning issue and outside the scope of the ETE. The purpose of including the proposed approach in the ETE was to provide an estimate of the time required to conduct the confirmation, using one suggested method. The inclusion of an estimated confirmation time is required by Section V of NUREG-0654, FEMA-REP-1, Rev. 1, App. 4, p. 4-10.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

None

ASSOCIATED ATTACHMENTS:

None