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NUCLEAR REGULATORY COMMISSION

before the

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE, et al. (Seabrook Station, Units 1 and 2)	Docket Nos. 50-443-OL 50-444-OL (Off-site Emergency Planning Issues)

APPLICANTS' REBUTTAL TESTIMONY NO. 16
(EVACUATION TIME ESTIMATES)

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I. INTRODUCTION

This testimony addresses the Joint Intervenor (JI) Contentions 1, 2, 3, 20, 21 and 22, regarding the Evacuation Time Estimates contained in the Seabrook Plan for Massachusetts Communities (hereafter the SPMC).

II. PURPOSE OF EVACUATION TIME ESTIMATES

The function of Evacuation Time Estimates (ETEs) is to provide realistic estimates of the time required to evacuate various sections or regions within the plume exposure Emergency Planning Zone (EPZ), under varying population and weather conditions. ETEs are, in turn, utilized by emergency response personnel as one of the inputs in protective action recommendation decision-making in order to maximize dose savings.

The emergency planning regulations do not prescribe specific time limits for the evacuation of plume exposure EPZs. Estimates of time within which an evacuation might be accomplished are determined on a case-by-case basis upon consideration of all relevant conditions prevailing within the specific locality. ETEs are to be as accurate as is reasonably achievable under the current state of the art, with due consideration given to their intended use. That is, from an emergency planning standpoint, ETE accuracy is achieved when additional refinements would not materially influence a protective action recommendation.

III. BACKGROUND OF SPMC ETES

Seabrook Station ETEs were first calculated by KLD Associates using the IDYNEV computer model over the period extending from late 1985 to August of 1986. These were included in Volume 6 of the New Hampshire Radiological Emergency Response Plan (NHRERP). During the Atomic Safety and Licensing Board (ASLB) hearings on the NHRERP (late 1987), the ETEs were updated using information obtained from more recent aerial surveys of the beach areas which, in turn, provided more accurate population and vehicle estimates. In addition, more accurate ramp capacity estimates based on the 1985 Highway Capacity Manual were applied along with a more realistic representation of through traffic along the interstate highways. The number of evacuation regions was extended from 9 to 12. KLD Associates again used the IDYNEV model for these updated ETE calculations. These issues were addressed in testimony on NHRERP presented as Applicants' Direct Testimony No. 7, Post Tr. 5622, passim, and particularly at 42-43. They are referenced in the Partial Initial Decision of this Board on the NHRERP, LBP-88-32 (hereinafter LBP-88-32), at Section 9, passim, and more particularly at 9.23.

The ETEs listed in SPMC IP 2.5, Attachment 4, (Attachment A hereto), were taken from the complete set of ETEs calculated following the filing of testimony for hearings on the NHRERP. The assumptions, method and inputs used to update these estimates were provided in the Applicants' Direct Testimony No. 7, Post Tr. 5622 at 27-41.

ETEs were again recalculated in early 1989 using the most recent version of IDYNEV and additional SPMC specific inputs and changes giving effect to the Board's proviso noted in LBP-88-32, at ¶ 9.130. These revised ETEs and inputs are discussed in Section V.E. of this testimony. The SPMC will be revised to include these new ETEs. Additionally, a revised evacuation time estimate study will be published in the future, either as an amendment to NHRERP Volume 6 or as a separate document. This update will document all ETE inputs and assumptions including those described in Applicants' Direct Testimony No. 7, Post Tr. 5622, and in this testimony.

IV. ETES ARE FOR MASSACHUSETTS ERPAS/CONSISTENCY WITH NUREG-0654

The ETEs contained in SPMC IP 2.5, Attachment 4 represent the times to evacuate from within five and ten miles of Seabrook Station, respectively, for ten scenarios. These scenarios are defined in NHRERP Volume 6 at Table 10-1. These ETEs cover both Emergency Response Planning Area (ERPA) combinations involving the Massachusetts portion of the EPZ as defined in NHRERP Volume 6 at Table 10-2 and Applicants' Direct Testimony No. 7, Post Tr. 5622 at 41. See also Attachment B hereto, for a map delineating all ERPAs within the Seabrook EPZ. The ETEs for five miles are those for Region 8 (ERPA A and B). The ETEs for ten miles are those for Region 13 (ERPA A through E).

The ETEs contained in SPMC IP 2.5, Attachment 4 were prepared to be consistent with the guidance of NUREG-0654, Rev. 1, Appendix 4 and Rev. 1, Supp. 1. Specifically, the SPMC's ETEs include (1) consideration of permanent resident, transient, employee, transit dependent and special facility populations within the plume exposure EPZ; (2) a description of the traffic analysis method and the method of arriving at road capacities as documented in NHRERP Volume 6; (3) a range of evacuation scenarios generally representative of normal and adverse weather conditions; (4) identification of critical roadway sections and need for traffic and access control; and (5) application of trip generation, distribution, assignment and traffic flow modeling techniques to obtain recommended evacuation routes and evacuation time estimates.

V. ETE ASSUMPTIONS AND INPUTS

A. ETEs Are Based on Accurate Roadway Capacities

The SPMC's ETEs are based upon accurate estimates of road, intersection and ramp capacities, and discharge headways. These values reflect the physical roadway geometrics and conditions in the EPZ.

1. Two-Lane Roads

Capacity estimates along sections of highway within the EPZ are discussed on pages 3-4 through 3-11 of Volume 6 of the NHRERP. The source material for these capacity estimates is the 1985 Highway Capacity Manual (HCM), Special Report 209 (Id. at 3-6). Field surveys were conducted to determine terrain type, percent no passing zones, traffic mix and number of lanes on each roadway section. (Id. at 3-8 and 3-10). This information was factored into the capacity estimation process.

Capacity estimates for four classifications of two-lane roads were identified and listed within Volume 6 of the NHRERP. Id. at 3-9. One-way capacities were arrived at by applying an average directional split (outbound/total volume) of 0.9 over the duration of the evacuation, to the two-way capacity estimates provided by the HCM procedures.

2. At-Grade Intersections

Capacity estimates on approaches to at-grade intersections are discussed in detail in Volume 6 of the NHRERP. Id. at 3-2 to 3-4. The mean queue discharge headway of vehicles (h_m) on an approach is estimated for each turn movement. These values of h_m are computed by IDYNEV using a mathematical model based, in part, on specified values of the saturation discharge headway for through vehicles (h_{sat}). The values of h_{sat} were obtained empirically at representative intersections throughout the EPZ, and ranged from 2.1 to 2.4 seconds per vehicle; the higher headway was adopted for all intersection approaches to account for any uncertainty in driver response at intersections. Id.

It is alleged that "the IDYNEV model runs assume that the guides alternate flow directions on a 75 second cycle . . . ." Testimony of Dr. Thomas J. Adler on Behalf of James M. Shannon, Attorney General for the Commonwealth of Massachusetts, Concerning Contentions JI-1, JI-2 (ETEs) and JI-3 (Data Collection) dated April 3, 1989, page 14. This is not correct. The input stream specifies estimates of signal split [i.e. the allocation of GO (i.e. green) time] to each approach at each intersection. This specification requires the user to define "phase" durations which sum to a cycle length. The cycle length specified is arbitrary and need only approximate, roughly, what would actually be implemented by the traffic guides. It is well-known that, at this level of cycle length and for a given signal split, capacity is insensitive to differences between the actual "cycle length" representing the actions of the traffic guides and the 75 seconds used in IDYNEV. In fact, if the guides' "cycle length" is longer than 75 seconds, which is likely under congested conditions, capacity will increase very slightly.

Thus, the selection of 75 seconds for cycle length for the IDYNEV input stream is reasonable and conservative.

3. Freeways

Two freeways, I-95 and I-495, traverse the EPZ within Massachusetts. Based on a number of factors obtained from the HCM and field surveys, a freeway capacity of 1728 vphl (vehicles per hour per lane) was computed for these sections of highway both in Massachusetts and New Hampshire. Id. at 3-10, 11. This estimate appears reasonable when compared with the highest one-way daily volume in 1985 on I-95 within the New Hampshire portion of the EPZ of 79,119 vehicles, recorded on Sunday, July 7th, made available by the New Hampshire Department of Transportation. Usually, the peak hour volumes exceed 10 percent of the average daily total. Specifically, the peak hour capacity of I-95 based on the per lane capacity is 1,728 vph x 4 lanes = 6,912 vph. This value is only 8.74 percent of the recorded average daily total of 79,119 vehicles. Thus, the estimate of 1,728 vphl is realistic. Id.

4. Ramps

Nominal capacities of ramps for undersaturated flow conditions is estimated at approximately 1330 vehicles per hour; under congested conditions, the estimated ramp capacity is approximately 1130 vehicles per hour. This estimate of nominal capacity is consistent with the ramp capacity estimates of Table 5-5 of the 1985 Highway Capacity Manual, Special Report 209. Any capacity reduction due to frictional effects of ramp traffic merging into the traffic on the main lines is handled internally by the IDYNEV traffic simulation model.

The lower capacity of the roadway section, or of the intersection approach is specified as the link capacity.

5. Capacity at Traffic Control Point B-AM-06

The ETEs are based upon accurate estimates of capacity and demand at the interchange of Route 110/I-95/Elm Street in Amesbury. Amesbury Traffic Control Point (TCP) No. B-AM-06 depicts all turn movements associated with this interchange. See TCP diagram for B-AM-06, Attachment C hereto.

As discussed in Applicants' Rebuttal Testimony No. 9 (Traffic Management and Evacuation of Special Populations) this TCP provides for the following three outbound movements:

- The outside lane services traffic onto the on-ramp to southbound I-95 from westbound Route 110.

- The center lane services traffic continuing westbound on Route 110 towards I-495.

- The inside lane services traffic that elects to execute the optional U-turns onto eastbound Route 110 within the intersection at Route 110 and Elm Street, then onto the on-ramp to southbound I-95 from eastbound Route 110.

In calculating the revised ETEs discussed in Section V.E. of this testimony, the revised traffic control strategy at this interchange, as described above, was utilized as input to the IDYNEV model. The estimated capacity of the U-turn movement was represented as 50 percent of the capacity of the ramp to I-95 southbound from eastbound Route 110. However, analysis of IDYNEV output indicates that the actual number of vehicles which elect to perform this U-turn maneuver is far less than that movement's capacity since the other two evacuation paths through this interchange are more attractive.

6. Capacity Reduction Factor

The ETEs were calculated using a feature of the IDYNEV simulation model which reduced roadway capacities by 15 percent during congested conditions by applying a factor of 0.85 to the HCM based estimates of nominal capacity. This capacity reduction factor was determined after evaluating the capacity reduction factors for uninterrupted traffic streams on limited access highway systems presented in the 1985 HCM (page 6-7). The HCM's capacity reduction factors, which range from 1.0 to 0.75, may be applied to the nominal highway capacity to estimate highway capacity under congested, or level of service (LOS) F, traffic conditions. The value of 0.85 approximates the mean of this range. The actual highway capacity operating at LOS F depends on a number of factors including highway geometrics, driver skills, the angle of the sun, etc. For example, NUREG/CR-4873 reports on a study of the IDYNEV simulation model which determined, among other things, that a capacity reduction factor of 1.0 (i.e., no capacity reduction) produced the best results in comparison with actual traffic flow measurements on a section of I-35 near Austin, Texas, under normal a.m. peak period conditions. The adoption of a 0.85 factor for highway traffic during an emergency evacuation is both prudent and reasonable.

For evacuation conditions, KLD also applied this 0.85 capacity reduction factor to the estimates of "nominal" capacity obtained by applying the HCM procedure for <u>at-grade</u> (non-limited access) roadways. For at-grade roadways, this capacity reduction factor represents the potential for inefficient traffic operations due to a variety of factors including driver uncertainty under emergency conditions in a congested traffic environment.

There is nothing in the HCM which suggests that a capacity reduction is warranted for at-grade roadways due to uncertain driver performance under congested flow during normal conditions. Neither does the HCM address the influence of downstream congestion on the capacity of at-grade intersections and the impact of queues spilling back into intersections thereby impeding the flow of traffic. Presence of queue spill-back into the intersection effectively reduces the roadway capacity below the estimates provided by application of the HCM procedures. Such queue spill-back is explicitly modeled by IDYNEV. Detailed review of IDYNEV output reveals that many roads within the Massachusetts portion of the EPZ, over long periods of time, discharge evacuation vehicles at a rate far below their capacity, due to queue-induced impedance.

Because the capacity reduction factor for at-grade roadways reflects potentially inefficient traffic operations during emergency evacuation conditions, it is not possible to empirically determine a site-specific capacity reduction factor under normal non-evacuation conditions.

7. ETEs Account for Vehicles Which Travel Across Evacuation Traffic Flow/Directional Split of Evacuation Traffic

The issue of the ETEs accounting for vehicles which travel across, against or with the flow of evacuation traffic (such as commuters returning home from work) and the directional split of traffic utilized for calculation of the ETEs was addressed as part of litigation of the NHRERP. See LBP-88-32, at ¶ 9.35 through 9.60. The returning commuters issue is also addressed in Lieberman's Affidavit dated January 25, 1989 and filed on January 25, 1989 in these proceedings.

B. Population Inputs

The ETEs are based on an accurate projection of the number of vehicles evacuating from and through the Massachusetts portion of the EPZ. Volume 6 of the NHRERP details the population groups considered and the vehicle estimates utilized for development of the ETEs. These include permanent residents, seasonal housing residents beach population, overnight transients, other transient populations, and employee population (NHRERP Volume 6, Sections 2 and 5). Additionally, updates to certain of these population groups and vehicle occupancy rates were discussed in Applicants' Direct Testimony No. 7, Post Tr. 5622.

1. Permanent Resident Population

The permanent resident population estimates contained in the SPMC, Section 3, Table 3.6.1, are based on numbers from Volume 6 of the NHRERP. The method utilized to obtain permanent resident population estimates is explained in Volume 6 at Section 2 and Appendix E, Item 15. Two sources were used to obtain this data: The Division of Health Statistics and Research, Department of Public Health, Commonwealth of Massachusetts and individual town clerk's local census data. The data obtained from both sources were for 1985 and were comparable. Since the State's data were projections, the town clerks' data were utilized.

During the annual review of the SPMC, the latest population figures will be obtained, extrapolated to the current year, and a determination made on whether to revise the ETEs.

2. Transient Populations

The ETEs account for the number of transients who visit beach areas in the Massachusetts portion of the EPZ. Peak population data were compiled through the aerial survey of Seacoast areas in Massachusetts and New Hampshire conducted on July 18, 1987. The transient population of the Parker River National Wildlife Refuge portion of Plum Island is included in the peak population totals obtained from the vehicle count performed by Avis Airmap from the July 18, 1987 aerial survey. These issues have been previously addressed and litigated under the NHRERP. (Applicants' Direct Testimony No. 7, Post Tr. 5622 at 34, 38.)

Concern was expressed by the Intervenors that the data provided by Avis did not accurately represent peak traffic conditions at Salisbury Beach. It was argued that over 1000 more cars were observed in a Massachusetts Attorney General (MAG) film than was projected using the Avis data. To explore the effect of a higher vehicle count in Salisbury Beach, a sensitivity study was undertaken. Here, the Salisbury Beach area traffic was increased by 20 percent (from 6,119 to approximately 7,343) over that observed on the

Avis films and the Region 1, Scenario 1 (full EPZ evacuation, summer weekend, midday, good weather) case was analyzed using IDYNEV with all other inputs used to calculate the revised ETEs discussed in Section V.E. unchanged. The ETE results are as follows:

- Original Salisbury Beach Avis Vehicles (6119) <u>ETE</u>: 7:40
- Twenty Percent Increase in Salisbury Beach Vehicles to approximately 7343: 7:40

It is seen that an increase of Salisbury Beach vehicle population over the 7,211 purportedly observed on the MAG films had no effect on ETE. The reason for this insensitivity of ETE with respect to Salisbury Beach traffic volume, is that the critical paths which control the ETE (Route 51, Route 1A in Rye and Route 151 in Greenland, all at 10 miles from the Station) for Regions 8 and 13 are all in New Hampshire and are totally unaffected by changes in Salisbury Beach population. While the ETE in Massachusetts increased somewhat, it still remained below 7:40. Thus, the concern over the estimate of Salisbury Beach population is not supported by detailed analysis.

The revised ETEs account for 1,440 "vehicles in transit" traveling on the roads in the beach areas at the time of an evacuation. These vehicles are distributed in accordance with the aerial photographs taken by Avis as follows:

Town	Number of "Vehicles in Transit"
Hampton	750
North Hampton	109
Ipswich	5
Newbury (Plum Island)	80
Newburyport (Plum Island)	12
Rowley	6
Rye	202
Salisbury	153
Seabrook	123
	1440

This modification was recommended in the LBP-88-32, at ¶ 9.12(, 9.122 and 9.130. The total number of vehicles in the beach areas accounted for in the ETEs totals 29,293 + 1440 = 30,733 vehicles.

The SPMC's ETEs account for the number of transients who visit areas of the EPZ which are outside the beach areas. Section 2 of NHRERP Volume 6 describes the demand estimation process. Specifically, for the City of Newburyport, Volume 6 indicates an estimated total of 671 vehicles (summer season) for transients and seasonal residents who visit retail establishments outside of the beach areas. This estimate is in addition to 1449 vehicles for employees who enter Newburyport from locations outside the EPZ. These values are based upon the NRC Kaltman Study and annual average employment figures discussed in NHRERP Volume 6 at Sections 2, 5, and Appendix M.

The NHRERP Volume 6 estimate of vehicles in locations outside the beach areas are comparable to other empirically collected data. Summation of the total transient, employee, and permanent resident vehicles in downtown Newburyport yields 2296 vehicles. MAG's testimony indicates a reported 2,246 parked vehicles and 148 in-traffic vehicles "in downtown Newburyport" from his July 5, 1987 aerial photos. (Testimony of High, Adler and Befort for MAG on Seacoast Anti-Pollution League (SAPL) Contentions 31, 34 and TOH revised III, pp. 12 and 13). Of course, this observed count includes vehicles belonging to residents of other communities within the EPZ that are accounted for separately in Volume 6. This data cannot be stratified so as to allocate the 2,246 parked cars to the categories of "off beach transient," "shoppers," "employees," and "residents." Clearly the observed vehicles represent some unknown mix of these categories. The purpose of this response, then, is to demonstrate that the estimates used in the ETE are comparable to the number of cars observed in the aerial photographs cited by MAG.

3. Special Event Days

"Special Events" also occur in the EPZ and should be considered to determine whether they are likely to add a significant number of evacuees who might materially impact the ETEs. In addressing "special events" in the course of developing ETEs, it is necessary, as a matter of practicality and realism, to distinguish between events which can materially influence ETE, and those which do not. For example, the peak beach population "event", in the best of summers with every weekend day producing peak attendance, would occupy in aggregate, less than one percent of a year (4 hours/day x 2 days/weekend x 10 weekends/season = 80 hours out of 8,760 hours, annually). Despite this small representation, in the temporal sense, it is necessary to consider this "event" because of the large number of evacuees involved and their material impact on ETE.

At the other extreme, consider a sporting event (e.g., a basketball or football game) at a local high school. Here, the number of transients attracted into the EPZ is very small relative to the EPZ population and the event only extends over a few hours. In this case, it is clear that no separate provisions need be made for ETE to account for this small increase in population for a few hours because:

- The effect on ETE is minuscule, at most, and lies within the uncertainty of the ETE calculations.
- There is no impact on a Protective Action Recommendation (PAR).

ETEs are calculated because they are used as one input in the PAR decision process. Any proliferation of scenarios and associated ETEs, in order to account for "special events" which would, under no circumstances, influence the PAR, introduces unnecessary complexity in the decision process and yields no benefits.

Finally, it is important to note that the potential for additional transients attracted to special events to materially impact the ETE is limited unless the number of attending transients from outside the EPZ is substantial in relation to the number of residents plus transients already counted within the EPZ. This is because all transients require little mobilization time prior to evacuating the area -- most simply walk to their respective cars and leave. Most residents on the other hand, return home to make preparations (see discussion on pp. 4-3 through 4-5 in Volume 6 of NHRERP) which defer the start of their evacuation trips, relative to the transients. Thus, unless these additional transients are substantial in number, there is, to a large extent, a temporal separation between the evacuation trip-making of transients who enter the EPZ for "special events," and residents. This temporal separation implies that one group impedes the other only to a small extent: the transients leave the EPZ early enough to have a limited effect on the resident population evacuation.

4. Specific Special Events

Through the interrogatory process, the Town of Merrimac has identified special event days which, they allege, should be accounted for in the ETEs. The events identified were the "Old Home Days" and the "Santa Claus Parade."

Old Home Days was identified as taking place in August and is attended by "several hundred townspeople" who gather for approximately 3 to 4 hours near the Town Hall at Route 110 and Church Street. Since most attendees are local residents, a special ETE need not be calculated for this event, as these residents are already accounted for. The limited extent and duration of this event also obviates the need for separate consideration.

The Santa Claus Parade was identified as taking place on the first or second Sunday of December and as being attended by approximately 1,000 transients who gather on Route 110 and Church Street. The Town of Merrimac did not specify the number of residents and transients who attend this event or the event's duration. Notwithstanding this failure, we will assume that the event is solely attended by transients and that its duration is approximately 4 hours. Even on this hypothesis, there are a number of reasons why this event does not warrant consideration in the ETEs. First, this event occupies only about 0.05 percent (4 hours/8760 hours annually) of a year. Second, the 1,000 transients divided by 2.4 persons per vehicle (as was estimated for beach area vehicle occupancy rates during calculation of the ETEs) yields approximately 420 vehicles. This is viewed as a conservative value for such an event because it would be expected to be attended primarily by families, producing a somewhat higher vehicle occupancy rate and a reduced number of vehicles. Third, it is reasonable to expect that many, possibly most, of these transients reside in neighboring towns within the EPZ. To the extent this is so, these transients are already accounted for as residents of these neighboring towns. Fourth, even assuming, that all these transients are from outside the EPZ and that they all utilized only Route 110 to leave Merrimac, bypassing I-495, these additional vehicles would not impact the ETEs. Specifically, the capacity of Route 110 is approximately 1,000 vph (vehicles per hour) in this location (NHRERP, Volume 6, Appendix N). Dividing the total transient vehicles by this capacity yields 25 minutes. Thus, even in a worse case, we would find that the additional transients would have left the area in approximately 25 minutes. Trip generation time distribution for populations in areas other than the beach, as presented in the NHRERP, Volume 6, Section 4, indicates that only 5 percent of the total permanent resident evacuation trips have started within the first 25 minutes. Hence, these additional parade attending transients will have left the area prior to the time when the vast majority of the evacuation trips of residents, accounted for in Volume 6, have mobilized. Consequently, these transients would not impede the evacuation of residents. Thus, this special event does not warrant separate consideration in the ETEs because of its very short temporal extent, small magnitude and lack of impact on ETE.

The Town of Amesbury (TOA) identified a sequence of events known as "Amesbury Days" which usually occur over a 10-13 day period up to and including the 4th of July. TOA indicated that events are scheduled on each of these days attracting large crowds from beyond TOA. It was estimated that up to 30,000 people attend the 4th of July fireworks display. Since information was provided only for one specific event, it is not possible to analyze the other days comprising "Amesbury Days." However, it would appear by implication to be doubtful that these other events draw anywhere near the number of transients and residents as purported for the fireworks display. Chief Cronin, in considering the fireworks display, indicated that the display lasts for approximately half an hour or 45 minutes (Tr. at 16415). Further, it would seem reasonable to expect that the crowds associated with this event are assembled for no more than 3 hours. This being so, the event occupies only about 0.03 percent of a year (3 hours/8,760 hours annually). The attendees based on Chief Cronin's estimate of 30,000 people can be expected to be comprised of residents and non-residents. It would be reasonable to estimate that approximately 75 percent of the town's residents would attend such an event. Thus 0.75 x 14,258 (Amesbury resident population) = 10,694 residents out of 30,000 total people leaving 19,306 transients. Assuming that half the TOA residents use vehicles to attend the display, the total number of vehicles can be estimated by applying the factor of dividing by 2.4 persons per vehicle (as was estimated for beach area occupancy rates during calculation of the ETEs) to yield approximately 10,272 vehicles (i.e., (19,306 + 10,694/2)/2.4 = 10,272).

The minimum area required to park one car in a lot is about 250 square feet. Then 10,272 vehicles would require over 2.5 million square feet, or over 57 acres for parking. There are no closely-spaced parking facilities in TOA to accommodate this number of vehicles. It is unreasonable to expect that many vehicles will be permitted to park in private driveways. Furthermore, Chief Cronin stated that it took about 1.5 hours to clear the area of this traffic at the conclusion of the fireworks (Tr. at 16415, 16418). The KLD studies indicate that it is not possible to clear 10,272 vehicles out of the area in this time frame. We must conclude, on the basis of these calculations, that the TOA estimate of 30,000 people is grossly inflated.

Additionally, it is certainly reasonable to expect that many of the transients who attend this event are residents of other towns in the EPZ or are tourists who have entered the EPZ for the weekend. Thus, a substantial number of the transients, probably the majority, have been accounted for elsewhere in the ETE's population estimates.

Chief Cronin's estimate of 1.5 hours to clear the area includes TOA residents and transients from other EPZ communities who are already accounted for, plus additional transients from outside the EPZ. Since the IDYNEV output indicates that TOA evacuates within approximately 3:30 hours the total evacuation time where an accident at Seabrook is coincident with this event would be 5:00 hours, at most. This estimate is far less than the ETE of 7:05 for Region 13, Scenario 1.

As discussed above, there is gross uncertainty in the proffered estimate of people; there is obvious large-scale double-counting of vehicles already accounted for; and there is a short span of time associated with this event. Furthermore, the ETE is controlled by the need to service more congested parts of the evacuation network. Thus, this event does not warrant separate consideration in the ETEs.

Two other special event days were identified by the Massachusetts Attorney General as having ETE influence. These were the Salisbury Pro Beach Volleyball Tournament and Newburyport Homecoming. MAG, however, did not provide any information as to the number of persons attending these special events, whether they were primarily residents or transients, where they would gather and for how long. Notwithstanding this, these events are discussed below.

The Salisbury Beach Pro Volleyball Tournament does not warrant consideration in the ETEs for the following reason. It is reasonable to assume that the attendance at this event will be largely dependent on the number of parking spaces available for the spectators, and will be comprised mostly of people already counted in the peak beach population. It is therefore unreasonable to expect that there would be any meaningful incremental increase in beach population due to this event above the values used in the ETEs. Thus, this special event does not warrant separate consideration in the ETEs.

Newburyport Homecoming (or Yankee Homecoming) is a major event which is held in Newburyport each summer. It usually extends over about nine days between the last Saturday in July to the first Sunday in August. Each day different activities of various magnitudes take place. For example, these include clam bakes, barbecue dinners, craft festivals, sidewalk sales, fireworks, concerts and a 10K road race. Examination of newspaper articles describing the 1988 Newburyport Days reveals that the larger activities attract the major interest: the concert (4,300 people for one evening) and the road race (1,300 entrants). The newspapers also indicated that parking was available in the four downtown lots and on the streets.

It is not necessary to consider Newburyport Days in the ETEs for the following reasons. First, while the entire event takes place over a nine-day period there are only a few activities, which take place over a relatively short period of time, that attract the higher volumes of people (such as the major concert). Second, it is highly probable that many attendees are residents of Newburyport and of neighboring towns within the EPZ and, thus, have already been accounted for in the ETE's permanent population estimates. Third, the ETEs already account for 671 transient vehicles in Newburyport. Assuming, for discussion purposes, that two-thirds of the attendees at the major concert were non-residents from outside the EPZ, this would add approximately 523 cars to the 671 already accounted for in the ETEs (2/3 x 4,300/2.4 people/vehicle = 1,194 vehicles). This represents an increase in the total number of Newburyport vehicles of under 6 percent [523 /9,377 = 0.056 where 9377 is obtained from Appendix M of NHRERP, Volume 6]. As discussed earlier for the Santa Claus event in Merrimac, it is expected that these non-residents would begin their evacuation trips earlier than EPZ residents and would not materially impede these late trips or increase ETE. At worst, it is expected that the local evacuation time (or clear time) from

Newburyport will increase no more than 6 percent. Inspection of the IDYNEV output for Region 1, scenario 1, (10-mile keyhole evacuation, summer weekend, good weather) reveals that Newburyport clears within approximately 4:25 hrs:min. Increasing this value by 6% yields 4:40 hrs:min, which is far less than the ETF of 7:05. It is reasonable to expect that the actual increment to the ETE would be smaller for the reasons cited above. Even in the cited example, it is seen that there is no impact on ETE. Thus, this special event (or specific activity) does not warrant separate consideration because of its short temporal extent and lack of impact on the ETE.

5. Through Vehicles

"Through" vehicles are those that are traveling within the EPZ at the time of an evacuation and are "external-external" trips. That is, they enter the EPZ from points outside and travel through the EPZ without stopping. NHRERP, Volume 6, page 2-27, estimates some 3,000 of these vehicles; these vehicles must be added to the total estimate of vehicles that evacuate from within the EPZ.

These through vehicles are assumed to travel on interstate routes I-95 and I-495 which are the primary through roads in the EPZ. This estimate of 3,000 through vehicles is based on observations of levels of service (LOS) on these interstate highways (which did not exceed LOS B or

C) while traveling on the network (Applicants' Direct Testimony No. 7, Post Tr. 5622 at 71). These levels of service represent vehicle densities which correspond to a range of 2,990 to 6,900 vehicles, based on the total lane miles of the interstate highways within the EPZ. The value of 3,000 through vehicles is appropriate because many of the observed vehicles include local or non-external-external trips.

The revised ETEs discussed in Section V.E. reflect current access control procedures. Specifically, the number of through trips on the interstate highways are generated at high volumes (4400 vehicles per hour) for over one hour following the order to evacuate (OTE). This is consistent with the expectation that the volume of traffic will enter the EPZ from the south prior to the activation of the ACPs after entering volumes decline. A sensitivity test was conducted which added another hour of entering traffic from both the north and the south along I-95, at a level of 2000 vehicles per hour. This test revealed that this higher number of entering through traffic had no impact on ETE. This result is explained by the fact that the indicated volumes, even with evacuating volumes added to them, do not exceed the capacity of I-95.

Maintaining the through trips originating south of the EPZ in Massachusetts at 4400 vehicles per hour for over one hour produces roughly the same number of vehicles (i.e., 5000) estimated by Dr. Adler over a 4 hour period. Testimony of Dr. Thomas J. Adler on Behalf of James M. Shannon, Attorney General for the Commonwealth of Massachusetts Concerning Contention JI-4 (Traffic Management Plan) dated February 21, 1989 at 8. By concentrating this through traffic over 1+ hours, instead of 4 hours, a higher density of traffic along I-95 results, with a higher prospect for impeding evacuees. The ETE results of the sensitivity test, discussed above, confirms that through vehicles have little, if any, effect on ETE. The ACPs are expected to be activated approximately 2 hours after the OTE. Applicants' Rebuttal Testimony No. 9 at 33), which is consistent with the time distribution for commuters returning home (Id. at I.H.) and with the estimated time at which the ACPs can be staffed by the traffic guides. (Id. at I.F.). Further analysis of the Exercise TCP/ACP staffing data reveals the ACPs on the interstates in Massachusetts would be staffed well before 2 hours after an OTE given the planning basis timeline. Thus, representing through trips in the ETE analysis as described above is appropriate and consistent with traffic control operations implemented under the SPMC.

C. Vehicles Which Travel From Seabrook Beach Into Salisbury Beach

Another assumption regarding the ETEs for Massachusetts communities concerns the number of vehicles that will travel southbound on Route 1A from Seabrook Beach into Salisbury Beach. It stands to reason that many, possibly most, of these evacuees are Massachusetts residents.

The control strategy employed at New Hampshire TCP A-SE-06 regulates the amount of traffic which travels south from Seabrook Beach into Salisbury Beach along Route 1A. This TCP, which is at the intersection of Route 1A and Route 286 in New Hampshire, (NHRERP, Volume 6, Appendix I), just north of the state border, facilitates the movement of southbound traffic along Route 1A from Seabrook Beach, onto westbound Route 286, as long as westbound Route 286 is not congested to the extent that its queue spills back into this intersection. If the westbound queue on Route 286 threatens to spill back into this intersection, a portion of the southbound traffic on Route 1A from Seabrook Beach is routed south on Route 1A into Salisbury Beach until the westbound Route 286 queue moves forward, allowing more vehicles to enter westbound Route 286. This strategy allows a continuous movement of traffic out of Seabrook Beach. Thus, it is not expected that evacuees would disregard this control strategy which expedites evacuation movement.

The ETEs contained in the SPMC were calculated with the turn movements permitted by this traffic control point implicitly modeled by IDYNEV. Output from the traffic assignment (TA) model, which selects evacuation routes based on minimizing evacuee travel time, indicated that the use of westbound Route 286 was the preferable route selected by evacuees from Seabrook Beach. Thus, for the IDYNEV traffic simulation model, all traffic southbound on Route 1A from Seabrook was coded as 100 percent right turns onto westbound Route 286. Analysis of the simulation output indicated this turn movement specification may produce a spill-back queue into the intersection of Routes 286 and 1A which could impede evacuation movement out of Seabrook Beach. Two sensitivity runs were conducted to represent explicitly the control policy described above, for the Region 1 (entire EPZ), Scenario 1 (summer weekend, midday, good weather) setting. One of these directed 20 percent of the southbound traffic from Seabrook Beach to continue south on Route 1A into Salisbury Beach. The other run directed 40 percent of this traffic south into Salisbury Beach. The results indicate that if 20 or 40 percent of southbound Route 1A traffic continues south at this location, there is no impact on the overall ETE. However, it should be noted that any traffic moving south into Salisbury Beach would, for the most part, be among the last vehicles to exit Salisbury Beach.

In calculating the revised ETEs in Section V.E, this TCP's turn movements were explicitly modeled using the recently completed Traffic Assignment and Distribution (TRAD) model of the IDYNEV system. This model which performs both trip distribution and trip assignment provides improved estimates of turn movements relative to the prior IDYNEV assignment model. In all summer scenarios a non-zero through movement was produced by TRAD for southbound link (4,6) out of Seabrook Beach and into Salisbury Beach. In situations where a spill-back queue develops on westbound Route 286 into this intersection, the non-zero through movement allows the IDYNEV simulation model's queue adjustment feature to permit evacuating traffic from Seabrook Beach to continue through into Salisbury Beach as specified by the control policy at TCP A-SE-06. This computational treatment realistically reflects the control strategy implemented at this TCP.

D. ETEs Insensitivity to Slower Evacuee Mobilization

The SPMC provides for coordinated dissemination of public information to avoid confusing the public. This is addressed in Applicants' Rebuttal Testimony No. 19. Different or conflicting messages are not likely to occur because they are coordinated and controlled at the source. Public messages are also monitored to ensure that the correct information is being broadcast. Even if the mobilization process of evacuees is somewhat slower than estimated in

Volume 6 of the NHRERP, studies were conducted which show that the ETEs for the summer scenarios prove to be relatively insensitive to any reasonable delays in evacuee mobilization providing that the roadways become saturated (i.e., their capacities are fully utilized) as quickly under the delayed mobilization.

Sensitivity runs were previously conducted using the IDYNEV model with the original NHRERP inputs to evaluate the effects of slower evacuee mobilization following the order to evacuate. These runs extended the trip generation process by 40 minutes for Scenario 3 (summer, midweek, mid-day, good weather) and regions 1, 5 and 9 (evacuation of full 10, 5 and 2-mile areas, respectively). This scenario was chosen because it accounts for beach, transient and employee populations. The results of this study indicate that while there are some limited differences in the internal distribution of evacuation time, there is no overall impact on the ETE. It is expected that the same result would be realized using the updated SPMC-specific ETE inputs.

In order to understand this result, one must first appreciate that the effect of trip generation time on evacuation travel time depends on whether a network is operating at an "undersaturated" or "saturated" condition. A network is undersaturated when most or virtually all the links, i.e., sections of roadway, in the system are servicing traffic demand levels that are below the available roadway capacity for a significant portion of the evacuation timeframe. For an undersaturated condition, the total time required to service the total evacuation traffic demand is little more than the aggregate time over which that demand is generated. Thus, the trip generation time is the controlling factor which contributes to evacuation time when conditions are, for the most part, undersaturated. During saturated conditions several, and perhaps many, links in a network may experience traffic demands that exceed roadway capacity throughout the course of the evacuation activity. For the saturated case, extending the trip generation time has little or no influence on the total time required to service the total demand, as long as the extended trip generation time is materially less than the eventual evacuation time. Since the extended mobilization time in the sensitivity runs was under 5 hours, which was well below the ETE for the summer scenarios, the extension of the trip generation process was not expected to -- and did not -- affect the ETE.

E. SPMC Inputs/Updates to ETEs

1. Planning Basis

The ETEs employ a planning basis which assumes the accident begins at an ALERT concurrent with a SITE AREA EMERGENCY, escalates to a GENERAL EMERGENCY 15 minutes later, and the Order to Evacuate (OTE) is transmitted to the public

10 minutes after the GENERAL EMERGENCY is declared. NHRERP Volume 6, pg. 4-1. This timeline represents a rapidly escalating accident scenario. It provides a temporal framework for estimating trip generation distributions and ETE, and a reference point for the initiation of evacuation support operations under the SPMC's procedures. The planning basis also assumes for summer scenarios that an order to close the beaches is issued at the SITE AREA EMERGENCY.

The planning basis utilized and the corresponding ETEs are consistent with the SPMC. Specifically, the SPMC's procedures provide for beach closure at the SITE AREA EMERGENCY between May 15 - September 15. SPMC, Section 3.6.1.E and IP 2.5, 5.2.1.

Allegations that the ETEs should assume New Hampshire beaches are closed prior to the Massachusetts beaches are misplaced. Although the NHRERP and the SPMC provide for consideration of closing the beaches at the ALERT and SITE AREA EMERGENCY, respectively, the ETE planning basis scenario begins at the SITE AREA EMERGENCY. "The Trip Generation Time Distribution for the beach areas has its origin point (i.e., time zero) at the time of the announcement of the SITE AREA EMERGENCY (assumed to be concurrent with the ALERT level)." NHREPP, Volume 6, page 4-17. Under this scenario both the NHRERP and the SPMC would provide for consideration of beach closure at the initiation of the accident.

Allegations that the ETE planning basis should account for hypothetical delays associated with the involvement of Massachusetts officials in the PAR development process are without basis. The ETEs contained in the SPMC are referenced to the OTE and do not include the times between notification or an order for "beach closure" and the OTE; this was done because beach closure may precede an OTE by hours and possibly days in a given situation. Thus, any incremental time increase required for Massachusetts officials to make a PAR decision would delay the OTE. It would not affect ETEs.

Similarly, allegations that the ETEs should account for purported notification delays associated with the SPMC's Vehicular Alert Notification System (VANS) are also without basis. The VANS has been designed to comply with the same regulatory requirements for a prompt notification system as the fixed siren system was designed to.

2. Traffic Control

The ETE calculations are based, in part, on estimates of roadway capacities which reflect evacuation conditions under implementation of the SPMC's traffic control plan. The ETEs assume that the Traffic Guides will implement the traffic control strategies specified in the SPMC, and described in the TCP diagrams, in accordance with the directions provided in their procedure. (SPMC, Appendix J, pp. J-1 through J-7.) The ETE, however, assumed that available capacity was somewhat lower than that during normal conditions. On approaches to signalized intersections, the upper bound of observed headways (time between vehicles) is input to IDYNEV. The use of this upper bound, rather than an average value, translates into lower discharge capacity. Additionally, along all roadway sections a reduction in capacity of 15 percent is applied under congested conditions to represent a lower level of operational efficiency due to driver uncertainty and other factors, under emergency conditions. Finally, the capacities of the roads servicing the beach areas are estimated on the basis of "rolling" terrain. Actually, the terrain east of I-95 is a flat coastal plain. The effect of assuming rolling terrain is to decrease capacity estimates for the roads in the coastal plain by approximately 10 percent. Thus, the ETEs include conservative assessments of capacity and represent the evacuation conditions expected under the implementation of the SPMC's traffic control plan.

S. Traffic Guide Mobilization

As indicated in the discussion on traffic guide mobilization in Applicants' Rebuttal Testimony No. 9 (Section I.F.), empirical results indicate that traffic guides will start arriving at the most important traffic control points (TCPs) (i.e. TCPs which have the greatest influence on ETEs) within approximately 1.5 hours from the declaration of a SITE

AREA EMERGENCY (SAE). Since the planning basis used to calculate the ETEs assumes that beach closure would occur at the SAE and that the OTE follows 25 minutes later, traffic guides would not be available to provide traffic control for the very early stages of an evacuation under this accident escalation scenario.

The absence of traffic guides at the early stages of an emergency has two primary effects on evacuation operations: First, traffic guides will not be available to expedite the traffic exiting the beach areas due to the beach closure recommendation; nor will they be available to expedite the movement of other evacuation traffic during the early stages of evacuation. Thus, any capacity enhancement provided by the traffic management plan will not be realized at a TCP until the guides are in place. Second, it is reasonable to expect that there will be a degree of evacuee deviation from the recommended evacuation routes when traffic guides are not available to facilitate traffic movements. To realistically represent the staged arrival of traffic guides at their TCPs and the resulting changes in traffic control and in traffic movements, the following procedure was followed to develop the inputs to the IDYNEV system:

1. A careful examination was made of the evacuation routes that would most likely be taken by evacuation trips

generated from each origin centroid, to reflect the absence of traffic guides throughout the EPZ.

2. Based on this analysis, a set of candidate destination nodes located at the periphery of the EPZ was specified for each origin centroid. That is, these evacuation routes and destination nodes would be "attractive" to those evacuees generated at the origin centroid in the absence of traffic guides since their travel would be generally outbound relative to Seabrook Station and would represent reasonable behavior on their part.

3. The specification of the roadway network and of the available link-specific turn movements were modified to reflect the absence of traffic guides. For example, evacuees traveling westbound along Beach Road in Salisbury from the beach area could elect to either proceed through Salisbury Square toward westbound Route 110, or turn left onto southbound Route 1. Of course, with no guides present, Route 110 would function as a two-way road with one lane servicing traffic in each direction.

4. The service rates at key intersections were reduced relative to those of the "WITH GUIDES" set of runs, to reflect the absence of traffic guides. For example, the service rate for the westbound Beach Road approach to Salisbury Square was estimated to be lower with no guides available to form two lanes, than when guides are present.

Thus, the capacity enhancement effects of traffic guides at this location are absent prior to the time that this TCP is activated.

5. This modified network configuration, exhibiting more "relaxed" turn movements (than when traffic guides discourage some movements) and the reduced capacities of key links was input to the TRAD model of the IDYNEV system.

6. The TRAD model was executed to perform an integrated trip distribution and trip assignment analysis using equilibrium principles which:

- Distributed trips from each origin centroid to each of the destination nodes in the set of candidate destinations specified for that origin node. Note that the Step 2 activity specified (i.e., input) a set of candidate destination nodes for each origin centroid. It is the trip distribution process within the TRAD model that computes the actual number of trips which travel from the origin centroid to each of these candidate destination nodes.
- Assigns the trips from each origin centroid to paths along the roadway network. This process also computes the turn movement percentages for each network link.

Steps 2 through 6 are repeated in steps 7 through 11, respectively, except that the IDYNEV input stream now represents the effects of <u>all</u> traffic guides in place at the TCPs.

7. The set of candidate destination nodes for each origin centroid now represents the effects of traffic control exercised at each TCP. Consequently, the routing facilitated by the traffic guides will produce, in general, a somewhat <u>different</u> set of candidate destination nodes, than for the case when traffic guides are absent.

8. The specification of the roadway network and of the available link-specific turn movements represents the presence of traffic guides at all TCPs. For example, with traffic guides present, evacuees traveling westbound along Beach Road in Salisbury from the beach area will form two lanes and all proceed through Salisbury Square toward westbound Route 110; none turn left onto southbound Route 1. Route 110 services this traffic along 2 lanes.

9. The service rates at key intersections reflect the presence of traffic guides. Note that the presence of traffic guides do not increase capacities, in general, relative to the HCM-derived values (which, of course, do not consider active traffic control) except at key locations where their activities specifically are designed as capacity-enhancing. Note that on-ramp capacities are not influenced

by the presence or absence of traffic guides since none are deployed on the on-ramps. Furthermore, the arrival of traffic guides to facilitate the movement of traffic entering on-ramps cannot influence, in any way, the capacity of the on-ramps themselves.

10. This network configuration exhibits the turn movements recommended by the traffic guides and the capacities which reflect the traffic guides' presence. This representation of the network configuration was input to the TRAD model.

11. The TRAD model was then executed. See the description of step 6 for details.

12. At this point in the process, the TRAD model has generated results which describe the evacuation traffic environment (1) before the traffic guides arrive at any TCP and (2) after the guides have arrived at all TCPs. The need to represent both conditions reflects the fact that TRAD is a quasi-steady-state model which represents average conditions for a speci' .d traffic environment, but cannot dynamically represent changes in control over time.

13. The real world traffic environment is dynamic: it transitions in stages from the "before" condition (no traffic guides in place) to the "after" condition (when all traffic guides are in place). The change in traffic environment, over time, can only be adequately represented by the IDYNEV

simulation model. This model can replicate the arrival, over time, of the traffic guides at various locations, by introducing inputs at different points in simulated time which describe the <u>effects</u> associated with the activation of TCPs on a location-by-location basis. A small modification was introduced into the simulation model to reflect the staged activation of the TCPs.

14. As each TCP is activated, the inputs to the IDYNEV simulation model replace the "before" traffic pattern (i.e., turn movement percentages) with the "after" pattern. Furthermore, any capacity enhancement associated with the activation of a TCP is represented by changing the service rate. (In detail, a lower service rate associated with the absence of guides is represented in the input stream as a [capacity-reducing] "blockage factor." When the TCP is activated, this blockage is removed from the input stream). Finally, when all TCPs are activated, the traffic environment (turn patterns and service rates) is that of the "after" condition.

15. Results were produced by the IDYNEV simulation model responding to input streams which described the dynamic changes in the traffic environment arising from the staged activation of TCPs. These simulation results provide ETEs which are consistent with the expected rate at which TCPs are

activated. These results are presented in Attachment D hereto.

The impact on the ETE of the effects of delayed staffing of TCPs varies with evacuation scenario. For example, for winter scenarios which are characterized largely by non-capacity constrained network conditions, the effect of delayed activation of the TCPs on the ETE is minimal. That is, to a large extent, traffic demand remains less than the roadway capacity even prior to implementation of capacity enhancing measures at the "more important" TCPs. For summer scenarios which are characterized by capacity constrained network conditions, the system responds in two ways to the early absence of traffic guides: (1) Increased non-compliance with the recommended evacuation routes has, in some locations, the potential to further disperse traffic demand and, thus, reduce ETE; (2) Not staffing the capacity enhancing TCPs prior to the onset of congestion reduces service rates at these locations, which serves to increase ETE. Results are discussed in the Section, V.E.5 "Discussion on Revised ETEs."

4. Updates to ETEs

The ETEs have been revised to reflect SPMC specific and other inputs as part of the ongoing evaluation and update process. These revised ETEs are Attachment D hereto. The following is a summary of the revised inputs:

• The inputs explicitly reflect the control strategies implemented at the SPMC's TCPs and ACPs. This includes TCPs B-AM-06 and A-SE-06 as previously discussed.

• The inputs reflect the delayed implementation of access control operations consistent with SPMC procedures. See also Section V.B.5, "Through Vehicles."

• A total of 1440 "vehicles in transit" have been added to the beach area vehicle populations in accord with the Avis data.

• The inputs reflect where and when traffic control will be available at traffic control points under the assumed planning basis timeline as based on empirically determined traffic guide mobilization data.

Specifically, the revised ETEs, as well as the ETEs contained in the current version of IP 2.5 Attachment 4, reflect the control strategies implemented at the TCPs and ACPs specified in the SPMC. Minor changes and updates that occurred in the TCP diagrams from Volume 6 of the NHRERP to the SPMC had no material impact on the ETEs in IP 2.5 Attachment 4.

5. Discussion on Revised ETEs

Review of the revised ETEs for Region 13 indicates that the evacuation times for the summer scenarios are somewhat higher than the ETEs contained in IP 2.5 Attachment 4, and are comparable for the off-season scenarios. For Region 8, the revised ETE are comparable to those in IP 2.5. These revised ETEs are presented in Attachment D hereto. These ETE results reflect several factors:

1. The addition of 1440 moving vehicles in the beach areas tends to increase the summer scenario ETEs. This follows from the fact that 1061 of the 1440 additional vehicles are on the New Hampshire beaches in Hampton, North Hampton and Rye which evacuate along the critical paths (i.e. those which are the last to clear and which dictate the ETE).

2. The latest version of the IDYNEV simulation model asserts a more conservative application of the capacity reduction factor. Previously, the link capacity during congestion (LOS F) was reduced by <u>up to</u> 15 percent. However, recent freeway operations data suggests that once LOS F conditions take hold, the capacity reduction remains in effect; thus the 15 percent reduction is maintained in the updated model, for the most part, for as long as congestion prevails. This new treatment tends to increase ETE.

3. The staged staffing by traffic guides of key TCPs results in lower service rates (i.e. lower capacity) for the time period when the points are not staffed, and in more external trips entering the EPZ for the time period when the ACPs are not activated. Both conditions have the potential to increase the ETE.

4. The ability of evacuees in Hampton Beach to travel south into Seabrook and Salisbury Beaches in the absence of traffic guides acts to shift vehicles from the critical paths in New Hampshire to other paths which exhibit lower ETE. This acts to lower overall ETE.

5. The TRAD model is more effective in estimating the distribution and assignment of evacuation trips. This more accurate representation of real-world travel patterns has the potential for reducing the calculated ETE.

The net effects of traffic control on ETE relative to the traffic control for Region 1 (Entire EPZ), Scenario 1 (summer weekend, midday, good weather) and for Scenario 5 (off-season, mid-week, mid-day, good weather) cases are presented below:

CASE DESCRIPTION	ETE Results: Region 1 Scenario 1	ETE Results: Region 1 Scenario 5
A. All traffic guides are at the TCPs at the start of beach evacuation	7:35	5:40
B. Traffic guides arrive at their TCPs over a period of 1 to 3.75 hours according to data obtained during the 1988 Exercise	7:40	5:35
C. No TCPs are manned throughout the evacuation	9:00	6:30

The following conclusions may be drawn:

1. The trade-off between Factors 2 and 3 which tend to increase ETE, and Factors 4 and 5 which tend to lower ETE, results in a virtual stand-off in that the ETE reflecting the expected delays of TCP/ACP activation is comparable to the ETE reflecting the immediate activation of TCPs. This is shown by comparing the ETE of 7:40 for Case B with 7:35 for Case A.

2. Further delays on the part of traffic guides to man their TCPs will act to increase the ETE. This is shown by comparing the ETE of 7:40 for Case B, with the extreme condition of Case C, "no guides", which produces an ETE of 9:00.

3. For the extreme condition of "no guides", it is seen that Factor 3 outweighs Factor 4 when the delays in manning TCPs grow. The increase in ETE from 7:40 to 9:00 due to the total absence of guides, rather than their delayed arrival, testifies to the effectiveness of the traffic control policies in reducing ETE, even when the guides at the critical TCPs arrive after the start of beach closure and the OTE.

4. For the off-season scenarios, Factors 1 and 4 are inapplicable. Factors 2 and 3 are applicable but have a more moderate impact than for the summer scenarios as traffic operations experience lower levels of congestion on the

network, reflecting the lower levels of traffic volume relative to the summer scenarios. Factor 5 remains important, since motorists will select the most efficient evacuation paths and the improved representation offered by the TRAD would produce more accurate representation of vehicle routing than the Traffic Assignment model, alone.

As explained in Conclusion 1, above, the lateness of the traffic guides in manning the TCPs in the summer relative to the time of the beach closures does not materially alter the ETEs relative to an "immediate" manning of the TCPs. For the off-season the capacity-enhancing activities of traffic guides are of lesser value in reducing ETE since the ETE is largely dependent on mobilization time -- and less sensitive to the efficiency of traffic operations. Thus, since traffic flow conditions are congested to a lesser extent than during the summer, capacity-enhancement has a somewhat lesser effect on expediting traffic flow.

Thus, overall, the revised ETEs are based on planning bases and assumptions that are consistent with the SPMC procedures.

VI. PROTECTIVE ACTION RECOMMENDATIONS

A. Use of ETEs in PAR Decision-Making

Implementing Procedure (IP) 2.5, Attachment 4 of the SPMC provides ETEs for the two regions (8 and 13) which include the Massachusetts communities within the Seabrook

Station EPZ. This table provides ETEs for ten scenarios (these are the same scenarios utilized for calculation of the ETEs in the NHRERP) and two keyhole configurations (Regions 8 and 13) of five and ten miles respectively from Seabrook Station. These scenarios consider such factors as season (winter, summer), day of week (weekend or weekday), the time of day (mid-day, evening, all day), and weather conditions (normal, rain, snow). A brief description of each scenario is also provided. (IP 2.5, Attachment 4). Combinations of these factors which define the various scenarios are readily determinable and produce conditions that can influence the ETEs.

Specifically, the following parameters vary with scenario and with the region to be evacuated: 1) total population and area to be evacuated; 2) geographical distribution of that population; 3) mobilization time of the population (trip generation time); and 4) free-flow speeds and highway capacity.

The SPMC's ETEs provide all of the necessary information and parameters to allow proper selection of a representative ETE for determination of Protective Action Recommendations. Local conditions and the location of traffic impediments could vary widely. It is not possible nor prudent to attempt to analyze in advance every situation which could occur during an emergency evacuation.

Sensitivity runs have been previously executed using the IDYNEV model and NHRERP inputs to explore the response of ETE to roadway impediments and changes in beach population. These sensitivity runs show the following:

For Region 1, Scenario 1, the effect of ten traffic impedances which are active over varying, substantial periods of time on different randomly selected high-volume EPZ evacuation links, was estimated by using the IDYNEV model. The testimony filed during the New Hampshire ASLB hearings described these runs. (Applicants' Direct Testimony No. 7, Post Tr. 5622 at 62-63). The number 10 represents the anticipated number of accidents from defined statistics, based on the vehicle miles of travel expended during the evacuation. Id. This study adopted the overly conservative assumption that all accidents result in roadway impediments. The results show that impedances of one to two hours duration resulted in a range of increase in ETE of 0-10 minutes; impedances of two to three hours resulted in ETE increases in the range of 30-60 minutes. Id.

Sensitivity tests were performed, reducing the beach population up to 60 percent below the estimated peak values as determined from the data provided by Avis, Airmap Inc. as discussed in Applicants' Direct Testimony No. 7, Post Tr. 5622. The results appear below for Region 1 (Entire EPZ) and Scenario 1 (summer weekend, mid-day, good weather):

Percent Difference in Beach Area Population Relative to the Estimated Peak Values	ETE	Percent Difference in ETE Relative to that for the Estimated Peak Value of Beach Area Population
0 (Peak)	7:40	0
-20	7:05	-7.6
-40	6:35	-14.1
-60	6:10	-19.6

As indicated above, while the beach area population varied by up to 60 percent below peak values, the ETEs were reduced by only about one-third the reduction in population (expressed as a percentage). Thus, any uncertainty in beach area population does not translate into a disparity in ETE sufficient to influence the PAR.

The SPMC provides for assessing potential constraints to evacuation in IP 2.5, Section 5.5.4. As detailed there, the Accident Assessment Coordinator and Assistant Offsite Response Director, Response Implementation, brief the Radiological Health Advisor on any constraints to evacuation, and considerations or scenarios which may enhance the estimated evacuation time. As discussed in this section, the ETEs are not particularly sensitive to many variables such as road impediments and variations in beach population. No adjustments need be made to the ETEs in IP 2.5, Attachment 4, since, for the vast majority of occurrences, the adjustments in ETE would be limited and in fact are unlikely to affect the choice of protective action.

In summary, the ETEs contained in IP 2.5, Attachment 4 (as they will be updated by the ETEs in Attachment D hereto) will be adequate for PAR decisionmaking for the following reasons:

1. The ETEs were calculated using a state of the art methodology and are as accurate as reasonably achievable.

2. The ETEs provided to the PAR decisionmakers are for an adequate number of scenarios which account for the most predominant conditions and variables normally experienced in the Seabrook EPZ.

3. The ETE scenarios in the SPMC are the same ones used in the NHRERP which the Board concluded were adequate for PAR decisionmaking.

4. The ETEs prove to be relatively insensitive to roadway impediments and expected variations in beach area population.

5. PAR decisionmakers are alerted to consider emergency specific conditions which may direct additional logistical considerations for added flexibility.

6. Under most conditions evacuation would be the preferred PAR for the Seabrook EPZ.

7. There is no evidence to support the argument that further refinement of the ETEs would make a further contribution to public protection.

B. Real Time ETEs

It has been alleged that a real time computer based system to collect traffic data in order to estimate the number of vehicles within the beach area to generate a real time ETE should be utilized within the Seabrook EPZ during the summer. However, there is no assurance that such a system is feasible. By "feasible", it is meant that the accuracy and reliability of the data collected, and of the inferred estimate of beach area vehicle population, satisfy reasonable criteria under all circumstances and represent significant improvements relative to estimates based on time of day, day of week and weather conditions. Even if it was feasible, it does not appear that any incremental benefit would constitute a material improvement over the current SPMC procedures for determining ETEs such that the PAR decision process is materially affected. See Section VI.A for the sensitivity of ETE with respect to varying beach population.

The pursuit of more realistic or real-time data is not easy. Establishing a real-time computer based system for data collection and computation of ETEs, as described in contention JI-03, would entail placing automatic traffic recorders (ATR) at all points of ingress and egress to the beach areas to form a closed cordon and establish a "controlled" area. These detectors would be linked to a computer system which would have to be programmed to discern the net vehicle flux within this controlled area as a function of time and to calculate the estimated vehicle content. This data would then be used as input to the IDYNEV model or be directly compared to a list of ETEs which utilize beach population as an independent variable to determine the "real-time" ETE.

Such a system could be infeasible for several reasons. First, the accuracy of the system would be related to the accuracy of the automatic traffic recorders. Dr. Adler's testimony for the Massachusetts Attorney General in the ASLB hearings on the NHRERP indicated that, based on empirical data collected by HMM Associates in the beach areas of the Seabrook EPZ, the magnitude of aggregate errors in vehicle accumulation for pneumatic counters around a section of the beach area is in the realm of 80,000 vehicles over a four month period (Adler Rebuttal Testimony, Figure 1, dated 1/22/88, Post Tr. 9524). This translates to an average accumulated error of almost 5,000 vehicles per week.

While it is true that the counters referenced were the pneumatic tube type, electronic detectors are also subject to error, particularly when recording traffic under congested conditions. The magnitude of these errors depends on many factors: detector installation, electronics, detector tuning, on-line data reduction software, number and placement of detectors, composition of traffic, volume, speed of traffic, weather and traffic operations (passing, vehicle lateral position). Some data indicates recorded errors are 7 percent or more under congested conditions unless compensatory software is supplied. Moreover, these errors are not uniform; some days the error constitutes an undercount and other days an overcount is registered. Additionally, some errors are not easily controlled. Vehicles which pass each other using the oncoming lane may be counted as inbound when they are actually outbound. Others that use the shoulder or breakdown lane would not be counted at all.

The suggested system of detectors forming a cordon would potentially involve multiple detectors to attempt to estimate net changes in vehicle content by subtracting the aggregate counts of detectors on outbound lanes from the aggregate counts of detectors on inbound lanes. The presence of these errors, or even a malfunction of <u>one</u> detector, would produce serious errors in the net vehicle content estimate. For example, if a detector which normally counts 10,000 vehicles per day malfunctions or becomes inoperative for only a few hours, then clearly <u>all</u> data is worthless and the system must be recalibrated.

A survey reported in NCHRP Report No. 233 yielded data which indicates that a surveillance system of detectors experiences a failure rate of approximately 30 percent annually. That is, the probability of each detector failing over a period of one year is about 0.3. Thus, provision must be made for rapid response maintenance of the system during the summer months.

A paper entitled "Traffic Detector Errors and Diagnostics" by L. Chen and A.D. May, in Transportation Research Record 1132, dated 1987 reported on several studies addressing detector failure. One cited report documented the results of an empirical study which revealed a failure rate of 1.18 failures per year per detector. Also referenced was another study which revealed that 10.5 to 14.8 percent of detectors on a Los Angeles freeway surveillance system were unavailable (i.e., non-functioning) at any time. Loop detector failures can be caused by moisture, sealant deterioration, pavement cracking, broken wires, detuned amplifiers and lightning surges.

This accumulation of error and likelihood of malfunction makes it necessary to repeatedly "recalibrate" the system by directly estimating the vehicle content of the "controlled" beach areas at some point in time by using some empirical data collection method such as aerial photographs. The frequency of this recalibration depends on the rate of detector error, which can vary widely due to its non-uniformity, the frequency of detector failures, and the precision needed to provide materially better accuracy than is currently available using historical data.

Consider the use of aerial photographs for this recalibration. Suppose a flyover is undertaken on Monday morning. The film must then be developed. Following that, data reduction activities would be undertaken. Even if considerable effort and personnel are utilized, it is reasonable to expect that a reliable estimate of vehicle content on Monday would not be available until Tuesday evening, or later. Thus, about 36 hours would have elapsed after the area was photographed, before the data base in the computer is upgraded. But, additional data would have been collected by the surveillance system during this 36-hour period and detector errors would have been aggregated over this period, as well. Thus, the process of accurately recalibrating a real-time system becomes questionable with initialization data which is approximately 36 hours old, when the vehicle flux data collected during this period contains errors of unknown magnitude and direction.

Another consideration with a real-time system is what to do when a component of the system malfunctions. Clearly it is necessary to recalibrate the system. Is it practical and realistic to presume to have a plane, pilot, equipment, and data-reduction technicians available at all times in such an event so as to rapidly restore and recalibrate the system?

Furthermore, it serves no useful purpose to recalibrate the system while a detector is inoperative -- it is first necessary to repair or replace the detector and ascertain that it is functioning properly. Is it reasonable to expect that personnel and equipment are always available to rapidly repair the problem?

Suppose an emergency occurs after a malfunction but before the system can be brought back on line following a flyover and recalibration. What fallback provision is used in the interim? And, in fact, if this fallback provision is considered acceptable, why not use it in the first place rather than depend on a complex real-time system?

It is also possible that an emergency could occur at a time when significant errors have accumulated in the data base and before the recalibration activity (assuming it is viable) is completed. In this circumstance, the real-time system would be counter productive, producing an erroneous estimate of vehicle population and an ETE which may be less accurate than those developed from the current methodology.

The bottom line value of a real-time system becomes questionable when one analyzes the sensitivity of the ETE to variations in beach population. For example, sensitivity studies with IDYNEV presented in Section VI.A indicate that a 60 percent reduction in beach population produces about a 1.5

hour (or 20 percent) reduction in ETE. Several questions arise:

How much more accurate in estimating beach area vehicle content must a real-time system be (assuming it is feasible) than the current methodology to constitute an "improvement?"

Consider a favorable assessment of a real-time system: Assume the real-time system has only a 10 percent error in its estimate of vehicle content while the present methodology has a 40 percent error. The consequent difference in ETE is about 47 minutes, or 10 percent. Thus, in this extreme example, a hypothetical reduction in the error in the estimate of beach area vehicle content by a factor of 4, translates to a small percentage of improvement in ETE accuracy. The likelihood that such a large hypothetical improvement in the estimate of beach area population would translate into a different PAR is extremely remote. Note that a 10 percent error for the beach areas cited by MAG amounts to about 2400 vehicles which is about half the accumulated error of 5000 per week, as discussed earlier. Thus, even with all components of the system functioning perfectly, there is no reasonable assurance that the real-time system's error rate will be as low as 10 percent.

The contention basis noted, without support, that the beach population fluctuates by "tens of thousands" in a few hours. As shown in Table 2-3 of Volume 6 of the NHRERP, the most pronounced increase in vehicle count in 1983 amounted to 5674 vehicles over 7 hours, aggregated for both Hampton and Seabrook beaches.

Table 2-3 of the NHRERP, Volume 6 presents data describing the variation of beach area population on the Seabrook and Hampton beaches south of Route 51 over the course of a crowded summer weekend Saturday. Based on the projected peak beach vehicles population of 11,889 in the beach areas (9104 + 2785), Applicants' Direct Testimony No. 7, Post Tr. 5622 at 38, the data in Table 2-3 shows that the beach vehicle population between the hours of 10 a.m. and midnight varies between 72 - 100 percent of the peak value which occurs at about 2 p.m. According to the data in Section VI.A the variation in ETE corresponding to this variation in beach area population is 6:53 to 7:40, a range of about 10 percent. Thus, as a practical matter, the maximum error in ETE on a crowded day is about 10 percent. It is highly unlikely that a real-time system can provide any material utility in this situation.

In summary, a real-time ETE system is not required by established guidelines and regulations and is not reasonable for Seabrook because:

- It incorporates many problems and limitations which must be satisfactorily resolved prior to this approach achieving feasibility. At this time there is no assurance that such feasibility is attainable.

• Its implementation cannot assure a material improvement in emergency planning. The prospect of an unavoidable accumulation of error over time, and of the periodic failure of system components, leading to a requirement of periodic recalibration using manual techniques, imply that such a system is of questionable utility, even if implementable. It provides no assurance that, even if feasible and successfully implemented, that a meaningful beneficial influence on PAR would result.

C. Special Populations ETEs

Estimates of special population evacuation times are included in Volume 6 of the NHRERP. This analysis considered special facilities, schools and transit dependent at home and accounted for factors which would influence evacuation time, including resource mobilization time, inbound travel time, time to load passengers and outbound travel time. The method of calculation and associated assumptions are included in the NHRERP, Volume 6 (pp. 11-1 through 11-27). These ETEs were evaluated as adequate in FEMA's December 1988 Review and Evaluation of Seabrook Plan for Massachusetts Communities, (Evaluation Criteria J.10.1).

The goal of protective action decision-making is to maximize the dose savings of the EPZ population. Two possible actions to achieve this dose savings are sheltering or evacuation. In accordance with IP 2.5, Attachment 3, a PAR is reached for the general population as a whole (including special populations) after comparing the dose savings of evacuation and sheltering. The resulting protective action is recommended for all population groups within the area implementing the PAR.

For protective action recommendation decision-making, the two key parameters in determining relative dose savings are, for evacuation, the ETE and for sheltering, the dose reduction factor (DRF) of the shelter facility.

The only way that ETEs for each special population group and special facility would be of any use is if comparisons of dose savings afforded by evacuation and sheltering were calculated for each and every facility and population group in the area implementing the PAR. This approach would require not only ETEs but sheltering dose reduction factors for each special facility and population group within the area of interest. This is an impractical, unreasonable and time consuming approach to making a PAR.

Even if this information was available, recommending PARs on a facility-by-facility basis is not likely to provide any additional dose savings for the special populations. The only situations where making a PAR on a facility-by-facility basis could even have the potential for increased dose savings is if one assumes the following hypothetical. Assume that the special facility ETEs are substantially longer than those for the general population, evacuation is recommended for the general population and the dose reduction factors for special facilities are better than those for the general population. However, even in a situation where these three hypothetical assumptions are all true, evacuation would still remain the preferred PAR. This is because the only other alternative would be to shelter, and this is the action the special populations would be taking prior to the time when transportation arrives to assist with evacuation. Thus, the special facility population would already be receiving the dose savings from sheltering. When the transportation arrives this population group would then evacuate. This trip out of the EPZ under this hypothetical situation would be at normal travel speeds due to post evacuation uncongested conditions. Because this trip would take approximately 15 minutes or less to reach the EPZ boundary (NHRERP, Volume 6, pg. 11-26). (As discussed later, the special facility ETEs are comparable to those for the general population, thus eliminating any need to consider separate PARs for special facility populations.)

Given that the special facilities and special populations protective action recommendations will be the same as those of the general public, the SPMC will provide for special consideration of these groups. The SPMC will be revised to incorporate a priority list for allocating evacuation vehicles to all special populations. This list will indicate which population category should receive resources first and the sequence in which facilities within each category will be serviced. Specifically, schools and day care facilities would be assigned vehicles first, followed by the transit dependent general population routes, curbside pick up (homebound) routes, special facilities and then hospitals. When there are multiple facilities within a category, the facilities which are closest to the Seabrook Station would be serviced first followed by those that are further away. This assignment priority ensures the most efficient use of transportation resources. Thus the SPMC takes all appropriate steps for maximizing dose reduction for EPZ special populations.

The evacuation time estimates for special populations are contained in Section 11 of Volume 6 of the NHRERP. ETEs for special populations account for mobilization of response personnel and resources, inbound travel time, time to load transit dependents and outbound travel time. It is necessary to reevaluate these special population ETEs only when these inputs change substantially.

The special population inputs for the SPMC which differ from those in Volume 6 are the availability of buses and the bus mobilization procedures. Other inputs, such as the ambulance and wheelchair van mobilization process, have not changed; hence, Volume 6 ETEs still apply. This discussion addresses bus operations in the context of the rapid accident escalation scenario defined in Volume 6.

For the ETE scenario, the Offsite Response Organization (ORO) would use the SPMC bus mobilization procedures for fast breaking accident scenarios which will utilize the Northern Essex Community College (NECC) as a forward bus staging area. Applicants' Rebuttal Testimony No. 6 (Transportation Resources). During his initial contact with each bus company, the Bus Company Liaison confirms that the bus company contact has mobilized drivers and dispatched buses to the NECC located just off of Interstate 495, Exit 52, in Haverhill. Bus Dispatchers, Dosimetry Recordkeepers and Route Guides are dispatched from the ORO Staging Area (located in Haverhill) to the Northern Essex Community College. Assignments for buses are then confirmed by the Bus Dispatchers with the Bus Company Liaison. Bus drivers will receive dosimetry and an assignment briefing and be matched with Route Guides at NECC. The Bus Dispatchers will then dispatch buses to perform their specific assignment as they become ready.

In order to quantify the elapsed times from the SAE to the times that the first and last buses will arrive at the EPZ boundary, it is necessary to estimate the time to perform each individual procedural step. Next, it is necessary to determine those steps which are undertaken in parallel and those which are in sequence with other steps. Finally, it is necessary to sum both the shortest and longest paths or sequence of steps for each bus yard. This analysis of the SPMC's bus mobilization process has been performed and is described in Attachment E hereto.

The results of this analysis indicate that the current bus mobilization procedures enable the first buses to arrive at the EPZ boundary within approximately 2:04 from the issuance of an OTE. For the same scenario the last buses would arrive there within approximately 3:50 from the OTE. These times are comparable to those calculated for special population bus evacuation operations documented in Volume 6 of the NHRERP. Specifically, the Volume 6 ETE analysis assumed the last buses would be mobilized at the bus yards within 3 hours of the start of mobilization and inbound travel and processing at the staging area would require an additional hour. Thus, that analysis estimated that the last buses would arrive at the EPZ boundary within about 3 + 1.00 = 4.00 hours of the SAE, or 3:35 of the OTE. This is within 15 minutes of the time estimated for the last buses under the revised SPMC procedures.

Bus evacuation operations within the EPZ (such as travel times and loading times) under the SPMC are the same as those discussed in Volume 6. For example, while the general population transit dependent bus route travel times on individual routes have changed due to revised routes, the total time to complete the longest route is the same as the original estimates. (See Applicants' Rebuttal Testimony No. 9, Attachment F.) Since SPMC bus availability is comparable to those presented in Volume 6 of the NHRERP (even assuming a very fast breaking scenario) and that operations within the EPZ are expected to take the same amount of time as estimated in Volume 6, the special populations ETEs provided in Volume 6 are applicable to evacuation operations implemented under the SPMC.

VII. ANALYSIS OF DR. ADLER'S ETES FOR DISCUSSION OF THE SPMC'S TRAFFIC MANAGEMENT PLAN

The following testimony addresses statements describing ETEs associated with the SPMC traffic management plan, by Dr. Adler in his testimony on Contention JI-4, dated February 21, 1989. Specifically, it was stated on page 4 that "[a]nalyses indicate that the Plan as currently designed will increase the amount of time required for evacuation of the Massachusetts population noticeably above the level that might be achieved without traffic guides actively re-directing the traffic flow". Dr. Adler focuses attention on "two major intersections," where TCPs B-SA-06 and B-AM-06 are located.

As indicated by the discussion in Section V.E., the deployment of traffic guides in accordance with the SPMC provides significant benefits in terms of reducing ETE for the studies conducted on the Region 1, Scenarios 1 and 5, Cases. The disparity between these results and those of Dr. Adler is explained by flaws in Dr. Adler's analysis. As detailed below, the work performed by Dr. Adler contains two levels of errors: (1) methodological and (2) the detailed representation of the traffic environment in the IDYNEV input streams used to generate the results shown in Figures 1 and 2 of his testimony.

A. Methodological Problems

These were discussed in Section I.K of Applicants' Rebuttal Testimony No. 9. The summary presented therein at 43 was:

- These sensitivity tests were improperly designed leading to invalid results.

- The TCP control was misrepresented and probably improperly input to the IDYNEV model, thereby producing incorrect results.

B. Errors in the Detailed Representation of the Traffic Environment in the IDYNEV Input Streams

<u>Since the filing of Applicants' Rebuttal Testimony No. 9, the IDYNEV input streams used by Dr. Adler to generate the results displayed in Figures 1 and 2 of his testimony were</u>

provided by MAG. With this information available it was possible to identify the input stream errors.

1. At Node 93

This node represents the intersection of Routes 1A (Beach Road), 1 and 110, which is known as Salisbury Square. The condition, "NO TRAFFIC GUIDES", was represented in the input stream by the specification of a left-turn movement from link (3, 93) representing westbound Beach Road, and by specifying that one-third of the traffic on that road will turn left onto southbound Route 1, with the remainder continuing through onto westbound Route 110. For the "WITH GUIDES" condition, all Beach Road traffic was routed through onto westbound Route 110. The errors in this specification undermine the validity of this study:

- The absence of guides at this TCP B-SA-06 will assuredly reduce the productivity (i.e. the service rate) of traffic entering Salisbury Square. Effectively, the guides' absence reduces the capacity of the westbound Beach Road approach. Specifically, the absence of the guide which forms two lanes of westbound traffic, to the east of the Square, and of the other guides maintaining this two-lane flow, will certainly degrade the productivity of traffic flow. Since this reduction in capacity is not represented by Dr. Adler in the IDYNEV input stream as it should be, the ETE results for the NO GUIDES condition are too low.

• The absence of guides at this TCP will leave Route 110 functioning as a two-lane, two-way road. Thus, only one lane of westbound travel would be available. Dr. Adler did not modify link (93, 45), which represents Route 110 westbound, to reduce the number of outbound lanes from two to one, accordingly. This error attributes twice the capacity to this link than it actually would have. As a result, the ETE is too low for this NO GUIDES condition.

• Because the absence of traffic guides in Hampton Beach was not represented in the input stream, the IDYNEV model did not represent traffic flowing south into Seabrook Beach and into Salisbury Beach across the Hampton Harbor Bridge. For this NO GUIDES condition, traffic <u>would</u> flow southward into Salisbury Beach. The failure to represent this additional traffic moving into Salisbury Beach and thence along westbound Beach Road, in the IDYNEV inputs, produced incorrect lower traffic volumes there, which lowered the ETE below the correct value for the NO GUIDES condition.

• Specifying that one-third of Beach Road traffic turns left onto Route 1 in the NO GUIDES condition is completely arbitrary. Chief Beevers testified under cross examination that while several drivers exiting westbound Beach Road turned left onto Route 1, most continue west onto Route 110 and travel toward the Interstate highways (<u>Tr.</u> at 17177). Indeed, the TRAD model for the NO GUIDES condition, routed about 17 percent onto southbound Route 1. The combination of lower westbound volume (67 percent of Beach Road traffic instead of, say 83 percent) along Route 110 and the incorrect specification of two lanes for that road instead of one lane, (i.e., lower demand and higher capacity than is actually the case), also lowers ETE below the correct value.

2. At Node 45

This node represents the interchange between Route 110 and I-95 in Amesbury where TCP B-AM-06 is located. The condition of WITH GUIDES is represented with inputs which improperly specifies, as a through movement, the right-turn movement from link (93, 45) (westbound Route 110) onto the on-ramp to I-95 southbound; and the U-turn movement onto eastbound Route 110. is properly coded as a left diagonal movement. Each movement is assigned about 50% of the total traffic on link (93, 45). The condition of NO GUIDES is represented properly as a through movement from link (93, 45) onto westbound Route 110, a right diagonal movement onto the on-ramp to I-95 southbound and a left turn for the U-turn onto the other on-ramp to southbound I-95. The two percentages remain the same: about half the traffic on link (93, 45) moves through, with the other half moving diagonally.

The errors in this input stream are:

- Link (93, 45) in the NO GUIDES condition is incorrectly specified as two lanes westbound; it should be specified as one lane, as discussed above for node 93. This will produce ETE which is too low.

- Inexplicably, a through movement westward onto Route 110 is properly represented for the NO GUIDES condition, but is arbitrarily <u>prohibited</u> for the WITH GUIDES condition despite the TCP instructions to the guides to <u>facilitate</u> this through movement. This error of unrealistically prohibiting an available through movement for the WITH GUIDES condition, while accommodating the through movement for the NO GUIDES condition, will greatly increase ETE for the WITH GUIDES condition above actual values. It is insupportable to argue that evacuees will totally reject the through movement onto westbound Route 110 with traffic guides waving them on in that direction yet accept that movement when there are no guides there at all.

- Setting aside the above errors, for this discussion, the specification of an equal split in movements (i.e., half to the on-ramp, the other half to the U-turn) for the WITH GUIDES condition is arbitrary and unrealistic since the U-turns have half the capacity as the movement directly onto the on-ramp. As an example, consider a ramp capacity of 1000 vehicles per hour and a U-turn capacity of 500 vehicles per hour. If the total traffic approaching this interchange along westbound Route 110 is say, 6000 vehicles under saturated conditions, then according to Dr. Adler's turn percentage specifications, 3000 will attempt to enter the ramp and 3000 will attempt U-turns. The traffic entering the ramp will be serviced in 3 hours, i.e., capacity of 1000 veh/hour x 3 hours = 3000 vehicles serviced. At the end of 3 hours, however, only 1500 vehicles will have completed the U-turn, i.e., capacity of 500 veh/hour x 3 hours = 1500 vehicles serviced. This leaves 6000-3000-1500 = 1500 vehicles remaining to be serviced. If half insist on taking U-turns, as is specified in the input stream, then it will take (750 vehicles/500 vehicles per hour) 1.5 hours to clear the interchange from this point, or a total of 3+1.5 = 4.5 hours. In the real world, evacuees will seek the fastest way out and will favor the higher capacity on-ramp rather than the U-turn. A specification at 67 percent movement to the on-ramps and 33 percent U-turn movement would clear the interchange in 4.0 hours which would realistically represent actual driver behavior -- and lower ETE by 0.5 hours relative to the inputs specified. This incorrect 50/50 specification of turns tend to increase ETE for the WITH GUIDES condition.

It is seen from the above discussions that the errors in the input stream <u>all</u> either

- Increased calculated ETE above actual values for the condition WITH GUIDES.
- Decreased calculated ETE below actual values for the condition NO GUIDES.

Small wonder, then, that Dr. Adler reached the erroneous conclusion that the SPMC plan WITH GUIDES significantly increased ETE relative to NO GUIDES: his erroneous inputs to IDYNEV forced this conclusion.

There are other errors in the specification of inputs describing the Route 51 overpass of I-95 in New Hampshire, but we need not expand on this here. Still other input errors include:

- Salisbury Beach vehicle content is specified at over 9000 vehicles, some 3000 more than the peak projections based on the Avis counts and 2000 more than the maximum number the MAG films purportedly contain. This error will, of course, tend to increase the ETE in Massachusetts above actual values.
- The number of vehicles in Hampton Beach was reduced by about 1600 below the estimate based on the Avis films. The number of beach area vehicles in Rye was also reduced by about 200.
- The IDYNEV input specifications used to "initialize" the network (i.e. fill it with cars representing traffic conditions at the outset of beach closure), instead

congested beach roads (contrary to actual conditions at 2 p.m.) and created a false, artificial queue of some 500 <u>additional</u> vehicles in Salisbury Beach. This error, would, of course, increase ETE in Massachusetts above actual values.

Dr. Adler's testimony notes that the inputs he prepared for the IDYNEV runs "[r]eflect the conditions written into the Joint Stipulation Regarding ETE issues . . . ." Examination of the input stream, however, reveals some important departures:

- The inputs specify a decrease in the capacity of 9 ramps, at close to 6 percent, as called for in the Stipulation. The capacities of 13 other ramps, however, were reduced by 13 percent in violation of the Stipulation. This departure would tend to increase the calculated ETE above the actual value.

- The staged manning of TCPs called for in the Stipulation was not represented.

In summary, the results produced by IDYNEV in Dr. Adler's testimony are incorrect due to input errors. The conclusion reached, based on these IDYNEV results, concerning the effectiveness of the SPMC traffic management plan is therefore without merit.

ESTIMATED EVACUATION TIMES FOR THE MASSACHUSETTS COMMUNITIES

Estimated Time (HRS:MIN) 5* Miles	10** Miles	Season	Day	Time	Weather	Scenario
6:20	6:40	Summer	Weekend	Mid-day	Good	Beach area population at capacity. Employees are at percent of mid-week in towns with beach area, 40 percent in remaining towns. Tourists fill available seasonal and overnight facilities, with half of them at the beach areas.
7:45	8:10	Summer	Weekend	Mid-day	Rain	As above. Sudden rain occurs with beach population at capacity concurrent with accident at Seabrook Station.
5:15	5:40	Summer	Mid-week	Mid-day	Good	Beach area and tourist population at 75 percent of capacity. Employees are at 100 percent of mid-week work force.
6:50	7:05	Summer	Mid-week	Mid-day	Rain	As above. Sudden rain occurs.
4:00	5:30	Off-Season	Mid-week	Mid-day	Good	Tourist population at 50 percent of yearly capacity (i.e., facilities which remain open the entire year). No beach area transients. Employees at 100 percent.
5:10	6:40	Off-Season	Mid-week	Mid-day	Rain	As above, but for inclement (rain) weather.
6:00	7:25	Off-Season	Mid-week	Mid-day	Snow	Conditions the same as for Scenario 5 except that there is inclement weather (snow). Evacuees must clear driveways.
3:35	3:40	Off-Season	Mid-week Weekend	Evening All day	Good	Tourist population at 50 percent of yearly capacity. No beach area transients. Employees at 25 percent of mid-week, mid-day.
4:00	4:25	Off-Season	Mid-week Weekend	Evening All day	Rain	As above, but for inclement (rain) weather.
4:[illegible]	6:00	Off-Season	Mid-week Weekend	Evening All day	Snow	As above, but for inclement (snow) weather. Evacuees must clear driveways.

* These times assume the simultaneous evacuation of all communities (Seabrook, Hampton Falls, Hampton Beach) within a two mile radius and only Massachusetts communities (Amesbury and Salisbury) in the downwind direction between 2 and 5 miles.

**These times assume the simultaneous evacuation of all communities (Seabrook, Hampton Falls, Hampton Beach, North Hampton, Kensington, South Hampton, Amesbury and Salisbury) within a five mile radius and only Massachusetts communities (Newbury, Newburyport, Merrimac and West Newbury) in the downwind direction between 5 and 10 miles.

Figure 10-1. Map of EPZ Delineating all Emergency Response Planning Areas (ERPA)

AMESBURY TRAFFIC CONTROL POST NO. B-AM-06

TOWN: AMESBURY

PRIORITY: 1-SUMMER
2-OFF-SEASON

LOCATION: ROUTE 110, I-95 & ELM ST.

EPRA: B

NODE: 45, 253, 255

KEY:

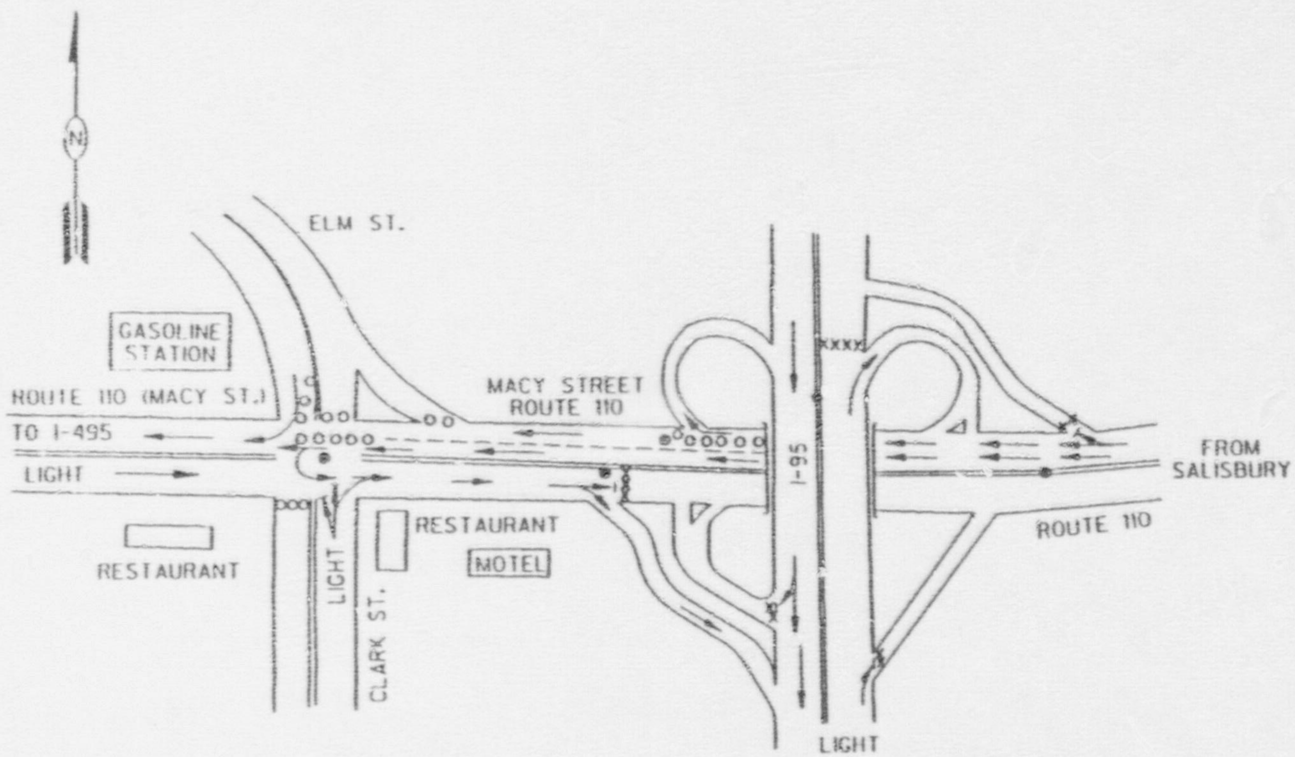
→ MOVEMENT FACILITATED
→| MOVEMENT DISCOURAGED
⊗ TRAFFIC GUIDE
O TRAFFIC CONE
X TRAFFIC BARRICADE

DESCRIPTION:

1. FACILITATE WESTBOUND THROUGH TRAFFIC MOVEMENT ALONG ROUTE 110 AND FROM ELM ST. TO WESTBOUND ROUTE 110.
2. FACILITATE TRAFFIC MOVEMENT FROM WESTBOUND ROUTE 110 ONTO ENTRY RAMP TO SOUTHBOUND I-95.
3. FACILITATE U-TURN BY WESTBOUND TRAFFIC ON ROUTE 110 AT ELM ST. FOR THOSE WHO ELECT TO TRAVEL ON SOUTHBOUND I-95, OR IF WESTBOUND ROUTE 110, WEST OF ELM ST. IS CONGESTED.
4. DISCOURAGE NORTHBOUND TRAFFIC ON I-95.
5. DISCOURAGE ENTRY ONTO NORTHBOUND I-95 BY TRAFFIC WESTBOUND ON ROUTE 110.
6. DISCOURAGE EASTBOUND TRAFFIC ON ROUTE 110, EAST OF ENTRY RAMP TO SOUTHBOUND I-95.
7. DISCOURAGE ENTRY ONTO NORTHBOUND ELM ST.

MANPOWER/EQUIPMENT

5 TRAFFIC GUIDES
21 TRAFFIC CONES
13 TRAFFIC BARRICADES



ORO-01 09 06

REVISED ETEs FOR THE SPMC

Scenario	Region 8	Region 13
1	6:10	7:05
2	7:45	9:10
3	5:00	6:00
4	6:30	7:10
5	4:00	5:00
6	4:30	6:05
7	6:00	7:10
8	3:35	3:35
9	3:55	4:35
10	4:55	5:50

BUS MOBILIZATION ANALYSIS

Item Number On Figure 1	Event or Activity	
1	Bus Company Liaison arrives at EOC. Exercise results indicate that this takes place approximately 30 minutes after notification (i.e. at T=30). (From Exercise: ALERT at 9:15, log indicates Bus Company Liaison arrived at 9:45.) In accord with the planning basis in Volume 6 of the NHRERP, the ALERT and SAE are coincident.	
2	Bus Company Liaison calls the bus companies and requests them to mobilize their drivers to travel to their yards.	
	T = 40	Assume first call is made 10 minutes after the Bus Company Liaison arrives at the EOC. T = 10 + 30 = 40.
	T = 73	Assume all bus companies are called within 33 minutes (11 bus companies @ 3 minutes/call = 33 minutes). Thus, the last call is completed at T = 40 + 33 = 73.
3	Bus company mobilizes bus drivers to bus yards.	
	T = 51	As shown on Attachment 1, the first drivers arrive at Dee Bus Co. approximately 11 minutes after first call is made to first bus company. This estimate is based on bus company mobilization times documented in the FEMA Bus Company survey. Thus, T = 40 + 11 = 51.
	T = 133	As shown in Attachment 1, the last bus driver to arrive at a bus company is 93 minutes after the first call is made to the first bus company. Thus T = 93 + 40 = 133.
4	Bus drivers are dispatched from the bus yards.	
	T = 66	Assume bus drivers take approximately 15 minutes from their arrival at the bus company yard to obtain a bus and be dispatched to NECC. Thus, T = 51 + 15 = 66.
	T = 148	Here, T = 133 + 15 = 148.

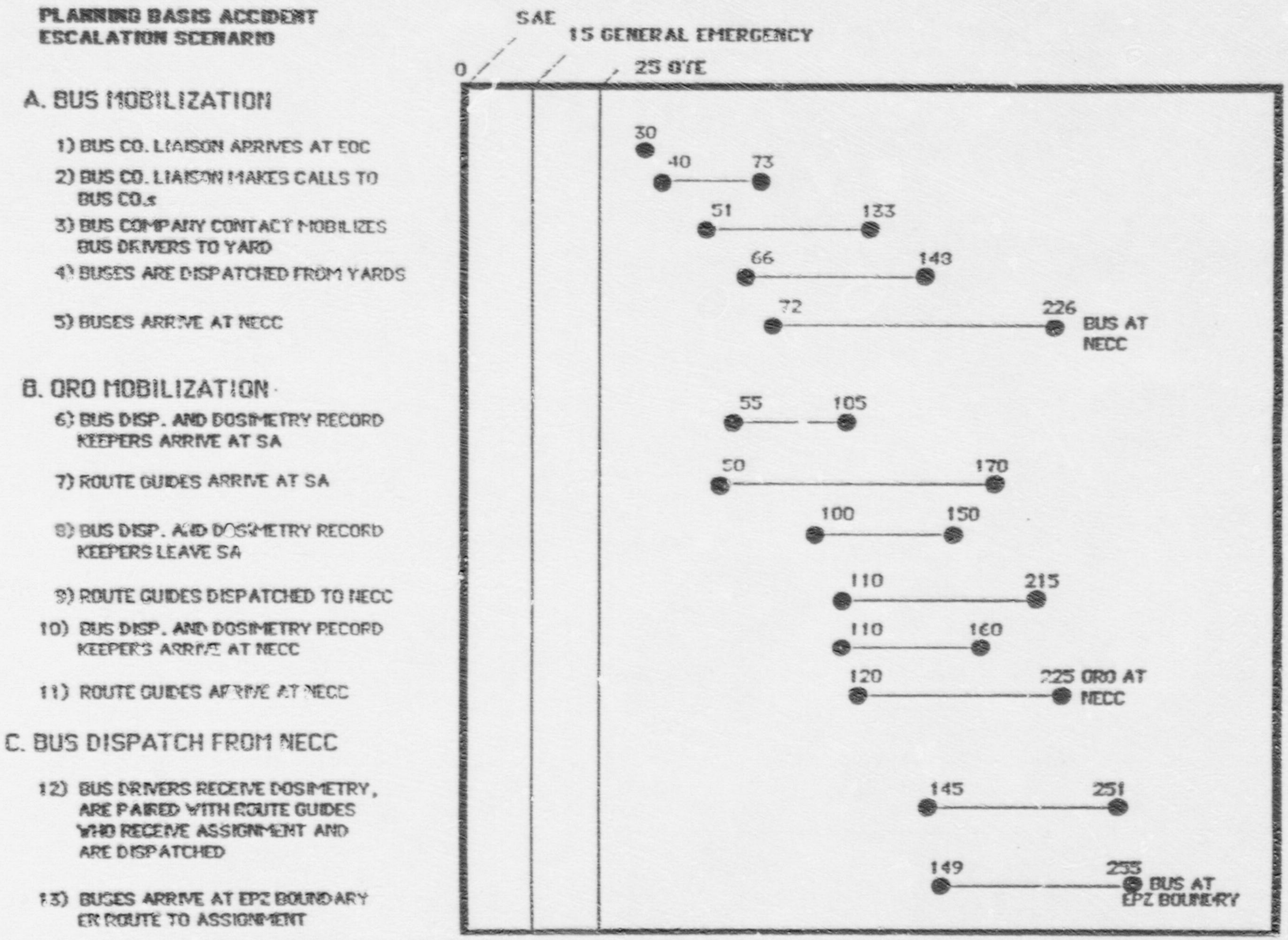
Item Number On Figure 1	Event or Activity	
5	Bus drivers arrive at NECC.	
	T = 72	The earliest time that a bus arrives at NECC as shown in Attachment 1, Column G, is 32 minutes after the first call is made to the first bus company. Thus, T = 40 + 32 = 72.
	T = 226	The latest time that a bus arrives at NECC as shown in Attachment 1, Column G is 186 minutes after the first call is made to first bus company. Thus, T = 40 + 186 = 226.
6	Bus Dispatchers and Dosimetry Record Keepers arrive at the staging area.	
	T = 55 to 105 minutes	This data is obtained from the Exercise Sign-In Sheets.
		NOTE: Evacuation Support Dispatchers also arrive within approximately this same time frame. Thus, the evacuation support dispatchers are available to brief the Bus Dispatchers and Dosimetry Record Keepers.
7	Route Guides arrive at the staging area.	
	T = 50 to 170 minutes	This data is obtained from the Exercise Sign-In Sheets.
8	Bus Dispatchers and Dosimetry Record Keepers are dispatched from the staging area to NECC.	
	T = 100 to 150	It is estimated that briefing these personnel at the Staging Area takes approximately 45 minutes. Thus, T = 55 + 45 = 100 and T = 105 + 45 = 150.

Item Number On Figure 1	Event or Activity	
9	Route Guides are dispatched from the staging area to NECC.	
	T = 110	Time the first Route Guides are dispatched to NECC. Assume the first briefing for Route Guides starts 10 minutes after the arrival of the first Bus Dispatchers and Evacuation Support Dispatchers at T = 55, and that the briefings last 45 minutes. Thus, T = 55 + 10 + 45 = 110.
	T = 215	Time the last Route Guides are dispatched to NECC. Estimate is based on the time the last Route Guide arrived at the staging area (T = 170) plus the briefing time, 45 minutes. Thus, T = 170 + 45 = 215.
10	Bus Dispatchers and Dosimetry Record Keepers arrive at NECC.	
	T = 110	Time the earliest Bus Dispatchers and Dosimetry Record Keepers arrive at NECC. Travel from the Haverhill Staging Area to NECC is estimated to take approximately 10 minutes. (See Attachment 2). The first Bus Dispatchers and Dosimetry Record Keepers are dispatched from the Staging Area at T = 100 plus 10 minutes equals 110 minutes.
	T = 160	Time the last Bus Dispatchers and Dosimetry Record Keepers arrive at NECC. T = 150 + 10 = 160.
11	Route Guides arrive at NECC.	
	T = 120 tc 225 minutes	Add 10 minutes travel time to the estimates of Step 9.

Item Number On Figure 1	Event or Activity	
12	Bus drivers are dispatched to EPZ after receiving dosimetry and briefing at NECC	
	T = 145	Time first Bus Drivers receive dosimetry, briefing and are dispatched from NECC. Assume briefings start 10 minutes after Bus Dispatchers and Dosimetry Record Keepers arrive at NECC and that the briefing takes 25 minutes. Thus, T = 110 + 10 + 25 = 145.
	T = 251	Time last Bus Drivers receive dosimetry, briefing and are dispatched from NECC. Assume briefing starts immediately after last bus driver arrives. Thus, T = 226 + 25 = 251.
		NOTE: Last route guide arrives at NECC at T = 225. Since the guides have already been briefed at staging area, the bus drivers control the time-line.
13	Buses arrive at EPZ boundary.	
	T = 149	Time first buses arrive at EPZ boundary. The time to travel from NECC to EPZ boundary is estimated at 4 minutes. (See Attachment 2). Thus, T = 145 + 4 = 149
	T = 255	Time last buses arrive at EPZ boundary. Thus, T = 251 + 4 = 255.

FIGURE 1

MOBILIZATION and DISPATCH of BUS RESOURCES



Attachment 1
Page 1 of 3

A	B	C	D	E	F	G
BUS COMPANY	TIME PHONE CALL TO BUS COMPANY IS COMPLETE	TIME TO MOBILIZE BUS DRIVERS TO YARDS	TIME BUS DRIVERS ARRIVE AT YARD	TIME TO OBTAIN BUS	APPROXIMATE TRAVEL TIME TO NECC	ARRIVAL AT NECC
Buckingham	3	90 min. max	93 max	15	52	160 max
Dee	6	5 - 60 min.	11 - 66	15	56	82 - 137
Fox	9	15 - Assume 30 min.	24 - 39	15	83	122 - 137
McGregor	12	0 - 60 min.	12 - 72	15	5	32 - 92
Weybridge	15	4 - 60 min.	19 - 75	15	76	110 - 166
Parent	18	5 - Assume 30 min.	23 - 48	15	20	58 - 83
Denise	21	15 - 30 min.	36 - 51	15	32	83 - 98
Weagle	24	0 - 15 min.	24 - 39	15	71	110 - 125

A	B	C	D	E	F	G
BUS COMPANY	TIME PHONE CALL TO BUS COMPANY IS COMPLETE	TIME TO MOBILIZE BUS DRIVERS TO YARDS	TIME BUS DRIVERS ARRIVE AT YARD	TIME TO OBTAIN BUS	APPROXIMATE TRAVEL TIME TO NECC	ARRIVAL AT NECC
Hudson	27	20 - 30 min.	47 - 57	15	41	103 - 113
Park	30	Assume 0 - 60 min.	30 - 90	15	81	126 - 186
Big W	33	5 - 15 min.	38 - 48	15	85	135 - 148

A - Bus Companies, as listed in SPMC Appendix M

B - Time phone call to Bus Company is complete, assumes 3 min./call - made in order of listing

C - Time to mobilize bus drivers to bus yard: from FEMA Survey

D - Time bus drivers arrive at bus yard (relative to when first call was made to first bus company): D = B + C.

E - Time to obtain bus: assume 15 minutes

F - Approximate travel time from bus yard to NECC. Based on the following travel speeds:

Interstate Highways - 50 mph
Primary Roads - 40 mph
Secondary roads - 35 mph
Tertiary Roads - 25 mph

See Attachment 2 for actual calculations.

G - Bus Drivers arrive at NECC: G = D + E + F or
G = B + C + E + F

MILEAGE

ROUTE FROM BUS COMPANY TO NECC	INTERSTATES	PRIMARY ROADS	SECONDARY ROADS	TERTIARY ROADS
Hudson Bus Co., Medford Ma				
1) Rt 38 (North) to Rt 60				0.2
2) Rt 60 (East) to I-93				0.3
3) I-93 (North) to I-495	17.9			
4) I-495 (North) to Rt 110 (Exit 52)	14.3			
5) Rt 110 (South) to NECC			0.5	
Total Mileage	32.2	0	0.5	0.5
Travel Time (hrs)	32.2/50 mph=0.644 hr	0	0.5/35mph = 0.014	0.5/25mph = 0.02
Travel Time (min)	38.6	0	0.85	1.2
Total Travel Time [41 min]				
Weybridge Bus Co., Shewsbury, MA				
1) Rt 20 (East) to Rt 140		0.8		
2) Rt 140 (North) to I-290		5.1		
3) I-290 (East) to I-495	7.6			
4) I-495 (North) to Rt 110 (Exit 52)	47.5			
5) Rt 110 (South) to NECC			0.5	
Total Mileage	55.1	5.9	0.5	0
Travel Time (hrs)	55.1/50mph = 1.1	5.9/40mph - 0.148	0.5/35mph = 0.014	
Travel Time (min)	66	8.9	0.85	
Total Travel Time [76 min]				

ROUTE FROM BUS COMPANY TO NECC	INTERSTATES	PRIMARY ROADS	SECONDARY ROADS	TERTIARY ROADS
	MILEAGE			
Buckingham Bus Co., Groton, MA				
1) Station Ave. (East) to Rt 119				0.2
2) Rt 119 (East) to I-495			6.8	
3) I-495 (North) to Rt 110 (Exit 52)	32.6			
4) Rt 110 (South) to NECC			0.5	
Total Mileage	32.6	0	7.3	0.2
Travel Time (hrs)	32.6/50mph = 0.65		7.3/35mph = 0.21	0.2/25mph = 0.01
Travel Time (min)	39		12.5	0.5
Total Travel Time [52 min]				
Dee Bus Co., Concord, MA				
1) Rt 62 (East) to Rt 2			0.5	
2) Rt 2 (East) to I-95		7.1		
3) I-95 (North) to I-93	10.3			
4) I-93 (North) to I-495	12.2			
5) I-495 (North) to Rt 110 (Exit 52)	14.3			
6) Rt 110 (South) to NECC			0.5	
Total Mileage	36.8	7.1	1.0	0
Travel Time (hrs)	36.8/50mph = 0.74	7.1/40mph = 0.177	1.0/35mph = 0.029	
Travel Time (min)	44	10.7	1.7	
Total Travel Time [55 min]				

ROUTE FROM BUS COMPANY TO NECC	MILEAGE INTERSTATES	PRIMARY ROADS	SECONDARY ROADS	TERTIARY ROADS
McGregor Smith Bus Co. Merrimac, MA				
1) Rt 110 (South) to NECC			2.53	
Total Mileage	0	0	2.53	0
Travel Time (hrs)			2.53/35mph - 0.07	
Travel Time (min)			4.3	
Total Travel Time [5 min]				
Park Transportation Avon, MA				
1) Wales Ave. (South) to Bodwell Ave				0.2
2) Bodwell Ave. (South) to to Page St.				0.2
3) Page St. (North) to Rt 139				1.0
4) Rt 139 (East) to Rt 24				0.4
5) Rt 24 (North) to I-93		2.9		
6) I-93 (South) to I-95	[illegible].9			
7) I-95 (North) to I-93	28.8			
8) I-93 (North) to I-495	12.2			
9) I-495 (North) to Rt 110 (Exit 52)	14.3			
10) Rt 110 (South) to NECC			0.5	
Total Mileage	59.2	2.9	0.5	1.8
Travel Time (hrs)	59.2/50mph - 1.18	2.9/40mph = 0.07	0.5/35mph = 0.014	1.8/25mph = 0.072
Travel Time (min)	71	4.4	0.86	4.32
Total Travel Time [81 min]				

ROUTE FROM BUS COMPANY TO NECC	MILEAGE: INTERSTATES	PRIMARY ROADS	SECONDARY ROADS	TERTIARY ROADS
Fox Bus Co., Millbury, MA				
1) McCracken Rd. (East) to Rt 146				0.3
2) Rt 146 (North) to I-290		3.3		
3) I-290 (East) to I-495	15.8			
4) I-495 (North) to Rt 110 (Exit 52)	47.5			
5) Rt 110 (South) to NECC			0.5	
Total Mileage	63.3	3.3	0.5	0.3
Travel Time (hrs)	63.3/50mph = 1.27	3.3/40mph = 0.08	0.5/35mph = 0.014	0.3/25mph = 0.012
Travel Time (min)	76	5	0.85	0.72
Total Travel Time [83 min]				
Denise Bus Co., Peabody, MA				
1) Rt 1 (North) to I-95		3.4		
2) I-95 (North) to Rt 97	6.9			
3) Rt 97 (West) to Haverhill Town Line			4.5	
4) Rt 97 (West) to Rt 125				2.4
5) Rt 125 (North) to Rt 110				0.4
6) Rt 110 (North) to NECC via Kenzoa and Shattuck Streets				1.85
Total Mileage	6.9	3.4	4.5	4.65
Travel Time (hrs)	6.9/50mph = 0.138	3.4/40mph = 0.085	4.5/35mph = 0.129	4.65/25mph = 0.166
Travel Time (min)	8.3	5.1	7.7	11.2
Total Travel Time [32 min]				

MILEAGE

ROUTE FROM BUS COMPANY TO NECC	INTERSTATES	PRIMARY ROADS	SECONDARY ROADS	TERTIARY ROADS
Big W, Ashland, MA				
1) Fountain St. (South) to Rt 135				0.2
2) Rt 135 (West) to W. Main St.			4.5	
3) W. Main St. (West) to I-495				1.7
4) I-495 (North) to Rt 110 (Exit 32)	59.7			
5) Rt 110 (South) to NECC			0.5	
Total Mileage	59.7	0	5	1.9
Travel Time (hrs)	59.7/50mph = 1.19		5/35mph = 0.14	1.9/25mph = 0.076
Travel Time (min)	72		8.6	4.6
Total Travel Time [85 min]				
Wt Holmes Bus Co., Norfolk, MA				
1) Myrtle St. to Main St.				0.3
2) Main St. to Rt 115				1.6
3) Rt 115 (North) to Rt 109			3.8	
4) Rt 109 (West) to I-95			10.1	
5) I-95 (North) to I-93 (Exit 37B)	25.2			
6) I-93 (North) to I-495 (Exit 44A)	12.2			
7) I-495 (North) to Rt 110 (Exit 52)	14.5			

ROUTE FROM BUS COMPANY TO NECC	MILEAGE INTERSTATES	PRIMARY ROADS	SECONDARY ROADS	TERTIARY ROADS
Wt Holmes Bus Co. (continued)				
8) Rt 110 (South) to NECC			0.5	
Total Mileage	51.9	0	14.4	1.9
Travel Time (hrs)	51.9/50mph = 1.04		14.4/35mph = 0.41	1.9/25mph = 0.076
Travel Time (min)	52.3		24.7	4.6
Total Travel Time [92 min]				
Parent Bus Co., Andover, MA				
1) Pearson St. (East) to Rt 28				0.5
2) Rt 28 (North) to I-495			1.8	
3) I-495 (North) to Rt 110 (Exit 52)	12			
4) Rt 110 to NECC			0.5	
Total Mileage	12	0	2.3	0.5
Travel Time (hrs)	12/50mph = 0.24		2.3/35mph = 0.066	0.5/25mph - 0.02
Travel Time (min)	14.4		3.95	1.2
Total Travel Time [20 min]				

ROUTE FROM BUS COMPANY TO NECC	MILEAGE: INTERSTATES	PRIMARY ROADS	SECONDARY ROADS	TERTIARY ROADS
Weagle Bus Co., Shewsbury, MA				
1) Rt 140 (North) to I-290		2.7		
2) I-290 (East) to I-495	7.6			
3) I-495 (North) to Rt 110 (Exit 52)	47.5			
4) Rt 110 to NECC			0.5	
Total Mileage	55.1	2.7	0.5	0
Travel Time (hrs)	55.1/50mph = 1.1	2.7/40mph = 0.67	0.5/35mph = 0.014	0
Travel Time (min)	66	4.1	0.83	
Total Travel Time [7[illegible] min]				
Travel from NECC to EPZ Boundary				
1) Rt 110 to I-495 (Exit 52)			0.5	
2) I-495 to Merrimac Town Boundary	2.1			
Total Mileage	2.1	0	0.5	0
Travel Time (hrs)	2.1/50mph = 0.04		0.5/35mph = 0.01	
Travel Time (min)	2.5		0.86	
Total Travel Time [4 min]				

MILEAGE

ROUTE FROM BUS COMPANY TO NECC	INTERSTATES	PRIMARY ROADS	SECONDARY ROADS	TERTIARY ROADS
Route from Haverhill Staging Area to NECC				
1) Rt 97 (West) to Rt 125				0.34
2) Rt 125 (North) to Rt 110				0.4
3) Rt 110 (North) to NECC via Kenzoa and Shattuck Streets				1.85
Total Mileage	0	0	0	2.59
Travel Time (hrs)				2.59/25mph = 0.1
Travel Time (min)				6.2
Total Travel Time [6.2 min]				

CERTIFICATE OF SERVICE

I, George H. Lewald, one of the attorneys for the Applicants herein, hereby certify that on April 10, 1989, I made service of the within document by depositing copies thereof with Federal Express, prepaid, for delivery to (or, where indicated, by depositing in the United States mail, first class postage paid, addressed to):

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