LILCO, January 16, 1984

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
LONG ISLAND LIGHTING COMPANY	)	Docket No. 50-322-OL-3
	)	(Emergency Planning Proceeding)
(Shoreham Nuclear Power Station, Unit 1)	)	

SUPPLEMENTAL TESTIMONY OF MATTHEW C. CORDARO, JOHN A. WEISMANTLE AND EDWARD B. LIEBERMAN ON BEHALF OF LONG ISLAND LIGHTING COMPANY ON PHASE II EMERGENCY PLANNING CONTENTIONS 23.D. AND 65

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PURPOSE AND SUMMARY OF TESTIMONY

The purpose of this testimony is to analyze the estimates of (1) evacuation times, (2) frequency of automobile accidents, and (3) frequency of automobiles running out of gasoline presented in the direct testimony of Peter A. Polk filed on November 18, 1983. It demonstrates that the evacuation time estimates of up to 18 hours for evacuation of the full 10-mile EPZ developed by Mr. Polk are derived from a relatively simplistic model and data base. Further, it demonstrates that, to the extent that the evacuation time estimates exceed about 7 1/2 hours, the modeled traffic consists entirely of persons who leave voluntarily from the East End of Long Island, beyond the EPZ, never enter the EPZ, and do not materially impede the exit of the population leaving the EPZ. The population leaving the EPZ exits the boundary in 7 1/2 hours or less. Secondly, the testimony demonstrates that Mr. Polk's

estimate of the frequency of accidents is overstated by a factor of 40 because of an error in the interpretation of the data relied on by him. Third, it shows that Mr. Polk has overstated the likelihood that evacuating automobiles will run out of gasoline by about a factor of three, and that his testimony fails to account for the presence of multiple refueling tank trucks, each one of which will be able to assist more cars than Mr. Polk's testimony hypothesizes will need refueling.

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TESTIMONY

1. Q. Please state your name and business address.

A. [Cordaro] My name is Matthew C. Cordaro. My business address is Long Island Lighting Company, 175 Old Country Road, Hicksville, New York, 11801.

[Weismantle] My name is John A. Weismantle. My business address is Long Island Lighting Company, 100 Old Country Road, Hicksville, New York, 11801.

[Lieberman] My name is Edward B. Lieberman. My business address is KLD Associates, Incorporated, 300 Broadway, Huntington Station, New York, 11746.

2. Q. Please summarize your professional qualifications and your role in emergency planning for the Shoreham Nuclear Power Station.

   A. [Cordaro, Weismantle, Lieberman] Our professional qualifications and our roles in emergency planning for the Shoreham Nuclear Power Station are detailed on pages 2 and 3 of our earlier testimony on Contention 65. Those qualifications and roles have not changed since the preparation of that testimony.

3. Q. Could you briefly summarize the purpose of this supplemental testimony?

   A. [Cordaro, Weismantle, Lieberman] This testimony has two basic purposes. First, it will review the inputs, modeling methodology and results of the traffic evacuation time estimates presented in the direct testimony of Peter A. Polk on behalf of Suffolk County, dated November 18, 1983 (hereinafter "Polk Testimony"). Second, it will review the estimates presented in the Polk Testimony of the frequency of occurrence of automobile accidents and of automobiles running out of gasoline during an assumed evacuation of the entire Shoreham EPZ. The bases for this testimony include, primarily, review of detailed computer printouts, maps and other documents provided by Suffolk County at LILCO's request pursuant to this Board's Orders of December 12 (Tr. 1289-90) and December 23, 1983, the

deposition of Mr. Polk on January 6, 1984, and documents received earlier in discovery and the general literature.

4. Q. What conclusions have you reached regarding those aspects of Mr. Polk's testimony reviewed by you?

A. [Cordaro, Weismantle, Lieberman] With respect to the evacuation time estimates, we concluded generally as follows: First, the input data to the PRC model used by Mr. Polk are roughly comparable to those used in the KLD model analyses performed by Edward Lieberman for LILCO, with one exception. Unlike Mr. Lieberman's analyses for LILCO, which utilize evacuation of an approximately 10-mile EPZ as a base case but also evaluate varying degrees of voluntary evacuation from beyond the EPZ boundary as alternate cases, Mr. Polk's analyses always presume evacuation from of the entire East End of Long Island, and of population elsewhere out to a range of 20 miles. However, by detailed analysis of computer printouts and materials obtained on discovery it is possible to distinguish Mr. Polk's treatment of the evacuation process for persons leaving the EPZ from that of voluntary evacuees from beyond it.

Second, as to models, the PRC model used in Mr. Polk's analysis is in many respects, particularly in its treatment of evacuation routes as separate and unconnected

roads rather than a part of a highway network and its failure to account for many physical realities along evacuation roadways, a simpler and less flexible model than the KLD model used by Mr Lieberman. As a result, while it does not necessarily yield "incorrect" results for any given case, one cannot place the same degree of confidence in the accuracy of those results as one can in results obtained from the KLD model.

Third, despite the differences in models, the results yielded by them are remarkably similar when one evaluates the time it takes persons originating from within the EPZ to reach its boundary. As is explained more fully below, detailed analysis of the computer printouts and other documents provided by the County reveals that the last vehicle leaving from within the EPZ reaches its boundary, using Mr. Polk's model and data, at about 7 hours 30 minutes after the start of a full 10-mile EPZ evacuation, assuming summer population, normal weather, no special traffic controls, and voluntary evacuation by persons originating outside the EPZ. This is virtually identical to the time calculated by Mr. Lieberman using the KLD model -- 7 hours 35 minutes -- for the last car to reach the EPZ boundary from within under virtually the same conditions (summer population, normal weather, normal traffic

controls (an "uncontrolled" case), 50% shadow outside the EPZ). The much longer times reported by Mr. Polk on the Sunrise Highway and the Long Island Expressway along or near the EPZ boundary -- 17 and 18 hours respectively -- are _entirely_ attributable to, and _entirely_ composed of, voluntary evacuees coming from the East End and the south shore, from outside the EPZ, never entering the EPZ, and never coming closer to Shoreham than the EPZ boundary. To put it another way, no person modeled by Mr. Polk as evacuating from within the EPZ reaches its boundary more than 7 hours 30 minutes after the start of the evacuation. Thus, properly analyzed, the PRC modeling results done by Mr. Polk corroborate, rather than dispute, the more detailed analyses done by Mr. Lieberman using the KLD model.

With respect to the frequency of occurrence of accidents during an evacuation, Mr. Polk's estimate stems from a serious misreading of the traffic engineering handbook on which he relies. Accident frequency is not simply a function of automobile speed, as is asserted by Mr. Polk, but of automobile speed _relative to that of the prevailing traffic_. Failure to account for this fact has produced an estimate which is excessive by a factor of approximately 40.

With respect to the frequency of automobiles running out of gasoline, Mr. Polk's estimate of 277 is overstated for two principal reasons: first, Mr. Polk's estimate does not account for the improved mileage efficiency of a 1985 fleet of automobiles, and second, Mr. Polk's estimate rests on a data manipulation error. The result is about a threefold overestimate of cars running out of gas: the proper number, using Mr. Polk's methodology, is approximately 96 cars. Even those present no difficulty, since LILCO will have fuel trucks dispersed at 7 locations, each of which can provide 3 gallons of gasoline to more than 400 cars, i.e., to more cars than Mr. Polk's uncorrected estimate assumes will run out of gasoline in the entire EPZ.

Those are the summary results of the reviews performed in this testimony.

5. Q. Could you briefly describe and compare the input data used in LILCO's and Suffolk County's evacuation time estimates?

A. [Lieberman] The DYNEV model used in LILCO's analyses and the EVACPLAN model used in Suffolk County's analyses require very different types of input data. As discussed on pages 25 and 26 of the November 18, 1983 testimony of this panel on Contention 65, the DYNEV system utilizes a large body of input information designed to reflect as

accurately as possible the entire evacuation network, including specific roadway attributes like roadway lengths, the presence of turn bays and a description of control devices at intersections; mean discharge headways; mean free flow speeds; and a trip table that specifies the number of vehicles leaving each origin node and their associated destination. By contrast, the EVACPLAN model used in Mr. Polk's analysis utilizes a far more limited body of information. The entire evacuation network is partitioned into a collection of unconnected, linear roadways, each of which is analyzed separately. For each intersection chosen as an evaluation point on an evacuation route, the number of lanes on each of up to three legs entering, and one leg exiting, the intersection must be specified; the highway type on a scale of one to four (each value is assigned a given capacity) described; and the population that enters the intersection from the cross-street legs specified. The input data do not include any information about physical distances between intersections or the actual traffic control devices present at each intersection.

A comparison of the input data used in LILCO's and Suffolk County's analyses for the area within the EPZ boundaries reveals:

1. The capacities used in LILCO's analyses for roadways common to both analyses are similar to, or lower than, those assumed in Suffolk County's analyses. (A detailed comparison of these capacities is attached to this testimony as Attachment 1). In most cases, the lower capacities used in LILCO's analyses result from the consideration of traffic control devices that limit the otherwise free flow of traffic.

2. LILCO's analyses are premised on a summertime population of 160,000 in 1985; Mr. Polk's analyses assume a population of 169,000.1/ LILCO's analyses assume 100% of this EPZ population will evacuate if ordered to do so; Mr. Polk's analyses assume 80% will evacuate.

3. LILCO's analyses assume a vehicle occupancy rate of approximately 3.0 persons/car during an evacuation; Mr. Polk's analyses assume a vehicle occupancy rate of 2.8 in summer and 2.7 in winter.

4. Given the input data described in items 2 and 3, LILCO's analyses assume approximately 53,000 vehicles would seek to evacuate the EPZ; Mr. Polk's analyses assume approximately 48,000 vehicles.

5. LILCO's analyses assume evacuation traffic from within the EPZ will access the roadway network at 64 roadway links; Mr. Polk's analyses assume access on 25 entering legs.

1/ The input data to Mr. Polk's analyses and the deposition testimony of Mr. Polk differ on this value. Mr. Polk's deposition testimony suggests a population of 151,800. Since the purpose of this testimony is to compare the evacuation time estimates produced by LILCO's and Suffolk County's analyses, the population value used in Mr. Polk's analyses was chosen for comparative purposes.

6. Q. Could you briefly compare the models used in LILCO's and Suffolk County's analyses?

A. [Lieberman] The DYNEV system used in LILCO's evacuation time studies is described in detail on pages 18-23 of this panel's previous testimony on Contention 65 and in Appendices B and C of Appendix A to the LILCO Transition Plan.

The EVACPLAN model was used to produce the results presented in Mr. Polk's testimony. This model is summarized in Appendix B to a report entitled "Preliminary Evacuation Time Estimates for the Shoreham EPZ" that was prepared by PRC Voorhees for Suffolk County in November 1982. Briefly, the EVACPLAN model is made up of two modules: an EVACURVE module and a QUEUE module. The EVACURVE module computes a departure time curve for each preparatory step to evacuation. The module then computes a joint probability distribution of all component steps, which describes the rate at which vehicles will enter the designated intersections. For the analyses presented in Mr. Polk's testimony this joint probability distribution is the same as that presented on pages B-4 to B-6 of the November 1982 PRC Voorhees report. The joint probability distribution and the individual distributions for time to travel home and to prepare to evacuate home presented there are shorter than comparable distributions that are discussed at pages 27 to 31 of that same report. These

latter distributions were shown to be virtually identical to those used in KLD's modeling analyses (see Figures 1 and 3 of Attachment 10 to this panel's earlier testimony on Contention 65). Thus, the trip generation distribution used in Mr. Polk's analyses is shorter than that used in LILCO's.

The QUEUE module is designed to simulate traffic flow on an evacuation roadway network. The primary inputs to this model are the major evacuation routes, their subroutes, and key intersections on those routes and subroutes; the population entering at each intersection on these routes and subroutes; the joint probability distribution from the EVACURVE module; and roadway capacities. The QUEUE module simulates traffic flow by first assigning four legs of traffic to each intersection (leg 1 represents traffic entering the intersection along the evacuation route being modeled, legs 2 and 4 represent traffic entering the system from side streets, and leg 3 represents traffic leaving the intersection along the evacuation route). The model then moves the traffic at discrete time intervals (in this case 15 minutes) according to available roadway capacities and to the existence of queues. Traffic queues are discharged at rates proportional to their magnitude and roadway capacity.

From this rather abbreviated description of each model, it can be seen that a major difference between the two models involves network continuity. The DYNEV system permits the modeling of an entire evacuation network including roads linking major evacuation routes. This permits cars to be routed, either by design or by individual choice, on an extremely large and diverse number of possible paths. By comparison, the EVACPLAN model does not provide this flexibility. Since only one departure path is permitted from each intersection, and that path is along the route being modeled, there is no linking of major evacuation routes. As applied in Mr. Polk's analysis, the EVACPLAN model's continuity was restricted even further since the designated subroutes were not linked to the major evacuation routes for modeling purposes. In other words, while the subroutes were modeled independently, the flow of traffic from the last intersection of the subroute was not fed into the appropriate intersection on the main evacuation route. Instead, when the main evacuation route was modeled, loading was performed as though the subroutes did not exist. Thus, for all intents and purposes, the analyses presented in Mr. Polk's testimony evacuate traffic on four unconnected routes.

One other difference in the way each model was applied is worthy of note. The DYNEV system was run over a series of iterations. These iterations were designed to be responsive to the guidance of NUREG/CR-1745, which recommends such a technique to identify potential bottlenecks and to provide alternative routings, (see Cordaro, et al. Testimony on Contention 65 at 35-39). By comparison, the EVACPLAN model appears to have been run only once following an assignment of traffic by a planner at PRC Voorhees. The result, as will be explored in more detail below, is that roadway capacities are unrealistically underutilized, arbitrary routing is postulated and unnecessarily extreme bottlenecks are formed.

7. Q. Could you explain the derivation of the evacuation time estimates contained in Mr. Polk's testimony?

A. [Lieberman] The evacuation time estimates contained in Mr. Polk's testimony, which include maximum values of 18 hours in summer and 12 hours in winter, were derived as follows in Mr. Polk's analysis:

1. The area on Long Island within 50 miles of the Shoreham plant was divided into 9 subregions. Subregion 1, which was defined as an area within 10 miles of the Shoreham plant, is roughly equivalent to the Shoreham EPZ.

2. For modeling purposes, 8 of the 9 subregions were assumed to evacuate. Subregion 8, which is located 20 to 50 miles west of the Shoreham site, was not

evacuated, presumably because the evacuation of these people would have no effect on the evacuation times for people within a 10-mile EPZ.

3. In each subregion, varying percentages of residents were assumed to evacuate. Within 10 miles of Shoreham (Subregion 1), 80% of the people were assumed to evacuate; 54-63% of the people from 10 to 20 miles from the plant (Subregions 2 to 7) were assumed to evacuate; and 48% of those more than 20 miles to the east of the plant (Subregion 9) were assumed to evacuate.2/

4. All evacuees were assigned to one of four major evacuation routes: the Jericho Turnpike, Route 347, the Long Island Expressway (LIE) or the Sunrise Highway. In addition, major evacuation routes were further detailed through the use of subroutes: one subroute was specified for Route 347; two for the LIE; and three for the Sunrise Highway. The major evacuation routes and subroutes, and each of the intersections at which traffic flow (i.e., the existence of queues) is modeled are shown in Attachment 2 hereto. The assignment of evacuees to major evacuation routes or subroutes was made by a

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2/ The computer results presented in Mr. Polk's testimony assume that 63% of the population to the east of the EPZ and 54% of the population to the west of the EPZ voluntarily evacuate. When questioned about the consistency of these values with opposite values presented on page 33 of the November 1982 PRC Voorhees report at his deposition, Mr. Polk could not explain the difference. Polk Deposition Tr. 28. Subsequently, on January 12, 1984, LILCO was provided with copies of revised evacuation time estimates based on 54% voluntary evacuation from the east and 63% from the west. These new evacuation time estimates are roughly equivalent to those presented in Mr. Polk's testimony, with variations in the time to clear roadways of less than one hour. Given the abbreviated form of the results that were provided to LILCO, this testimony will be based on the computer analyses that underlie Mr. Polk's testimony.

planner at PRC Voorhees, without the assistance of a traffic assignment model. A primary criterion in this assignment was that voluntary evacuees from outside the EPZ would not be assigned to evacuation routes that entered the EPZ. People were restricted to following, and not to deviating from, the major evacuation path chosen for them.

5. The 18-hour summer evacuation time estimate was the result of lengthy delays at the intersection of the LIE and Horse Block Road, which lies just beyond the southwest corner of the EPZ (Intersection 6 on the LIE on Attachment 2), and along the Sunrise Highway (Intersections 7 through 12 on the Sunrise Highway on Attachment 2). The intersection of the LIE and Horse Block Road also constrained the evacuation time estimate for winter.

In order to analyze the evacuation time estimates presented in Mr. Polk's testimony, it is necessary to understand where traffic entering any given intersection is coming from. This could not be discerned from the attachments to the Polk Testimony, but can be from the detailed computer listings provided on discovery pursuant to this Board's discovery order of December 12, 1983. Those listings, which show the extent of traffic entering and exiting each modeled intersection on each leg to it, have been summarized and reformatted for convenience on Attachment 3 to this Supplemental Testimony. Using these reformatted listings, it can be readily seen that the long queues and lengthy clearing times both at the intersection

of the LIE and Horse Block Road and on the Sunrise Highway are caused entirely by and consist entirely of voluntary evacuees from outside the EPZ who never enter the EPZ. The delay at the intersection of the LIE and Horse Block Road is caused by traffic that originates near the southern shore of Long Island (see southern subroute of LIE evacuation route on Attachment 2), beyond the 10-mile EPZ. This traffic proceeds westbound on the Montauk Highway until it reaches Horse Block Road (Intersection 6 on Montauk Highway), where it arbitrarily and inexplicably turns northwest onto Horse Block Road and intersects with the LIE (Intersection 7 on Horse Block Road, Intersection 6 on the LIE) just outside the EPZ boundary. The model runs that show the LIE-Horse Block Road Intersection clearing at 18 hours also show that all traffic heading westward on the LIE to that intersection from within the EPZ cleared the EPZ at 7 hours 30 minutes (see Attachment 3, LIE, Intersections 4, 5 (leg 1) and 6 (leg 1)); all remaining traffic flow is the East End traffic that never even touches the EPZ boundary until Horse Block Road, and never enters the EPZ. Thus all traffic delays at this intersection after 7 hours 30 minutes result from queuing on Horse Block Road, not on the LIE itself, in a queue which did not originate in the EPZ, never enters the EPZ,

and does not affect traffic exiting the EPZ (see Attachment 3, LIE, Intersection 6 (leg 2)).

The delays on the Sunrise Highway are likewise caused by the assumed voluntary evacuation of persons from the two forks of eastern Long Island, particularly the Southern Fork, beginning entirely beyond the 10-mile EPZ (see Sunrise Highway evacuation route on Attachment 2). In Suffolk County's analyses it is assumed that people from as far east as Montauk Point will seek to evacuate. Given the relatively large populations in these areas in the summer and the limited roadway capacities of the Sunrise Highway in the East Hampton and Southhampton areas, substantial delays result beginning at locations 20 to 30 miles east of the Shoreham plant (see Attachment 3, Sunrise Highway, Intersections 1, 2 and 3). These delays cause some voluntary evacuees to arrive at the southern boundary of the EPZ (Intersection 7 on the Sunrise Highway route) as late as 15 hours after the order to evacuate. As with the LIE evacuation route, detailed analysis of Mr. Polk's modeling shows that all EPZ residents who travel south and exit the EPZ at the Sunrise Highway (i.e., at Intersections 8 and 9) reach the Sunrise Highway no later than 2 hours 30 minutes. Though their progress is slow thereafter, given the assumption that over half of the

people from the East End are evacuating, it may be readily inferred from a review of the queue length and discharge rates used in Mr. Polk's analysis of the Sunrise Highway that each one of those EPZ evacuees would have cleared Intersection 10 on the Sunrise Highway, beyond the end of its run as an EPZ boundary, by 6 hours. Even this estimate ignores the fact that once persons are on the Sunrise Highway they are beyond the EPZ.

8. Q. What is the proper framework for consideration of persons who are not within the EPZ at the time of an evacuation recommendation, but nevertheless evacuate voluntarily without ever entering the EPZ?

A. [Cordaro, Weismantle, Lieberman] NUREG-0654, incorporated into the Commission's regulations at 10 CFR § 50.47, provides for the use of an emergency planning zone approximately 10 miles in radius. Two of the reasons underlying this provision are pertinent here. First, a 10-mile EPZ covers an area large enough to encompass the effects of the vast majority of realistically anticipatable accidents at a commercial reactor. Second, the logistic and support base adequate to provide emergency services within a 10-mile zone are generally considered to be substantial enough to be expandable, ad hoc, to address limited emergency needs beyond that zone. Thus under NUREG-0654 as incorporated into 10 CFR § 50.47, an EPZ is so defined

that plans which provide for protection of the population within it are an acceptable basis for emergency preparedness. It follows that the primary reason for considering populations outside the EPZ in the development of emergency plans pursuant to the Commission's regulations is to determine whether they affect the feasibility of implementing planning measures for persons within the EPZ.

The analyses presented in this testimony confirm what has been shown in our earlier testimony on evacuation time estimates: the voluntary evacuation of populations from beyond the EPZ does not materially affect the evacuation estimates for residents, and the extent of that effect, such as it is, is determinable.

Suffolk County's evacuation time estimate argument is pivoted not on the movement of the persons living within the EPZ -- those sought to be protected by the Commission's regulations -- but on the movement of persons living beyond the EPZ and not entering it. This is inconsistent with the Commission's regulations, as outlined above. It is also bad planning: if one were to accept the County's estimate of 18 hours to evacuate the 10-mile EPZ as the basis for protective actions rather than the appropriate range of about 5 to 7 hours, it would not conduce to the most accurate and therefore most effective development

of protective actions in the event of an accident.3/

Thus, both from a regulatory standpoint and from a planning standpoint, the County's proposal that evacuation time estimates for the 10-mile EPZ turn on the travel times of voluntary traffic which (1) originates outside the EPZ, (2) never enters it, and (3) does not materially impede the exodus of population from within the EPZ, is not useful.

9. Q. What would be the evacuation time estimates produced by Mr. Polk's analyses if the evacuation of the EPZ is used as the criterion for determining evacuation time?

A. [Lieberman] From the detailed computer printouts provided in response to LILCO's discovery request, it is possible to produce an evacuation time estimate for the people evacuating from Subregion 1, which is roughly analogous to the Shoreham EPZ. A review of Attachment 2 indicates that each of the four major evacuation routes carries people from within the EPZ to beyond its boundaries. In addition, the Route 25 subroute of Route 347 also carries

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3/ It should be noted that the County has not reported any evacuation time estimates for the far more likely scenarios of evacuation of radii less than 10 miles or of a less-than-10-mile radius plus a "keyhole" out to 5 or 10 miles. Thus its analysis simply does not apply to those circumstances.

people from within the EPZ. This subroute does not merge with Route 347 until roughly 8 miles west of the EPZ; therefore it should be considered as a separate evacuation route in determining the time needed to evacuate the EPZ.

The method used to determine the evacuation time for the EPZ, using each of the five routes just listed was as follows:

1. Identify from the input data provided by Suffolk County all intersections at which traffic from Subregion 1 enters an evacuation route. These are: (1) Intersection 1 for the Jericho Turnpike; (2) Intersections 1, 2 and 3 (only leg 2) for Route 25; (3) Intersections 1 and 2 for Route 347; (4) Intersections 1 through 5 on the LIE, as well as all three intersections on the North William Floyd Parkway subroute and Intersection 7 on the unnamed subroute that uses the Montauk Highway and Horse Block Road; and (5) Legs 2 and 4 of Intersections 8 and 9 on the Sunrise Highway and leg 4 of Intersection 2 of the subroute entitled "North Fork via E-61."

2. Produce time histories of traffic on all legs of these intersections as well as time histories for several intersections west of the EPZ on each route to ensure that queue formation at these intersections from outside the EPZ will not affect traffic evacuating the EPZ. The time histories for a summer evacuation are attached as Attachment 3 to this testimony.

3. Discern from each intersection-specific time history the time at which the intersection, or leg of interest, clears.4/

4/ The time histories presented in Attachment 3 indicate that an intersection has been cleared of queues at the time associ-

footnote continued

> The evacuation time needed to clear the subregion of interest, in this case Subregion 1, is defined as the longest time for any intersection or leg.

An examination of the time histories shows that the entire evacuation of Subregion 1 can be accomplished in approximately 7 hours 30 minutes in summer and 6 hours 45 minutes in the winter, notwithstanding the assumed existence of evacuation beyond it. In both cases, the limiting point is the intersection of the LIE and the William Floyd Parkway. This intersection takes approximately an hour longer to clear than any other area in the EPZ. The delay at this intersection results from a queue that forms along the William Floyd Parkway north of the LIE. This queue can be discharged onto the LIE at only one third the roadway capacity of the LIE because of the constraining capacity of the existing entrance ramp.

Closer examination of the time histories in Attachment 3 and of a map showing traffic assignments that were supplied in response to discovery indicates that even this

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footnote continued

ated with the final entry. In cases when the last entry is after 5 hours, it may be necessary to interpolate between hourly entries to determine the exact time at which the last queued car exits the intersection. The time needed to clear the queue on a specific leg of an intersection is when the value under the column headed "Q" for an individual leg is zero.

delay on the William Floyd Parkway could easily and realistically have been eliminated. First, traffic originating within five miles to the east and southeast of the Shoreham plant could be assigned to any of the three intersections of the LIE (1, 2, 3) east of the William Floyd Parkway intersection, rather than going entirely to the William Floyd Parkway. This reassignment would distribute demand more efficiently over existing roadway capacities, and would more realistically reflect the routes people living in this area would be likely to take. Second, the modeling results show that the intersection of the William Floyd Parkway southbound onto the Sunrise Highway was clear of traffic on the William Floyd Parkway after approximately 2 hours 30 minutes, or five hours before the William Floyd-LIE intersection (LIE Intersection 4), approximately two miles to the north, clears. Thus, it seems likely that some traffic sitting in a queue on the William Floyd Parkway waiting to enter the LIE would choose in any event to proceed south on the William Floyd Parkway and to evacuate on the Sunrise Highway. The result would be a further reduction in the time needed to clear the William Floyd-LIE intersection, and thus to evacuate the EPZ.

10. Q. How does this evacuation time estimate compare with evacuation time estimates produced by LILCO?

A. [Weismantle, Lieberman] The assumptions underlying the Polk Testimony's evacuation time estimates for Subregion 1, not including any reorienting of traffic on the William Floyd Parkway, most closely resemble those made in the summer, uncontrolled, 50% shadow run made by LILCO. The results of this run appear as Case 27 on Attachment 6 to this panel's earlier testimony on Contentions 23 and 65 and are further detailed in Attachment 11 to that testimony. The Case 27 results indicate an evacuation time estimate of 7 hours 35 minutes -- an evacuation time estimate virtually identical to the 7 hour 30 minute estimate produced by Mr. Polk.

The close agreement between these two analyses may reflect a trade-off between two opposing factors. On one hand PRC's arbitrary and relatively inefficient assignment of traffic to routes within the EPZ tends to concentrate traffic on only a portion of the available roadways. This approach will produce higher estimates of evacuation travel time than will actually be realized. On the other hand, the PRC estimates of capacity on some arterials appear to be somewhat generous (see Attachment 1). These higher capacities counteract the limited roadway system used by PRC.

By comparison, KLD's analysis produced routing patterns which utilized more roadways -- i.e., more of the available roadways network capacity -- than did those of PRC. Also, the KLD capacity estimates attempted to reflect the effects of congested conditions.

Thus, the results of the KLD analysis are more representative of the roadway network and actual motorist behavior, and are more likely to yield accurate evacuation time estimates over a spectrum of input assumptions.

11. Q. What conclusions have you reached regarding the estimates of the number of accidents contained in Mr. Polk's testimony?

A. [Lieberman] In his direct testimony, Mr. Polk predicted that 141 accidents would occur during an evacuation of the Shoreham EPZ (Polk Testimony at 10-11). This estimate contrasts sharply with this panel's estimate of approximately 4 accidents in its November 18, 1983 testimony on Contention 65.D. This difference becomes startling when one recognizes that both accident predictions are premised on the same background document -- the Transportation and Traffic Engineering Handbook.

The difference of interpretation of the Transportation and Traffic Engineering Handbook, and hence the difference in predicted accidents, centers on whether accident frequency increases at very low speeds. Mr. Polk's estimates

assume that it does. As support, Mr. Polk cites pages 816 and 818 of the Transportation and Traffic Engineering Handbook. These two pages, which are attached along with other pertinent pages from the handbook as Attachment 4 to this testimony, contain two curves, Figures 26.1 and 26.2, which present accident frequencies in terms of travel speed and variation from mean speed respectively. The frequency rate of 40,000 accidents per 100 million vehicle miles used as the basis for Mr. Polk's accident calculations is taken from Figure 26.1 alone assuming a travel speed of 15 miles per hour.

A closer examination of Figure 26.1 in context with Figure 26.2 and the accompanying text reveals that Figure 26.1 cannot be used in this manner. On page 815, Figure 26.1 is described as follows:

> Figure 26.1, taken from a study made by the Federal Highway Administration, reveals some interesting findings regarding accident involvement and speed on main rural highways, not including freeways. Accident-involvement rates are the highest at very low speeds, are lowest at about the average speeds, and increase again at very high speeds. A principal conclusion is that the more a driver deviates from the average speed of traffic, the greater is his or her chance of being involved in an accident.

An examination of the report cited as the source of Figure 26.1 confirms that Figure 26.1 was premised on an assumed average speed:

> One of the important findings of this study is that the greater the differential in speed of a driver and his vehicle from the average speed of all traffic, the greater the chance of that driver being involved in an accident. For example, a driver traveling at 40 or 80 miles per hour in relation to an average speed of 60 miles per hour for all traffic has a substantially greater chance of being involved in an accident than a driver traveling at the average speed. But, if the average travel speed were only 40 miles per hour on a section of highway, the possibility of a driver being involved in an accident would be least at the average travel speed of 40 miles per hour.

Solomon, "Accidents on Main Rural Highways Related to Speed, Driver, and Vehicles," U.S. Dept. of Commerce, Preface (1964).

Since congested conditions prevail most of the time during an evacuation, there will be little deviation from the mean speed of about 6.5 miles per hour; in other words, low speeds will be the norm rather than an aberration from normal free-flow highway speeds. Thus, Figure 26.2, which displays accidents rates as a function of variation from mean speed, is the figure Mr. Polk should have used. Assuming a variation of 0 miles per hour, i.e., a uniform speed of 6.5 miles per hour, then the accident frequency is only about 100 accidents per 100 million vehicle miles, or 1/40 of Mr. Polk's assumed rates.5/

5/ If some cars travel 10 miles per hour faster than the average speed, i.e., 16.5 miles per hour, there would be little effect on the expected accident rate.

Using this correct accident frequency, Mr. Polk's analysis would predict 3 accidents during an evacuation -- an accident rate virtually identical to that predicted in this panel's earlier testimony and consistent with national accident statistics.

12. Q. Does the testimony of other Suffolk County witnesses lend credence to Mr. Polk's accident estimate?

A. [Lieberman] No. Testimony filed by Inspector Roberts, et al. and by Philip Herr include accident statistics that are ostensibly designed to support the accident estimate of Mr. Polk. Neither does.

The testimony of Inspector Roberts, et al. states that 977 traffic accidents were reported at 126 intersections in the Sixth Precinct during the year beginning September 1982 (Roberts, et al. at 66-67). The Sixth Precinct, which served as the basis for this study, covers an area that approximates the Shoreham EPZ. The 126 intersections studied represent intersections along the five major highways within the Sixth Precinct. Thus, the accidents reported in this testimony can be expected to constitute a substantial percentage of the accidents that occur within the EPZ during a given year. If the 977 accidents are divided by the number of hours in a year -- 8,760 -- an accident rate of 1 accident approximately every nine hours

is produced. Stated in terms of a five-hour evacuation, Inspector Roberts, _et_ _al_.'s study shows that there is slightly greater than a 50% chance that _one_ accident will occur at one of the 126 intersections during an evacuation. While the rate of occurrence of accidents per unit of time (the frame of reference used by Inspector Roberts, _et_ _al_.) is not the most precise indicator for predicting accidents during an evacuation, it nevertheless serves to demonstrate that Inspector Roberts, _et_ _al_.'s accident study lends no credence to Mr. Polk's accident estimate or any value higher than the four accidents assumed in KLD's analyses.

Mr. Herr's reliance on accident statistics from the 1983 July weekend does nothing to undermine KLD's estimate of four accidents during an evacuation. Mr. Herr argues that the reported accidents produce an accident rate of four accidents per hour (Herr Testimony at 41). What Mr. Herr does not acknowledge is that the Fourth of July accident statistics he relies on reflect a population group of 1.16 million (the population of the five western towns in Suffolk County), or a population group more than 7 times larger than that expected to evacuate the EPZ. If Mr. Herr's accident statistics are normalized to reflect equivalent size population groups, then a population the

size of that within the EPZ would have 0.6 accidents per hour or approximately 3 accidents during an evacuation.

Thus, the testimony of Inspector Roberts, et al. and Mr. Herr contradicts the accident estimate of Mr. Polk, and supports KLD's estimates.

13. Q. What conclusions have you reached regarding the estimates of the automobiles running out of gas contained in Mr. Polk's testimony?

A. [Lieberman] Mr. Polk's estimate of the number of cars likely to run out of gas during an evacuation is overstated for a number of reasons. First, the estimate is premised on a fuel usage rate for idling that comes from a 1976 report (see Polk Testimony at 13 & n.5). This value overstates fuel consumption for cars that would be hypothesized to evacuate in 1985, because fuel efficiencies have been improving since 1976. For example, Table 6-4 of the Transportation and Traffic Engineering Handbook indicates that U.S. fleet fuel consumption improved 27 percent between 1975 and 1979. It has continued to improve further since then.

Second, Table 3 of Mr. Polk's testimony (Polk Testimony at 16) contains a numerical error in the values presented in the column headed "Proportion of Vehicles Running Out of Fuel." This error is most easily seen by examining the first entry, which relates to cars queuing from 0 to 30

minutes. For his analysis, Mr. Polk assumes that no car will start the evacuation with less than one gallon of gasoline, that the fuel usage rate for idling is 0.67 gallons per hour, that fuel consumption is 20 miles per gallon under normal driving conditions, and that the average evacuation trip is 10 miles (Polk Testimony at 12, 14). Using these assumptions, a car that queues for 30 minutes would consume 0.33 gallons of gasoline while idling in a queue and another 0.5 gallons in traveling out of the EPZ (10 mile trip at 20 miles per gallon). Thus, the car would use a total of 0.83 gallons. Since all cars are assumed to have at least 1 gallon of gas, then it follows that no cars queuing for 30 minutes or less would run out of gas. Yet Mr Polk's analyses assumes that 0.21% will (<u>see</u> Polk Testimony at 16). While the exact nature of Mr. Polk's error has not been determined, it appears clear that the other values that appear in the third column of Table 3 are similarly overstated. In addition, each value listed in column 3 is based on the maximum queuing time of each time interval presented (<u>i.e.</u>, for the time interval 30 minutes to 1 hour the value in column 3 of Table 3 represents a car queuing for 1 hour). The more appropriate value would be the midpoint of each range.

Making the correction in the values in column 3 just discussed and using the midpoint of each time interval, Mr. Polk's analysis would predict that 120 cars would run out of gas. If improved fuel efficiency values are used, this value would decrease to 96 vehicles, or about one third of the 277 vehicles reported in the Polk Testimony.

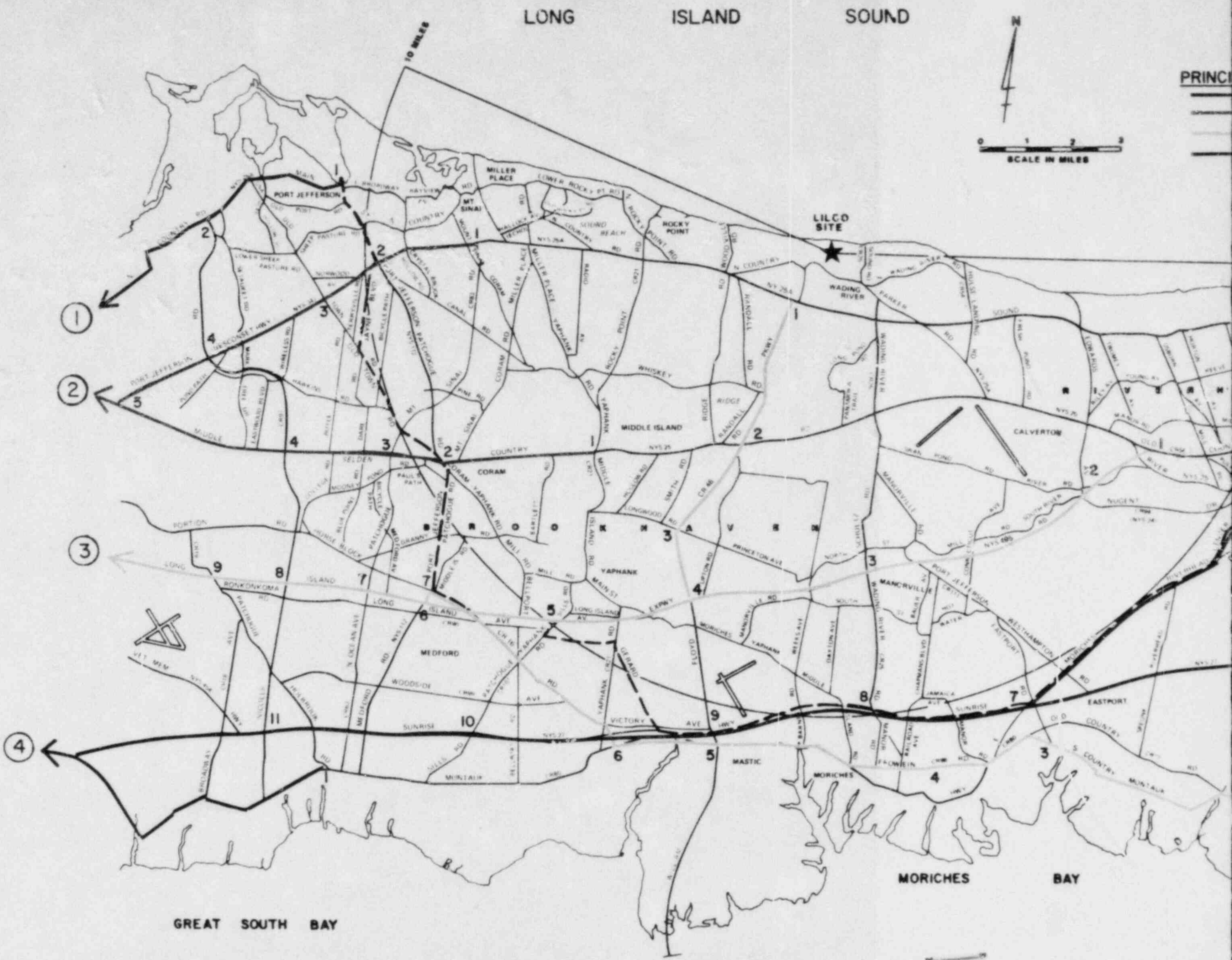
More importantly, Mr. Polk's estimate fails to take account of the fuel allocation plan that LERO will employ during an evacuation. That plan calls for fuel trucks to be dispersed at 7 locations within or just outside the EPZ (OPIP 3.6.3, p. 46b). Each fuel truck will have a fuel capacity of at least 1250 gallons and will dispense 3 gallons to each vehicle seeking fuel. Thus, 400 cars can be serviced by <u>each</u> fuel truck -- a larger number of cars than Mr. Polk's uncorrected estimate assumes will run out of gasoline in the entire EPZ.

ROADWAY CAPACITIES
(Vehicles/hour)

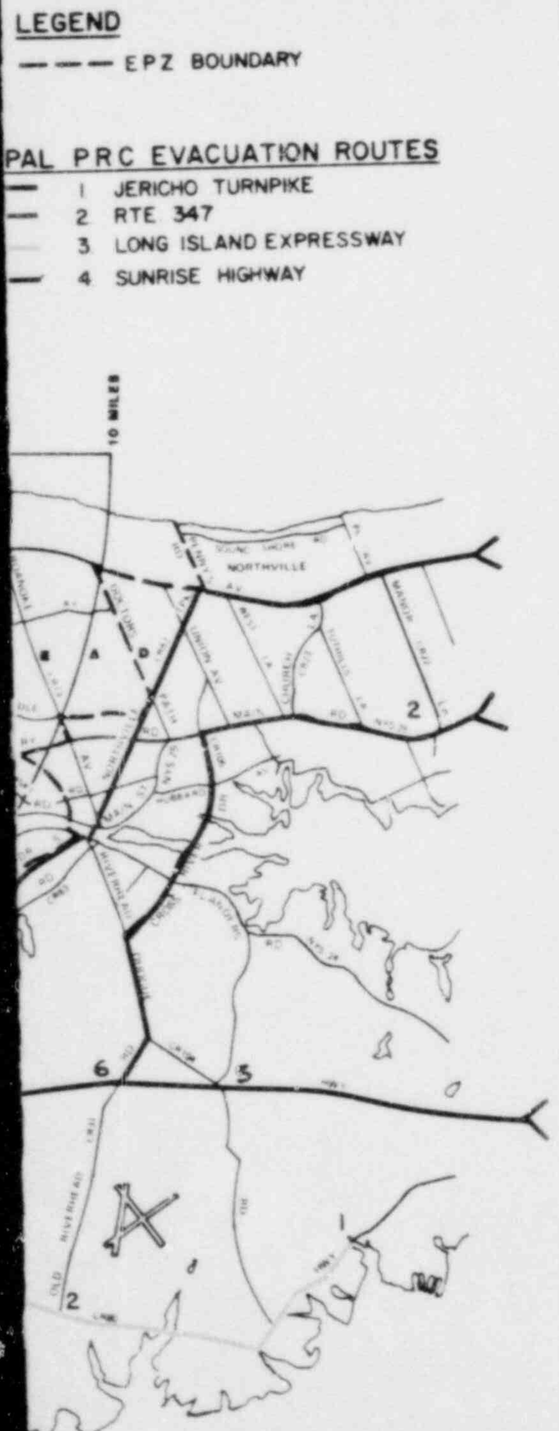
Roadway	KLD Analyses 1/	PRC Analyses	PRC Report (November 1982) 2/
North County Road	425	1280	1200
Route 25A/347	1275	1280	1500
Route 25 (Middle Country Road)	845	1280	1500
Long Island Expressway	4590	4560	5400
Sunrise Highway	3060	3040	3300 (arterial) 3600 (expressway)

1/ The reported capacity is the lowest capacity of a link on the indicated roadway that appears in Table IV to Appendix A to the LILCO Transition Plan.

2/ "Preliminary Evacuation Time Estimates for the Shoreham EPZ," PRC Voorhees, p. 6 (November 1982).



LONG ISLAND SOUND
10 MILES
N
0 1 2 3
SCALE IN MILES
PRINC
LILCO SITE
PORT JEFFERSON
MILLER PLACE
MT SINAI
ROCKY POINT
WADING RIVER
MIDDLE ISLAND
CALVERTON
SELDEN
CORAM
B R O O K H A V E N
YAPHANK
MANORVILLE
MEDFORD
EASTPORT
MASTIC
MORICHES
MORICHES BAY
GREAT SOUTH BAY


LEGEND
EPZ BOUNDARY
PAL PRC EVACUATION ROUTES
1 JERICHO TURNPIKE
2 RTE 347
3 LONG ISLAND EXPRESSWAY
4 SUNRISE HIGHWAY
10 MILES
NORTHVILLE
OLD RIVERHEAD

INTERSECTION TIME HISTORIES
FROM ANALYSIS OF A SUMMER EVACUATION
PRESENTED IN THE POLK TESTIMONY

LEGEND:

A - Vehicles arriving at the designated intersection on the specified leg (reduced by a factor of 10).

Q - Vehicles queuing on the specified leg (reduced by a factor of 10).

D - Vehicles departing the designated intersection (reduced by a factor of 10).

* - Designates the intersection of a major evacuation route or subroute that is at, or is the first beyond, the EPZ boundary.

** - Designates intersections on the Sunrise Highway where traffic from within the EPZ enters that evacuation route. (Intersections 7, 8 and 9 lie just outside the EPZ boundary. Intersection 7 receives evacuating traffic only from Subregion 6 (i.e., from outside the EPZ)).

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - JERICHO TURNPIKE

	Intersection 1: Top *							Intersection 2: Setauket							Intersection 3: Head of Harbor						
	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3
Time	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D
1:15	0	0	30	0	0	0	25	25	0	7	0	10	0	32	32	0	2	0	7	0	32
1:30	0	0	92	5	0	0	25	25	6	20	2	32	2	32	32	7	7	0	21	2	32
1:45	0	0	149	72	0	0	25	25	18	33	13	52	24	32	32	22	11	3	35	11	32
2:00	0	0	131	196	0	0	25	25	31	29	36	46	66	32	32	40	10	8	31	35	32
2:15	0	0	64	302	0	0	25	25	44	14	55	23	102	32	32	58	5	10	15	55	32
2:30	0	0	18	341	0	0	25	25	57	4	59	6	115	32	32	76	1	8	4	59	32
2:45	0	0	3	334	0	0	25	25	70	1	53	1	111	32	32	92	0	5	1	51	32
3:00	0	0	0	312	0	0	25	25	83	0	44	0	102	32	32	107	0	2	0	39	32
3:15	0	0	0	287	0	0	25	25	96	0	34	0	92	32	32	122	0	1	0	25	32
3:30	0	0	0	262	0	0	25	25	109	0	24	0	82	32	32	136	0	0	0	11	32
3:45	0	0	0	237	0	0	25	25	121	0	15	0	72	32	32	144	0	0	0	3	32
4:00	0	0	0	212	0	0	25	25	132	0	8	0	61	32	32	141	0	0	0	0	32
4:15	0	0	0	187	0	0	25	25	141	0	4	0	49	32	32	147	0	0	0	0	32
4:30	0	0	0	162	0	0	25	25	149	0	2	0	36	32	32	147	0	0	0	0	32
4:45	0	0	0	137	0	0	25	25	157	0	1	0	22	32	32	147	0	0	0	0	32
5:00	0	0	0	112	0	0	25	25	163	0	0	0	9	32	32	147	0	0	0	0	32
6:00	0	0	0	12	0	0	12	12	144	0	0	0	0	32	32	147	0	0	0	0	32
7:00								0	28	0	0	0	0	28	28	147	0	0	0	0	32
8:00															0	47	0	0	0	0	32
9:00																					
10:00																					
11:00																					
12:00																					
13:00																					
14:00																					
15:00																					
16:00																					
17:00																					
18:00																					

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - JERICHO TURNPIKE

	Intersection 4: Village of Branch						
	Leg 1		Leg 2		Leg 4		Leg 3
Time	A	Q	A	Q	A	Q	D
1:15							
1:30	32	0	45	0	45	0	64
1:45	32	15	72	21	72	21	64
2:00	32	31	64	69	64	69	64
2:15	32	47	31	109	31	109	64
2:30	32	63	9	116	9	116	64
2:45	32	79	1	101	1	101	64
3:00	32	95	0	78	0	78	64
3:15	32	111	0	54	0	54	64
3:30	32	127	0	30	0	30	64
3:45	32	137	0	9	0	9	50
4:00	32	137	0	0	0	0	32
4:15	32	137	0	0	0	0	32
4:30	32	137	0	0	0	0	32
4:45	32	137	0	0	0	0	32
5:00	32	137	0	0	0	0	32
6:00	32	137	0	0	0	0	32
7:00	32	137	0	0	0	0	32
8:00	32	137	0	0	0	0	32
9:00	0	56	0	0	0	0	32
10:00							
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - ROUTE 25 INTO 347

	Intersection 1: Top							Intersection 2: Coram-Yaphank*							Intersection 3: Route 83 Area						
	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3
Time	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D
1:15															39	0	18	0	19	0	64
1:30	0	0	106	0	0	0	50	50	0	16	0	0	0	64	64	6	55	3	60	3	64
1:45	0	0	170	56	0	0	50	50	2	26	0	0	0	64	64	48	89	38	98	41	64
2:00	0	0	151	176	0	0	50	50	9	23	5	0	0	64	64	91	79	106	86	118	64
2:15	0	0	74	277	0	0	50	50	14	11	9	0	0	64	64	134	38	164	42	183	64
2:30	0	0	21	301	0	0	50	50	15	3	5	0	0	64	64	177	11	181	12	204	64
2:45	0	0	3	272	0	0	50	50	8	1	1	0	0	60	60	220	2	171	2	195	64
3:00	0	0	0	225	0	0	50								50	259	0	152	0	176	64
3:15	0	0	0	175	0	0	50								50	288	0	131	0	155	64
3:30	0	0	0	125	0	0	50								50	317	0	110	0	134	64
3:45	0	0	0	75	0	0	50								50	346	0	89	0	113	64
4:00	0	0	0	25	0	0	25								25	375	0	68	0	92	64
4:15															0	379	0	47	0	71	64
4:30															0	356	0	30	0	48	64
4:45															0	327	0	16	0	26	64
5:00															0	288	0	6	0	10	64
6:00															0	48	0	0	0	0	48
7:00																					
8:00																					
9:00																					
10:00																					
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15:00																					
16:00																					
17:00																					
18:00																					

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - ROUTE 25 INTO 347

Time	Intersection 4: Route 97 Area						
	Leg 1		Leg 2		Leg 4		Leg 3
	A	Q	A	Q	A	Q	D
1:15	64	0	38	0	32	0	64
1:30	64	33	117	20	100	17	64
1:45	64	76	188	116	161	96	64
2:00	64	119	166	283	142	236	64
2:15	64	162	81	428	70	357	64
2:30	64	205	23	488	20	406	64
2:45	64	248	4	490	3	405	64
3:00	64	291	0	473	0	387	64
3:15	64	334	0	452	0	366	64
3:30	64	377	0	431	0	345	64
3:45	64	420	0	410	0	324	64
4:00	64	463	0	389	0	303	64
4:15	64	506	0	368	0	282	64
4:30	64	549	0	347	0	261	64
4:45	64	592	0	326	0	240	64
5:00	64	635	0	305	0	219	64
6:00	48	807	0	221	0	135	64
7:00	0	771	0	137	0	51	64
8:00	0	665	0	32	0	6	64
9:00	0	446	0	0	0	0	64
10:00	0	190	0	0	0	0	64
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - ROUTE 347

Time	Intersection 1: Top							Intersection 2: Canal and Rt. 112*							Inter. 3: Old Town Road Area						
	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3
	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D
1:15	0	0	44	0	0	0	32								50	0	6	0	14	0	64
1:30	0	0	138	12	0	0	32	32	0	25	0	30	0	64	64	4	18	1	43	1	64
1:45	0	0	223	118	0	0	32	32	8	40	7	49	8	64	64	36	29	9	69	22	64
2:00	0	0	196	309	0	0	32	32	22	35	26	43	32	64	64	75	25	23	61	66	64
2:15	0	0	96	473	0	0	32	32	33	17	40	21	53	64	64	118	12	27	29	106	64
2:30	0	0	27	537	0	0	32	32	45	5	37	6	51	64	64	156	4	27	9	110	64
2:45	0	0	4	532	0	0	32	32	52	1	26	1	35	64	64	194	1	19	1	93	64
3:00	0	0	0	504	0	0	32	32	52	0	13	0	18	64	64	230	0	11	0	66	64
3:15	0	0	0	472	0	0	32	32	41	0	4	0	6	64	64	265	0	6	0	37	64
3:30	0	0	0	440	0	0	32	32	18	0	1	0	1	52	52	291	0	2	0	15	64
3:45	0	0	0	408	0	0	32								32	292	0	0	0	3	64
4:00	0	0	0	376	0	0	32								32	263	0	0	0	0	64
4:15	0	0	0	344	0	0	32								32	231	0	0	0	0	64
4:30	0	0	0	312	0	0	32								32	199	0	0	0	0	64
4:45	0	0	0	286	0	0	32								32	167	0	0	0	0	64
5:00	0	0	0	248	0	0	32								32	135	0	0	0	0	64
6:00	0	0	0	120	0	0	32								32	7	0	0	0	0	39
7:00																					
8:00																					
9:00																					
10:00																					
11:00																					
12:00																					
13:00																					
14:00																					
15:00																					
16:00																					
17:00																					
18:00																					
19:00																					

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - ROUTE 347

Time	Intersection 4: Route 97 Area							Intersection 5: Route 25							Intersection 6: Nesconset Area						
	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3
	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D
1:15	64	0	6	0	7	0	64	64	0	146	0	0	0	64	64	0	23	0	17	0	64
1:30	64	11	18	1	21	1	64	64	32	454	114	0	0	64	64	25	72	9	54	7	64
1:45	64	36	29	7	35	9	64	64	64	732	536	0	0	64	64	64	116	61	87	41	64
2:00	64	72	25	20	31	24	64	64	96	646	1236	0	0	64	64	103	102	157	77	108	64
2:15	64	105	12	23	15	34	64	64	128	316	1850	0	0	64	64	142	50	239	38	165	64
2:30	64	148	4	23	4	28	64	64	160	90	2134	0	0	64	64	181	14	269	11	183	64
2:45	64	179	1	13	1	15	64	64	192	14	2192	0	0	64	64	220	2	263	2	174	64
3:00	64	199	0	4	0	5	64	64	224	1	2174	0	0	64	64	259	0	245	0	156	64
3:15	64	207	0	0	0	1	64	64	256	0	2143	0	0	64	64	298	0	225	0	136	64
3:30	64	208	0	0	0	0	64	64	288	0	2111	0	0	64	64	337	0	205	0	116	64
3:45	64	208	0	0	0	0	64	64	320	0	2079	0	0	64	64	376	0	185	0	96	64
4:00	64	208	0	0	0	0	64	64	352	0	2047	0	0	64	64	415	0	165	0	76	64
4:15	64	208	0	0	0	0	64	64	384	0	2015	0	0	64	64	454	0	145	0	56	64
4:30	64	208	0	0	0	0	64	64	416	0	1983	0	0	64	64	493	0	125	0	36	64
4:45	64	208	0	0	0	0	64	64	448	0	1951	0	0	64	64	530	0	104	0	21	64
5:00	64	208	0	0	0	0	64	64	480	0	1919	0	0	64	64	564	0	80	0	11	64
6:00	39	208	0	0	0	0	64	64	608	0	1791	0	0	64	64	653	0	1	0	0	64
7:00	0	79	0	0	0	0	64	64	736	0	1663	0	0	64	64	654	0	0	0	0	64
8:00								0	687	0	1535	0	0	64	64	654	0	0	0	0	64
9:00								0	559	0	1407	0	0	64	64	654	0	0	0	0	64
10:00								0	431	0	1279	0	0	64	64	654	0	0	0	0	64
11:00								0	303	0	1151	0	0	64	64	654	0	0	0	0	64
12:00								0	175	0	1023	0	0	64	64	654	0	0	0	0	64
13:00								0	47	0	895	0	0	64	64	654	0	0	0	0	64
14:00								0	0	0	686	0	0	64	64	654	0	0	0	0	64
15:00								0	0	0	430	0	0	64	64	654	0	0	0	0	64
16:00								0	0	0	174	0	0	64	64	654	0	0	0	0	64
17:00															0	572	0	0	0	0	64
18:00															0	316	0	0	0	0	64
19:00															0	60	0	0	0	0	64

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - NORTH WILLIAM FLOYD PARKWAY

Time	Intersection 2: Route 25							Intersection 3: Longwood into Floyd						
	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3
	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D
1:15														
1:30	21	0	74	0	25	0	64	64	0	14	0	12	0	64
1:45	34	4	120	48	40	4	64	64	18	23	4	19	8	64
2:00	30	14	106	148	35	24	64	64	46	20	12	17	10	64
2:15	15	18	52	235	17	40	64	64	77	10	15	8	13	64
2:30	4	11	15	266	5	36	64	64	104	3	10	2	9	64
2:45	1	3	2	255	1	15	52	52	121	0	4	0	3	64
3:00	0	0	0	225	0	0	32	32	115	0	0	0	0	64
3:15	0	0	0	193	0	0	32	32	83	0	0	0	0	64
3:30	0	0	0	161	0	0	32	32	51	0	0	0	0	64
3:45	0	0	0	129	0	0	32	32	19	0	0	0	0	51
4:00	0	0	0	97	0	0	32							
4:15	0	0	0	65	0	0	32							
4:30	0	0	0	33	0	0	32							
4:45	0	0	0	1	0	0	1							
5:00														
6:00														
7:00														
8:00														
9:00														
10:00														
11:00														
12:00														
13:00														
14:00														
15:00														
16:00														
17:00														
18:00														

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - LONG ISLAND EXPRESSWAY

Time	Intersection 2: Exit 71						
	Leg 1		Leg 2		Leg 4		Leg 3
	A	Q	A	Q	A	Q	D
1:15							
1:30							
1:45	39	0	40	0	8	0	79
2:00	35	0	35	8	7	0	74
2:15	17	0	17	11	3	0	48
2:30							
2:45							
3:00							
3:15							
3:30							
3:45							
4:00							
4:15							
4:30							
4:45							
5:00							
6:00							
7:00							
8:00							
9:00							
10:00							
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							

Time	Intersection 4: Exit 68						
	Leg 1		Leg 2		Leg 4		Leg 3
	A	Q	A	Q	A	Q	D
1:15	24	0	47	0	7	0	63
1:30	73	0	146	15	9	0	114
1:45	109	0	236	129	9	0	114
2:00	101	26	208	341	9	2	114
2:15	62	44	102	526	9	3	114
2:30	14	25	29	604	9	3	83
2:45	1	0	5	601	9	0	42
3:00	0	0	0	574	9	0	41
3:15	0	0	0	542	9	0	41
3:30	0	0	0	510	9	0	41
3:45	0	0	0	478	7	0	39
4:00	0	0	0	446	4	0	36
4:15	0	0	0	414	4	0	36
4:30	0	0	0	382	4	0	36
4:45	0	0	0	350	0	0	32
5:00	0	0	0	318	0	0	32
6:00	0	0	0	190	0	0	32
7:00	0	0	0	62	0	0	32
8:00							
9:00							
10:00							
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							

Time	Intersection 5: Exit 66						
	Leg 1		Leg 2		Leg 4		Leg 3
	A	Q	A	Q	A	Q	D
1:15	63	0	35	0	0	0	95
1:30	114	0	108	3	0	0	114
1:45	114	25	174	86	0	0	114
2:00	114	50	153	235	0	0	114
2:15	114	75	75	363	0	0	114
2:30	83	100	21	413	0	0	114
2:45	42	94	3	409	0	0	114
3:00	41	47	0	387	0	0	114
3:15	41	4	0	357	0	0	77
3:30	41	0	0	325	0	0	73
3:45	39	0	0	293	0	0	71
4:00	36	0	0	261	0	0	68
4:15	36	0	0	229	0	0	68
4:30	36	0	0	197	0	0	68
4:45	32	0	0	165	0	0	64
5:00	32	0	0	133	0	0	64
6:00	32	0	0	5	0	0	37
7:00							
8:00							
9:00							
10:00							
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - LONG ISLAND EXPRESSWAY

Time	Intersection 6: Exit 64 * Leg 1 A	Leg 1 Q	Leg 2 A	Leg 2 Q	Leg 4 A	Leg 4 Q	Leg 3 D
1:15	95	0	126	0	0	0	114
1:30	114	10	391	97	0	0	114
1:45	114	35	630	463	0	0	114
2:00	114	60	556	1068	0	0	114
2:15	114	85	272	1599	0	0	114
2:30	114	110	78	1846	0	0	114
2:45	114	135	12	1899	0	0	114
3:00	114	160	1	1886	0	0	114
3:15	77	185	0	1862	0	0	114
3:30	73	173	0	1837	0	0	114
3:45	71	157	0	1812	0	0	114
4:00	68	139	0	1787	0	0	114
4:15	68	118	0	1762	0	0	114
4:30	68	97	0	1737	0	0	114
4:45	64	76	0	1712	0	0	114
5:00	64	51	0	1687	0	0	114
6:00	37	0	0	1568	0	0	69
7:00	32	0	0	1440	0	0	64
8:00	0	0	0	1312	0	0	32
9:00	0	0	0	1184	0	0	32
10:00	0	0	0	1056	0	0	32
11:00	0	0	0	928	0	0	32
12:00	0	0	0	800	0	0	32
13:00	0	0	0	672	0	0	32
14:00	0	0	0	544	0	0	32
15:00	0	0	0	416	0	0	32
16:00	0	0	0	288	0	0	32
17:00	0	0	0	160	0	0	32
18:00	0	0	0	32	0	0	32

Time	Intersection 7: Exit 63 Leg 1 A	Leg 1 Q	Leg 2 A	Leg 2 Q	Leg 4 A	Leg 4 Q	Leg 3 D
1:15	114	0	7	0	17	0	114
1:30	114	20	21	1	54	3	114
1:45	114	57	35	7	87	35	114
2:00	114	98	31	22	76	102	114
2:15	114	139	15	33	37	158	114
2:30	114	180	4	28	11	175	114
2:45	114	221	1	12	2	166	114
3:00	114	253	0	4	0	145	114
3:15	114	280	0	1	0	121	114
3:30	114	306	0	0	0	96	114
3:45	114	331	0	0	0	71	114
4:00	114	356	0	0	0	46	114
4:15	114	381	0	0	0	21	114
4:30	114	399	0	0	0	3	114
4:45	114	402	0	0	0	0	114
5:00	114	402	0	0	0	0	114
6:00	69	372	0	0	0	0	114
7:00	64	177	0	0	0	0	114

Time	Intersection 8: Exit 62 Leg 1 A	Leg 1 Q	Leg 2 A	Leg 2 Q	Leg 4 A	Leg 4 Q	Leg 3 D
1:15	114	0	9	0	0	0	114
1:30	114	8	27	1	0	0	114
1:45	114	30	43	6	0	0	114
2:00	114	55	38	24	0	0	114
2:15	114	80	19	37	0	0	114
2:30	114	105	5	31	0	0	114
2:45	114	130	1	11	0	0	114
3:00	114	141	0	1	0	0	114
3:15	114	142	0	0	0	0	114
3:30	114	142	0	0	0	0	114
3:45	114	142	0	0	0	0	114
4:00	114	142	0	0	0	0	114
4:15	114	142	0	0	0	0	114
4:30	114	142	0	0	0	0	114
4:45	114	142	0	0	0	0	114
5:00	114	142	0	0	0	0	114
6:00	114	142	0	0	0	0	114
7:00	114	142	0	0	0	0	114
8:00	32	53	0	0	0	0	85

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - LONG ISLAND EXPRESSWAY

	Intersection 9: Exit 61						
	Leg 1		Leg 2		Leg 4		Leg 3
Time	A	Q	A	Q	A	Q	D
1:15	114	0	8	0	9	0	114
1:30	114	15	25	1	26	1	114
1:45	114	51	40	8	43	9	114
2:00	114	92	36	28	38	32	114
2:15	114	133	17	44	18	50	114
2:30	114	174	5	41	5	48	114
2:45	114	215	1	26	1	33	114
3:00	114	254	0	9	0	13	114
3:15	114	272	0	1	0	2	114
3:30	114	275	0	0	0	0	114
3:45	114	275	0	0	0	0	114
4:00	114	275	0	0	0	0	114
4:15	114	275	0	0	0	0	114
4:30	114	275	0	0	0	0	114
4:45	114	275	0	0	0	0	114
5:00	114	275	0	0	0	0	114
6:00	114	275	0	0	0	0	114
7:00	114	275	0	0	0	0	114
8:00	85	275	0	0	0	0	114
9:00							
10:00							
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							

	Intersection 10: Exit 59, Exit 60						
	Leg 1		Leg 2		Leg 4		Leg 3
Time	A	Q	A	Q	A	Q	D
1:15	114	0	6	0	6	0	114
1:30	114	11	18	1	18	1	114
1:45	114	40	29	5	29	5	114
2:00	114	83	25	13	25	13	114
2:15	114	129	12	15	12	15	114
2:30	114	166	4	9	4	9	114
2:45	114	187	1	2	1	2	114
3:00	114	193	0	0	0	0	114
3:15	114	193	0	0	0	0	114
3:30	114	193	0	0	0	0	114
3:45	114	193	0	0	0	0	114
4:00	114	193	0	0	0	0	114
4:15	114	193	0	0	0	0	114
4:30	114	193	0	0	0	0	114
4:45	114	193	0	0	0	0	114
5:00	114	193	0	0	0	0	114
6:00	114	193	0	0	0	0	114
7:00	114	193	0	0	0	0	114
8:00	114	193	0	0	0	0	114
9:00	32	193	0	0	0	0	114
10:00							
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							

	Intersection 11: Exit 57						
	Leg 1		Leg 2		Leg 4		Leg 3
Time	A	Q	A	Q	A	Q	D
1:15	114	0	9	0	29	0	114
1:30	114	29	29	11	89	7	114
1:45	114	70	46	11	144	75	114
2:00	114	111	41	37	127	199	114
2:15	114	152	20	58	62	306	114
2:30	114	193	6	58	18	348	114
2:45	114	234	1	25	3	346	114
3:00	114	275	0	25	0	329	114
3:15	114	313	0	8	0	308	114
3:30	114	343	0	2	0	284	114
3:45	114	369	0	0	0	259	114
4:00	114	394	0	0	0	234	114
4:15	114	419	0	0	0	209	114
4:30	114	444	0	0	0	184	114
4:45	114	469	0	0	0	159	114
5:00	114	494	0	0	0	134	114
6:00	114	594	0	0	0	34	114
7:00	114	628	0	0	0	0	114
8:00	114	628	0	0	0	0	114
9:00	114	628	0	0	0	0	114
10:00	32	493	0	0	0	0	114
11:00	114	165	0	0	0	0	114
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - SUNRISE HIGHWAY

	Intersection 1: East Hampton							Intersection 2: Shelter Island							Inter. 3: S.Hampton into Sunrise						
	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3
Time	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D
1:15	0	0	72	0	0	0	32	32	0	3	0	0	0	32	32	0	29	0	0	0	32
1:30	0	0	223	40	0	0	32	32	3	10	0	0	0	32	32	14	91	15	0	0	32
1:45	0	0	359	231	0	0	32	32	11	15	2	0	0	32	32	28	147	92	0	0	32
2:00	0	0	317	558	0	0	32	32	22	14	6	0	0	32	32	42	130	225	0	0	32
2:15	0	0	155	843	0	0	32	32	34	7	8	0	0	32	32	56	64	341	0	0	32
2:30	0	0	44	966	0	0	32	32	44	2	5	0	0	32	32	70	18	391	0	0	32
2:45	0	0	7	978	0	0	32	32	50	0	1	0	0	32	32	84	3	395	0	0	32
3:00	0	0	0	953	0	0	32	32	51	0	0	0	0	32	32	98	0	384	0	0	32
3:15	0	0	0	921	0	0	32	32	51	0	0	0	0	32	32	112	0	370	0	0	32
3:30	0	0	0	890	0	0	32	32	51	0	0	0	0	32	32	126	0	356	0	0	32
3:45	0	0	0	858	0	0	32	32	51	0	0	0	0	32	32	140	0	342	0	0	32
4:00	0	0	0	826	0	0	32	32	51	0	0	0	0	32	32	154	0	328	0	0	32
4:15	0	0	0	794	0	0	32	32	51	0	0	0	0	32	32	168	0	314	0	0	32
4:30	0	0	0	762	0	0	32	32	51	0	0	0	0	32	32	182	0	300	0	0	32
4:45	0	0	0	730	0	0	32	32	51	0	0	0	0	32	32	196	0	286	0	0	32
5:00	0	0	0	698	0	0	32	32	51	0	0	0	0	32	32	210	0	272	0	0	32
6:00	0	0	0	570	0	0	32	32	51	0	0	0	0	32	32	266	0	216	0	0	32
7:00	0	0	0	442	0	0	32	32	51	0	0	0	0	32	32	322	0	160	0	0	32
8:00	0	0	0	314	0	0	32	32	51	0	0	0	0	32	32	378	0	104	0	0	32
9:00	0	0	0	186	0	0	32	32	51	0	0	0	0	32	32	434	0	48	0	0	32
10:00	0	0	0	58	0	0	32	32	51	0	0	0	0	32	32	480	0	2	0	0	32
11:00															0	463	0	0	0	0	32
12:00															0	335	0	0	0	0	32
13:00															0	207	0	0	0	0	32
14:00															0	79	0	0	0	0	32
15:00																					
16:00																					
17:00																					
18:00																					

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - SUNRISE HIGHWAY

	Intersection 4: Exit 65							Intersection 5: Exit 64							Intersection 6: Exit 63						
	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3
Time	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D
1:15	32	0	53	0	17	0	76	76	0	10	0	0	0	76	76	0	32	0	0	0	76
1:30	32	2	164	23	54	1	76	76	9	31	1	0	0	76	76	23	99	9	0	0	76
1:45	32	8	265	162	87	30	76	76	32	51	9	0	0	76	76	46	159	85	0	0	76
2:00	32	11	234	404	77	94	76	76	55	45	37	0	0	76	76	69	141	221	0	0	76
2:15	32	12	114	615	38	148	76	76	78	22	59	0	0	76	76	92	69	339	0	0	76
2:30	32	13	33	706	11	163	76	76	101	6	58	0	0	76	76	115	20	385	0	0	76
2:45	32	14	5	717	2	152	76	76	124	1	41	0	0	76	76	138	3	382	0	0	76
3:00	32	14	0	700	0	132	76	76	156	0	9	0	0	76	76	161	3	362	0	0	76
3:15	32	14	0	678	0	110	76	76	166	0	0	0	0	76	76	184	3	339	0	0	76
3:30	32	14	0	656	0	88	76	76	166	0	0	0	0	76	76	207	0	316	0	0	76
3:45	32	14	0	634	0	66	76	76	166	0	0	0	0	76	76	230	0	293	0	0	76
4:00	32	14	0	612	0	44	76	76	166	0	0	0	0	76	76	253	0	270	0	0	76
4:15	32	14	0	590	0	22	76	76	166	0	0	0	0	76	76	276	0	247	0	0	76
4:30	32	11	0	566	0	5	76	76	166	0	0	0	0	76	76	299	0	224	0	0	76
4:45	32	2	0	536	0	0	66	66	166	0	0	0	0	76	76	322	0	201	0	0	76
5:00	32	0	0	504	0	0	64	64	156	0	0	0	0	76	76	345	0	178	0	0	76
6:00	32	0	0	376	0	0	64	64	108	0	0	0	0	76	76	437	0	86	0	0	76
7:00	32	0	0	248	0	0	64	64	60	0	0	0	0	76	76	520	0	3	0	0	76
8:00	32	0	0	120	0	0	64	64	12	0	0	0	0	76	76	523	0	0	0	0	76
9:00	32	0	0	479	0	0	76	76	713	0	81	0	0	76	32	479	0	0	0	0	76
10:00															32	303	0	0	0	0	76
11:00															32	127	0	0	0	0	76
12:00																					
13:00																					
14:00																					
15:00																					
16:00																					
17:00																					
18:00																					

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - SUNRISE HIGHWAY

	Intersection 7: Exit 61							Inter. 8: Wading River Road**							Intersection 9: Wm. Floyd Pky**						
	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3	Leg 1		Leg 2		Leg 4		Leg 3
Time	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D	A	Q	A	Q	A	Q	D
1:15	76	0	48	0	0	0	76	76	0	3	0	0	0	76	76	0	6	0	0	0	76
1:30	76	23	150	25	0	0	76	76	3	10	0	0	0	76	76	6	20	0	0	0	76
1:45	76	46	242	152	0	0	76	76	12	17	1	0	0	76	76	22	32	4	0	0	76
2:00	76	69	214	371	0	0	76	76	27	15	3	0	0	76	76	45	28	13	0	0	76
2:15	76	92	105	562	0	0	76	76	42	7	3	0	0	76	76	68	14	18	0	0	76
2:30	76	115	30	644	0	0	76	76	51	2	1	0	0	76	76	91	4	9	0	0	76
2:45	76	138	5	651	0	0	76	76	54	0	0	0	0	76	76	102	1	2	0	0	76
3:00	76	161	5	634	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
3:15	76	184	5	611	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
3:30	76	207	0	587	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
3:45	76	230	0	564	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
4:00	76	253	0	541	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
4:15	76	276	0	518	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
4:30	76	200	0	495	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
4:45	76	322	0	472	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
5:00	76	345	0	449	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
6:00	76	437	0	357	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
7:00	76	529	0	265	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
8:00	76	621	0	173	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
9:00	76	713	0	81	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
10:00	76	792	0	2	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
11:00	76	794	0	0	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
12:00	32	745	0	0	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
13:00	32	569	0	0	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
14:00	32	393	0	0	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
15:00	0	168	0	0	0	0	76	76	54	0	0	0	0	76	76	105	0	0	0	0	76
16:00															0	23	0	0	0	0	23
17:00																					
18:00																					

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - SUNRISE HIGHWAY

Time	Intersection 10: Rt. 101 Area						
	Leg 1		Leg 2		Leg 4		Leg 3
	A	Q	A	Q	A	Q	D
1:15	76	0	6	0	13	0	76
1:30	76	15	18	1	39	3	76
1:45	76	49	29	8	63	19	76
2:00	76	92	25	21	56	55	76
2:15	76	137	12	27	27	85	76
2:30	76	181	4	22	8	85	76
2:45	76	222	1	14	1	64	76
3:00	76	258	0	0	0	44	76
3:15	76	279	0	0	0	23	76
3:30	76	301	0	0	0	2	76
3:45	76	303	0	0	0	0	76
4:00	76	303	0	0	0	0	76
4:15	76	303	0	0	0	0	76
4:30	76	303	0	0	0	0	76
4:45	76	303	0	0	0	0	76
5:00	76	303	0	0	0	0	76
6:00	76	303	0	0	0	0	76
7:00	76	303	0	0	0	0	76
8:00	76	303	0	0	0	0	76
9:00	76	303	0	0	0	0	76
10:00	76	303	0	0	0	0	76
11:00	76	303	0	0	0	0	76
12:00	76	303	0	0	0	0	76
13:00	76	303	0	0	0	0	76
14:00	76	303	0	0	0	0	76
15:00	76	303	0	0	0	0	76
16:00	23	303	0	0	0	0	76
17:00	0	22	0	0	0	0	22
18:00							
19:00							
20:00							
21:00							
22:00							

Time	Intertersection 11: Rt. 97 Area						
	Leg 1		Leg 2		Leg 4		Leg 3
	A	Q	A	Q	A	Q	D
1:15	76	0	15	0	0	0	64
1:30	76	24	47	3	0	0	64
1:45	76	64	75	22	0	0	64
2:00	76	108	66	65	0	0	64
2:15	76	152	32	99	0	0	64
2:30	76	196	9	99	0	0	64
2:45	76	240	1	76	0	0	64
3:00	76	276	1	52	0	0	64
3:15	76	312	0	28	0	0	64
3:30	76	349	0	4	0	0	64
3:45	76	365	0	0	0	0	64
4:00	76	377	0	0	0	0	64
4:15	76	389	0	0	0	0	64
4:30	76	401	0	0	0	0	64
4:45	76	413	0	0	0	0	64
5:00	76	425	0	0	0	0	64
6:00	76	473	0	0	0	0	64
7:00	76	521	0	0	0	0	64
8:00	76	569	0	0	0	0	64
9:00	76	617	0	0	0	0	64
10:00	76	665	0	0	0	0	64
11:00	76	713	0	0	0	0	64
12:00	76	761	0	0	0	0	64
13:00	76	809	0	0	0	0	64
14:00	76	857	0	0	0	0	64
15:00	76	905	0	0	0	0	64
16:00	76	953	0	0	0	0	64
17:00	22	1001	0	0	0	0	64
18:00	0	767	0	0	0	0	64
19:00	0	511	0	0	0	0	64
20:00	0	255	0	0	0	0	64
21:00							
22:00							

Time	Intersection 12: Rt. 93 Area						
	Leg 1		Leg 2		Leg 4		Leg 3
	A	Q	A	Q	A	Q	D
1:15	64	0	12	0	12	0	64
1:30	64	17	36	3	36	3	64
1:45	64	52	58	21	58	21	64
2:00	64	95	51	58	51	58	64
2:15	64	138	25	88	25	88	64
2:30	64	181	7	92	7	92	64
2:45	64	230	1	75	1	75	64
3:00	64	270	0	56	0	56	64
3:15	64	308	0	37	0	37	64
3:30	64	342	0	20	0	20	64
3:45	64	367	0	8	0	8	64
4:00	64	380	0	2	0	2	64
4:15	64	384	0	0	0	0	64
4:30	64	384	0	0	0	0	64
4:45	64	384	0	0	0	0	64
5:00	64	384	0	0	0	0	64
6:00	64	384	0	0	0	0	64
7:00	64	384	0	0	0	0	64
8:00	64	384	0	0	0	0	64
9:00	64	384	0	0	0	0	64
10:00	64	384	0	0	0	0	64
11:00	64	384	0	0	0	0	64
12:00	64	384	0	0	0	0	64
13:00	64	384	0	0	0	0	64
14:00	64	384	0	0	0	0	64
15:00	64	384	0	0	0	0	64
16:00	64	384	0	0	0	0	64
17:00	64	384	0	0	0	0	64
18:00	64	384	0	0	0	0	64
19:00	64	384	0	0	0	0	64
20:00	64	384	0	0	0	0	64
21:00	0	383	0	0	0	0	64
22:00	0	127	0	0	0	0	64

THROUGHPUT AT INDICATED INTERSECTION - SUMMER - SUNRISE HIGHWAY

	Intersection 13: Rt. 85						
	Leg 1		Leg 2		Leg 4		Leg 3
Time	A	Q	A	Q	A	Q	D
1:15	64	0	104	0	0	0	96
1:30	64	0	322	72	0	0	96
1:45	64	0	519	362	0	0	96
2:00	64	0	458	849	0	0	96
2:15	64	0	224	1275	0	0	96
2:30	64	0	64	1467	0	0	96
2:45	64	0	9	1499	0	0	96
3:00	64	0	0	1478	0	0	96
3:15	64	0	0	1446	0	0	96
3:30	64	0	0	1414	0	0	96
3:45	64	0	0	1382	0	0	96
4:00	64	0	0	1350	0	0	96
4:15	64	0	0	1318	0	0	96
4:30	64	0	0	1286	0	0	96
4:45	64	0	0	1254	0	0	96
5:00	64	0	0	1222	0	0	96
6:00	64	0	0	1094	0	0	96
7:00	64	0	0	966	0	0	96
8:00	64	0	0	838	0	0	96
9:00	64	0	0	710	0	0	96
10:00	64	0	0	582	0	0	96
11:00	64	0	0	454	0	0	96
12:00	64	0	0	326	0	0	96
13:00	64	0	0	198	0	0	96
14:00	64	0	0	70	0	0	96
15:00							
16:00							
17:00							
18:00							

INSTITUTE
OF
TRANSPORTATION ENGINEERS

TRANSPORTATION AND TRAFFIC ENGINEERING HANDBOOK

SECOND EDITION

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lishment of load limits. Consideration must be given to the availability of alternative routes, the condition of pavements and structures on those routes, the economic loss resulting from additional travel distances, and other factors.

Many jurisdictions prohibit all trucks on streets designated as "parkways" or "boulevards." Such restrictions are generally based on the concept that large, heavy vehicles create excessive noise and interfere with the pleasure of driving on facilities that have been designed with special emphasis on visual aspects of the roadway and adjacent lands. When such restrictions are adopted, provisions must be made for parallel arterial street facilities which can be used by all classes of vehicles.

Restrictions on truck loading and unloading during peak traffic hours are limited in use to a few large cities with significant congestion. When such restrictions are under consideration, studies should be made to determine:

1. The number of truck loading and unloading operations which take place at various hours of the day in the area under study.
2. The effect of such operations on street capacity, congestion, and accidents.
3. The operating hours of business firms and other facilities served by truck loading and unloading operations.
4. The impact of truck loading restrictions on the cost of operations of delivery firms.

Provision of off-street loading space for loading and unloading operations is a more desirable method of alleviating street traffic problems related to truck operations than special traffic regulations.

When trucks are prohibited in certain areas, a "truck route" can be designated to guide commercial vehicles to the best route around such restrictions. Although such designations are not a traffic regulation, the installation of signs identifying special routes for trucks should be done only after study to make certain that the routing is suitable for safe usage by large commercial vehicles.

Speed regulations

Speed regulations and speed limits are intended to supplement motorists' judgment in determining speeds that are reasonable and proper for particular weather and roadway conditions. Speed limits are imposed in order to promote better traffic flow and reduce accidents. However, if drivers do not consider speed regulations to be reasonable, the limits will be disobeyed and lose much of their value. In recent years, much public attention has been given to the use of lower speed limits on highways designed for high-speed driving as a means of conserving fuel.

Factors affecting speed regulations

Public attitude. Transportation officials receive many requests for establishing new speed regulations or for altering the value of existing limits. Such requests often reflect the opinion that something is wrong with a particular section of street highway or with the operation of traffic thereon. A request for a revised speed limit, usually lower than the limit posted, is sometimes the only immediate solution that the public can offer. Such requests often are based on the misconception that almost all motorists will automatically exceed the posted limit by 5 or 10 mph and that the only way to reduce speeds is to reduce the speed limit. Citizens, acting as individuals or in groups, will frequently request lower speed limits for their own neighborhood streets than they, as drivers, would consider reasonable in similar neighborhoods elsewhere.

Public reaction to the imposition of speed limits varies. In 1971, West Germany proposed the imposition of a 100-km/h (62-mph) speed limit on two-lane rural roads where previously no speed limit had been posted. The purpose was to reduce West Germany's high accident rate. The general public reaction was one of anger.[14] In other instances, speed limits have been welcomed. In 1973, the United States adopted a national law requiring that no speed limit could be in excess of 55 mph. This law has been controversial and a high level of enforcement action has been initiated in many states to obtain obedience to the limit.

Accident frequency and severity as related to speed. Various safety campaigns have attempted to persuade motorists that speed is the cause of many accidents, and that if speed can be controlled, accidents will be prevented or reduced. Although excessive speed is often listed in police accident reports as the cause or major contributing factor in accidents, the problem can be better described as driving too fast for prevailing conditions.

Statistics have generally shown that the imposition of speed limits will lead to a reduction in the serious injury rate in urban areas and in the overall accident rate on a specific highway section.

Figure 26.1, taken from a study made by the Federal Highway Administration, reveals some interesting findings regarding accident involvement and speed on main rural highways, not including freeways. Accident-involvement rates are the highest at very low speeds, are lowest at about the average speeds, and increase again at very high speeds. A principal conclusion is that the more a driver deviates from the average speed of traffic, the greater is his or her chance of being involved in an accident.

Effect of environment on speeds. Although much information directed at the driver involves use of the term "safe speed," the term is relative and depends on many conditions and the situation involved. A safe speed in one location may not be safe in another, and a safe speed at a specific time at one location may not be safe under other conditions at the same location.

Roadway type and condition. Higher speeds are relatively safer on roadways with high design standards—wide lanes, absence of sharp curves, adequate sight distance, and clear roadsides—conditions such as exist on freeways. Average speeds for various kinds of vehicles by highway type

[14] A. Siegert, "Speed Limit Irks Germans," *Chicago Tribune*, Oct. 11, 1971, Sec. 1-A, p. 3.

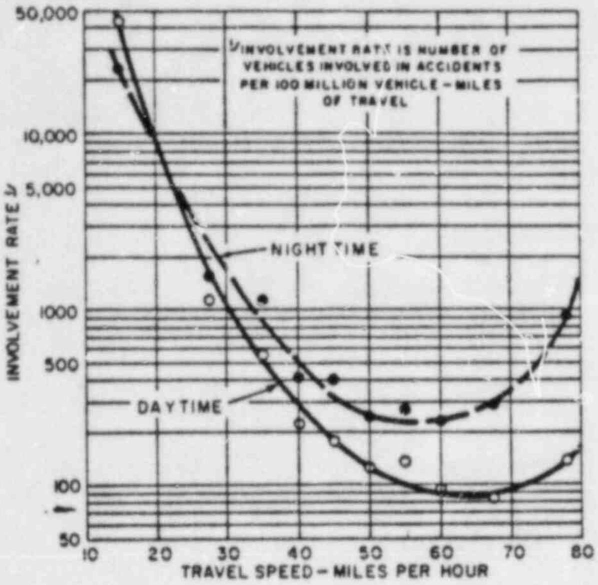


Figure 26.1. Involvement rate by travel speed, day and night. SOURCE: D. Solomon, *Accidents on Main Rural Highways Related to Speed, Driver, and Vehicle*, U.S. Department of Commerce, Bureau of Public Roads, Washington, D.C.: U.S. Government Printing Office, 1964, p. 1.

in the United States are shown in Table 26-5. Roadway surface conditions are also a significant factor affecting safe speed, especially surface characteristics that make one surface more slippery than another when wet.

Adjacent land use and access. Safe driving speeds are also affected significantly by intersecting streets and driveways. Speeds on urban streets tend to be much lower than on rural highways because of houses, businesses, and other kinds of development and increased traffic friction.

Weather conditions. Weather is also an important factor affecting safe speed. The most significant condition is the presence of snow and ice on the pavement. Rain and fog appear to have less influence. Data obtained at selected sites on California freeways and expressways in both day and night conditions indicate that the effects of fog on traffic flow are not large, mean speeds being reduced only 5 to 8 mph.[15] In extremely dense fogs, of course, traffic may be slowed to crawl speeds. Even heavy rain does not appear to have the same influence because sight distance is not greatly reduced.

TABLE 26–5
Average Speeds of Free-Moving Vehicles, and Percent Exceeding Various Speeds by Type of Highway

Highway System	Average Speed All Vehicles (mph)			Percent of Vehicles Exceeding								
				55 mph			60 mph			65 mph		
	1973	1974	1975	1973	1974	1975	1973	1974	1975	1973	1974	1975
Rural Interstate	65.0	57.6	57.6	89	65	68	72	29	27	50	9	7
Rural Primary	57.1	53.5	54.6	58	40	47	36	14	17	19	4	5
Main Rural*	60.3	55.3	55.8	70	51	55	50	21	21	31	6	6
Rural Secondary	52.6	49.5	51.7	39	24	33	21	8	12	10	3	3
Urban Interstate	57.0	53.1	54.7	58	35	48	33	10	13	16	2	3
Urban Primary	41.8	42.5	42.6	13	10	11	5	3	3	2	1	1

*Rural Interstate and Rural Primary

SOURCE: "Ramifications of the 55 mph Speed Limit," Institute of Transportation Engineers, 1977.

Establishment of speed limits

The Uniform Vehicle Code[16] contains the following provision:

> Whenever the (State Highway Commission) shall determine upon the basis of an engineering and traffic investigation that any maximum speed herein before set forth is greater or less than is reasonable or safe under the conditions found to exist at any intersection or other place or upon any part of the (State) highway system, said (Commission) may determine and declare a reasonable and safe maximum limit thereat, which shall be effective when appropriate signs giving notice thereof are erected.

Most jurisdictions use similar legislation to permit state or local officials to establish speed regulations at specific locations. This is usually done on the basis of a traffic engineering investigation, and the revision usually takes the form of modifying the basic speed limits set by law or ordinance. The establishment of the regulations at specific locations is commonly termed speed zoning.

There are two basic types of speed controls: (1) regulatory limits that have the effect of law and are enforceable, and (2) advisory maximum speed indications that are not enforceable but warn motorists of suggested safe speeds for specific conditions at a specific location.

Regulatory controls. Speed regulations may be classified as (1) regulations established by legislative authority and generally applicable throughout the nation, state, or local jurisdiction; and (2) zoned speed regulations for specific locations established by administrative action on the basis of engineering studies.

There are two basically different types of numerical maximum speed limits: (1) an absolute limit, and (2) a prima facie limit. An *absolute* speed limit is a limit above which it is unlawful to drive regardless of roadway conditions, the amount of traffic, or other influencing factors. A *prima facie* speed is a limit above which drivers are presumed to be driving unlawfully but where, if charged with a violation, they may contend that their speed was safe for conditions existing on the roadway at that time and, therefore, that they are not guilty of a speed violation. Enforcement officials prefer the absolute limit because it is much easier to prove guilt in a court of law.

Advisory controls. Advisory speed signs warn motorists of suggested safe speeds for specific conditions on a highway. They may be posted in the form of advisory speed plates generally used as a supplementary panel with a warning sign. In some court jurisdictions, driving above the

[15] *Highway Fog*, National Cooperative Highway Research Program Report 95, Highway Research Board, Washington, D.C., 1970, p. 3.

[16] *Uniform Vehicle Code*, rev. 1968, National Committee on Uniform Traffic Laws and Ordinances, p. 156.

TABLE 26-6
Check Sheet for Speed Zones*

	Highway Conditions (Three or More Must Be Satisfied)			
Design Speed (mph)	Minimum Length of Zone Equals or Exceeds (mi)	Average Distance between Intersections Equals or Exceeds (ft)	Number of Roadside Businesses Does Not Exceed (per mi)	Preliminary Estimate of Maximum Speed (mph)
20	0.2	No min.	No max.	20
30	0.2	No min.	No max.	30
40	0.3	125	8	40
50	0.5	250	6	50
60	0.5	500	4	60
70	—	1000	1	70

Speed Characteristics (Two or More Must Be Satisfied)			
85th Percentile Speed (mph)	Limits of 10-mph Pace (mph)	Average Test Run Speed Equals or Exceeds (mph)	Maximum Proposed Speed Limit (mph)
Under 22.5	Under 25	17.5	20
22.5–27.5	11–29	22.5	25
27.5–32.5	16–34	27.5	30
32.5–37.5	21–39	32.5	35
37.5–42.5	26–44	37.5	40
42.5–47.5	31–49	42.5	45
47.5–52.5	36–54	47.5	50
52.5–57.5	41–59	52.5	55
57.5–62.5	46–64	57.5	60
62.5–67.5	51–66	62.5	65
67.5 or over	over 55	67.5	70

*1 mi, 1.61 km; 1 ft, 0.305 mi.

SOURCE: ITE, *Traffic Engineering Handbook*, Prentice-Hall, Englewood Cliffs, N.J., 1965, Fig. 14.2.

posted advisory speeds may be admitted as evidence that the driver was operating in a reckless manner.

Speed limit studies. The establishment of speed limits must be based on proper engineering and traffic data. Traffic officials are often called upon to testify in court cases regarding speed limits and they must support their testimonies with data accumulated prior to the establishment of safe speed limits. This information should be of sufficient quantity and of proper quality to justify the value of the speed limit.

The following factors should be considered, and appropriate data gathered, in establishing speed limitations (see Table 26-6):

1. Prevailing vehicle speeds
   a. 85th percentile speed (the speed below which 85% of motorists travel)
   b. Average test run speeds
   c. Speed distribution data
2. Physical features
   a. Design speed
   b. Measurable physical features
      (1) Maximum comfortable speed on curves
      (2) Spacing of intersections
      (3) Number of roadside businesses per mile
   c. Roadway surface characteristics and conditions
      (1) Slipperiness of pavement
      (2) Roughness of pavement
      (3) Presence of transverse dips and bumps
      (4) Presence and condition of shoulders
      (5) Presence and width of median
3. Accident experience
4. Traffic characteristics and control
   a. Traffic volumes
   b. Parking and loading vehicles
   c. Commercial vehicles
   d. Turn movements and control
   e. Traffic signals and other traffic control devices that affect or are affected by vehicle speeds
   f. Vehicle–pedestrian conflicts

In the study of prevailing speeds, observations should be restricted to those vehicles having at least from 6- to 9-s headways from those ahead and making no apparent effort to overtake and pass them. The 85th percentile speed as determined by speed studies is a principal factor to be used in the determination of proper speed limits. A graphical presentation of speed data will usually show that the 85th percentile speed value is the point at which speed values become dispersed. Although collecting speed data is highly satisfactory on streets and highways with moderate to heavy volumes of traffic, it is difficult to do on low-volume roads because of the time consumed in gathering the necessary number of observations. In such cases, trial runs can serve as a satisfactory substitute.

Signing for speed limits. Signing for speed limits should be consistent with the appropriate sections of the latest edition of the *Manual on Uniform Traffic Control*

Devices (used in the United States) or its equivalent in other countries (see Chapter 23).

Signs for speed limits are erected at varying intervals, depending on highway type and general location. In urban areas, speed limit signs are usually erected at intervals not exceeding 0.5 mi (0.8 km) if the speed limit is 40 mph (65 km/h) or less. On freeways and in rural areas, frequency of signing varies considerably, with intervals between signs usually ranging from 1 to 5 mi (1.6 to 8 km).

Determination of advisory speed indications

Two basically different methods are available for determining advisory speed limits on horizontal curves: (1) by trial speed runs with an instrument-equipped vehicle, or (2) by office calculation. Either method is satisfactory, but field runs to check the office calculations are desirable in any event.

The trial-speed-runs method involves using a vehicle equipped with a ball-bank indicator to show the combined effect of the body roll angle, the centrifugal force angle, and the superelevation angle. Safe speeds on curves are indicated by ball-bank readings of 14° for speeds below 20 mph (32 km/h), of 12° for speeds between 20 and 35 mph (56 km/h), and of 10° for speeds of 35 mph (56 km/h) and higher. Also, 10° is safe for 50 mph (80 km/h) and even 60 mph (96 km/h), but for higher speeds a smaller reading should be used.

In using the office method for the determination of advisory speeds, the appropriate speed to be indicated may be calculated from formulas (19.5) or (19.6). Transposing to solve for the speed, these become

$$V = \sqrt{15 R (e + f)} \quad \text{British units}$$

$$V = \sqrt{127 R (e + f)} \quad \text{metric units}$$

where V = maximum speed in mph or km/h

e = superelevation rate in ft/ft or m/m

f = side friction factor

R = curve radius in feet or meters

Safe speeds determined by these methods may need to be modified by other factors. For example, the safe-stopping sight distance around the curve may require a more restrictive speed than the curvature itself. In this case, it would be advisable to post the advisory speed at the lesser speed (see Chapter 19).

Special problems

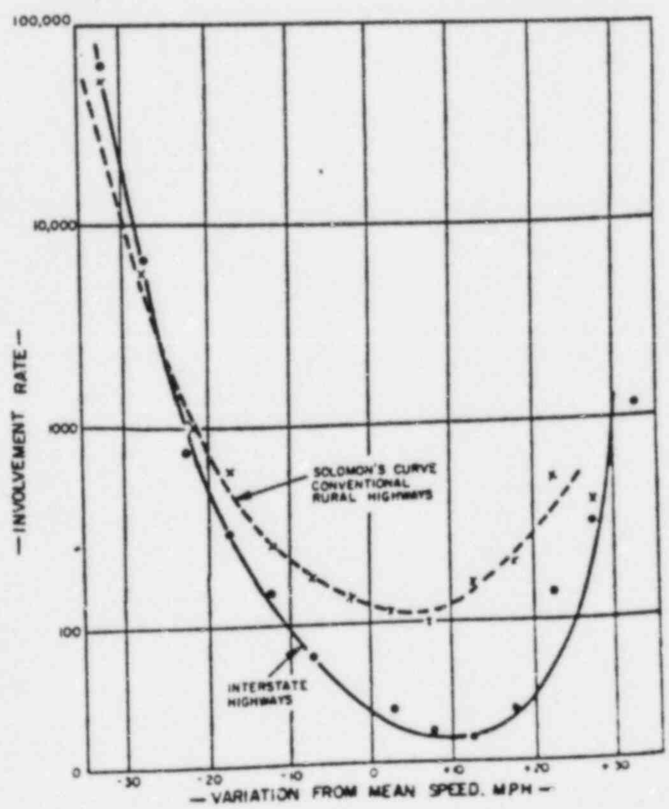
Differential limits by kind of vehicle. Some jurisdictions have laws or follow the practice of posting different speed limits for different kinds of vehicles. Differential limits are most common for (1) passenger cars, (2) trucks, and (3) buses. Some jurisdictions also post a reduced limit for towed vehicles, such as trailers, wrecked vehicles, or race cars. Differential limits are more likely to occur on at-grade rural highways than on freeways and urban streets.

The merits of differential speed limits are subject to debate. Proponents contend that reduced speed is desirable for larger vehicles because their operating characteristics (e.g., stopping distance) are not as good as for passenger cars. Opponents, on the other hand, argue that a differential limit creates variances in speeds and a hazardous condition. Such variances in speed are apparently undesirable, as evidenced by the results of studies by the Federal Highway Administration (see Figure 26.2).

Speed limits for adverse weather conditions. Basic traffic laws usually require drivers to adjust speed to existing road conditions. The primary responsibility for accommodating to adverse weather conditions thus rests with the driver. Nevertheless, some jurisdictions have found it desirable, primarily for safety reasons, to reduce speed limits at specific locations during adverse weather conditions by means of signs capable of displaying various messages. Such practice is generally limited to freeways or expressways.

Variable speed limits by lanes on freeways. In order to improve the quality and safety of traffic flow, the use of different speed limits for various lanes of a highway has been tried, principally on freeways or expressways. Where used, the practice is to post the higher limits on lanes closer to the median during peak traffic periods. One study reports that using changeable speed limit signs during the off-peak

Figure 26.2. Accident involvement rate by variation from mean speed on study units. SOURCE: *Ramifications of the 55 mph Speed Limit*, Committee 4M-2, Institute of Transportation Engineers, Arlington, Va., March 1977.



LILCO, January 16, 1984

CERTIFICATE OF SERVICE

DOCKETED USNRC

'84 JAN 18 A10:58

OFFICE OF SECRETARY DOCKETING & SERVICE BRANCH

In the Matter of
LONG ISLAND LIGHTING COMPANY
(Shoreham Nuclear Power Station, Unit 1)
Docket No. 50-322-OL-3

I hereby certify that copies of LILCO'S MOTION TO ADMIT SUPPLEMENTAL TESTIMONY OF MATTHEW C. CORDARO, JOHN A. WEISMANTLE AND EDWARD B. LIEBERMAN ON PHASE II EMERGENCY PLANNING CONTENTIONS 23.D AND 65 FOR GOOD CAUSE and SUPPLEMENTAL TESTIMONY OF MATTHEW C. CORDARO, JOHN A. WEISMANTLE AND EDWARD B. LIEBERMAN ON BEHALF OF LONG ISLAND LIGHTING COMPANY ON PHASE II EMERGENCY PLANNING CONTENTIONS 23.D AND 65 have been served this date upon all of the following by first-class mail, postage prepaid, or by hand (as indicated by one asterisk), or by Federal Express (as indicated by two asterisk).

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