

5. ESTIMATION OF TRIP GENERATION TIME

Federal Government guidelines (see NUREG 0654, Appendix 4) specify that the planner estimate the distributions of elapsed times associated with mobilization activities undertaken by the public to prepare for the evacuation trip. The elapsed time associated with each activity is represented as a statistical distribution reflecting differences between members of the public. The quantification of these activity-based distributions relies largely on the results of the telephone survey. We define the sum of these distributions of elapsed times as the Trip Generation Time Distribution.

Background

In general, an accident at a nuclear power station is characterized by the following Emergency Action Classification Levels (see Appendix 1 of NUREG 0654 for details):

1. Unusual Event
2. Alert
3. Site Area Emergency
4. General Emergency

At each level, the Federal guidelines specify a set of Actions to be undertaken by the Licensee, and by State and Local offsite authorities. As a Planning Basis, we will adopt a conservative posture, in accord with Federal Regulations, that a rapidly escalating accident will be considered in calculating the Trip Generation Time. We will assume:

- a. The Advisory to Evacuate will be announced coincident with the emergency notification.
- b. Mobilization of the general population will commence up to 10 minutes after the alert notification.
- c. Evacuation Time Estimates (ETE) are measured relative to the Advisory to Evacuate.
- d. Schools will be evacuated prior to the Advisory to Evacuate, if conditions permit.

We emphasize that the adoption of this planning basis is not a representation that these events will occur at WLS within the indicated time frame. Rather, these assumptions are necessary in order to:

- Establish a temporal framework for estimating the Trip Generation distribution in the format recommended in Appendix 4 of NUREG 0654.

- Identify temporal points of reference that uniquely define "Clear Time" and ETE.

It is more likely that a longer time will elapse between the various classes of an emergency at WLS.

For example, suppose one hour will elapse from the siren alert to the Advisory to Evacuate. In this case, it is reasonable to expect some degree of spontaneous evacuation by the public during this one-hour period. As a result, the population within the Emergency Planning Zone (EPZ) will be lower when the Advisory to Evacuate is announced, than at the time of the General Emergency. Thus, the time needed to evacuate the EPZ, after the Advisory to Evacuate will be somewhat less than the estimates presented in this report.

The notification process consists of two events:

- Transmitting information (e.g. using sirens, tone alerts, EAS broadcasts, loud speakers).
- Receiving and correctly interpreting the information that is transmitted.

The peak population within the EPZ approximates 60,000 persons (permanent residents, employees, and transients) who are deployed over an area of approximately 314 square miles and are engaged in a wide variety of activities. It must be anticipated that some time will elapse between the transmission and receipt of the information advising the public of an accident.

The amount of elapsed time will vary from one individual to the next depending on where that person is, what that person is doing, and related factors. Furthermore, some persons who will be directly involved with the evacuation process may be outside the EPZ at the time that the emergency is declared. These people may be commuters, shoppers and other travelers who reside within the EPZ and who will return to join the other household members upon receiving notification of an emergency.

As indicated in NUREG 0654, the estimated elapsed times for the receipt of notification can be expressed as a distribution reflecting the different notification times for different people within, and outside, the EPZ. By using time distributions, it is also possible to distinguish between different population groups and different day-of-week and time-of-day scenarios, so that accurate ETE may be obtained.

For example, people at home or at work within the EPZ will be notified by siren, and/or tone alert and/or radio. Those well outside the EPZ will be notified by telephone, radio, TV and word-of-mouth, with potentially longer time lags. Furthermore, the spatial distribution of the EPZ population will differ with time of day - families will be united in

the evenings, but dispersed during the day. In this respect, weekends will differ from weekdays.

Generally, the information required can be obtained from a telephone survey of EPZ residents. Such a survey was conducted. Appendix F presents the raw survey results. It is important to note that the shape and duration of the evacuation trip mobilization distribution is important at sites where traffic congestion is not expected to cause the evacuation time estimate to extend in time well beyond the trip generation period. The remaining discussion will focus on the application of the trip generation data obtained from the telephone survey to the development of the Lee Nuclear Station ETE.

Fundamental Considerations

The environment leading up to the time that people begin their evacuation trips consists of a sequence of events and activities. Each event (other than the first) occurs at an instant in time and is the outcome of an activity.

Activities are undertaken over a period of time. Activities may be in "series" (i.e. to undertake an activity implies the completion of all preceding events) or may be in parallel (two or more activities may take place over the same period of time). Activities conducted in series are functionally dependent on the completion of prior activities; activities conducted in parallel are functionally independent of one-another. The relevant events associated with the public's preparation for evacuation are:

<u>Event Number</u>	<u>Event Description</u>
1	Notification-accident condition
2	Awareness of accident situation
3	Depart place of work to return home
4	Arrive home
5	Leave to evacuate the area

Associated with each sequence of events are one or more activities, as outlined below:

Table 5-1. Event Sequence for Evacuation Activities

Event Sequence	Activity	Distribution
1 → 2	Public receives notification information	1
2 → 3	Prepare to leave work	2
2,3 → 4	Travel home	3
2,4 → 5	Prepare to leave for evacuation trip	4

These relationships are shown graphically in Figure 5-1.

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

It is seen from Figure 5-1, that the Trip Generation time (i.e. the total elapsed time from Event 1 to Event 5) depends on the scenario and will vary from one household to the next. Furthermore, Event 5 depends, in a complicated way, on the time distributions of all activities preceding that event. That is, to estimate the time distribution of Event 5, we must obtain estimates of the time distributions of all preceding events.

Estimated Time Distributions of Activities Preceding Event 5

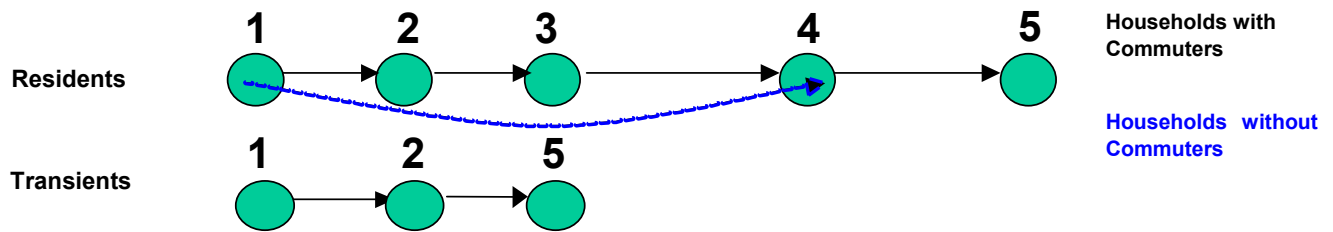
The time distribution of an event is obtained by "summing" the time distributions of all prior contributing activities. (This "summing" process is quite different than an algebraic sum since we are operating on distributions – not scalar numbers).

Time Distribution No. 1, Notification Process: Activity 1 → 2

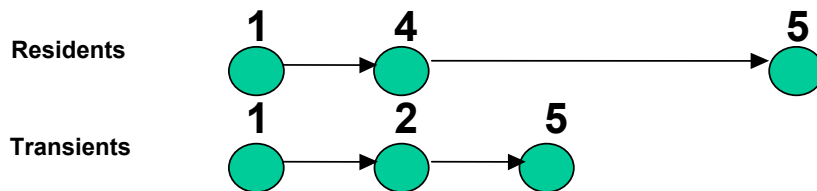
It is reasonable to expect that 85 percent of those within the EPZ will be aware of the accident within 30 minutes with the remainder notified within the following 20 minutes. The notification distribution is given below:

Table 5-2. Time Distribution for Notifying the Public

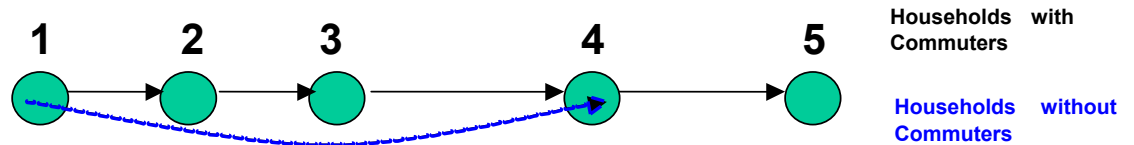
Elapsed Time (Minutes)	Percent of Population Notified
0	0
5	7
10	13
15	26
20	46
25	65
30	85
35	90
40	95
45	98
50	100



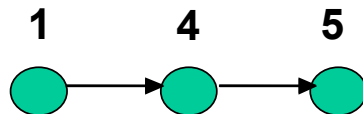
(a) Accident occurs during midweek, at midday; summer season



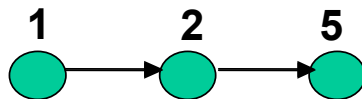
(b) Accident occurs during weekend, at midday; summer season



(c) Accident occurs during midweek, at midday; non-summer season



(d) Accident occurs in the evening; non-summer season



(e) Employees who live outside the EPZ

1 Notification
2 Prepare to Leave Activity
3 Travel Home
4 Prepare to Leave Home
5 Begin Evacuation Trip

Increasing Time

Event
Activity

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

Distribution No. 2, Prepare to Leave Work: Activity 2 → 3

It is reasonable to expect that the vast majority of business enterprises within the EPZ will elect to shut down following notification and most employees would leave work quickly. Commuters, who work outside the EPZ could, in all probability, also leave quickly since facilities outside the EPZ would remain open and other personnel would remain. Personnel or farmers responsible for equipment would require additional time to secure their facility. The distribution of Activity 2 → 3 reflects data obtained by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

Table 5-3. Time Distribution for Employees to Leave Work

Elapsed Time (Minutes)	Cumulative Percent Employees Leaving Work
0	0
5	20
10	32
15	46
20	56
25	67
30	77
35	80
40	83
45	86
50	88
55	91
60	94
65	95
70	96
75	97
80	98
85	99
90	100

NOTE: The survey data was normalized to distribute the "Don't know" response

Distribution No. 3, Travel Home: Activity 3 → 4

These data are provided directly by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

Table 5-4. Time Distribution for Commuters to Return Home

Elapsed Time (Minutes)	Cumulative Percent Returning Home
0	0
5	15
10	37
15	58
20	68
25	75
30	80
35	84
40	88
45	93
50	95
55	96
60	97
65	98
70	99
75	100

NOTE: The survey data was normalized to distribute the "Don't know" response

Distribution No. 4, Prepare to Leave Home: Activity 2,4 → 5

These data are provided directly by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

Table 5-5. Time Distribution of Population Ready to Evacuate

Elapsed Time (Minutes)	Cumulative Percent Ready to Evacuate
0	0
5	11
10	22
15	33
20	44
25	54
30	62
35	67
40	70
45	74
50	77
55	79
60	82
65	85
70	87
75	88
80	89
85	90
90	91
95	92
100	93
105	94
110	95
115	96
120	97
125	98
130	99
135	100

NOTE: The survey data was normalized to distribute the "Don't know" response

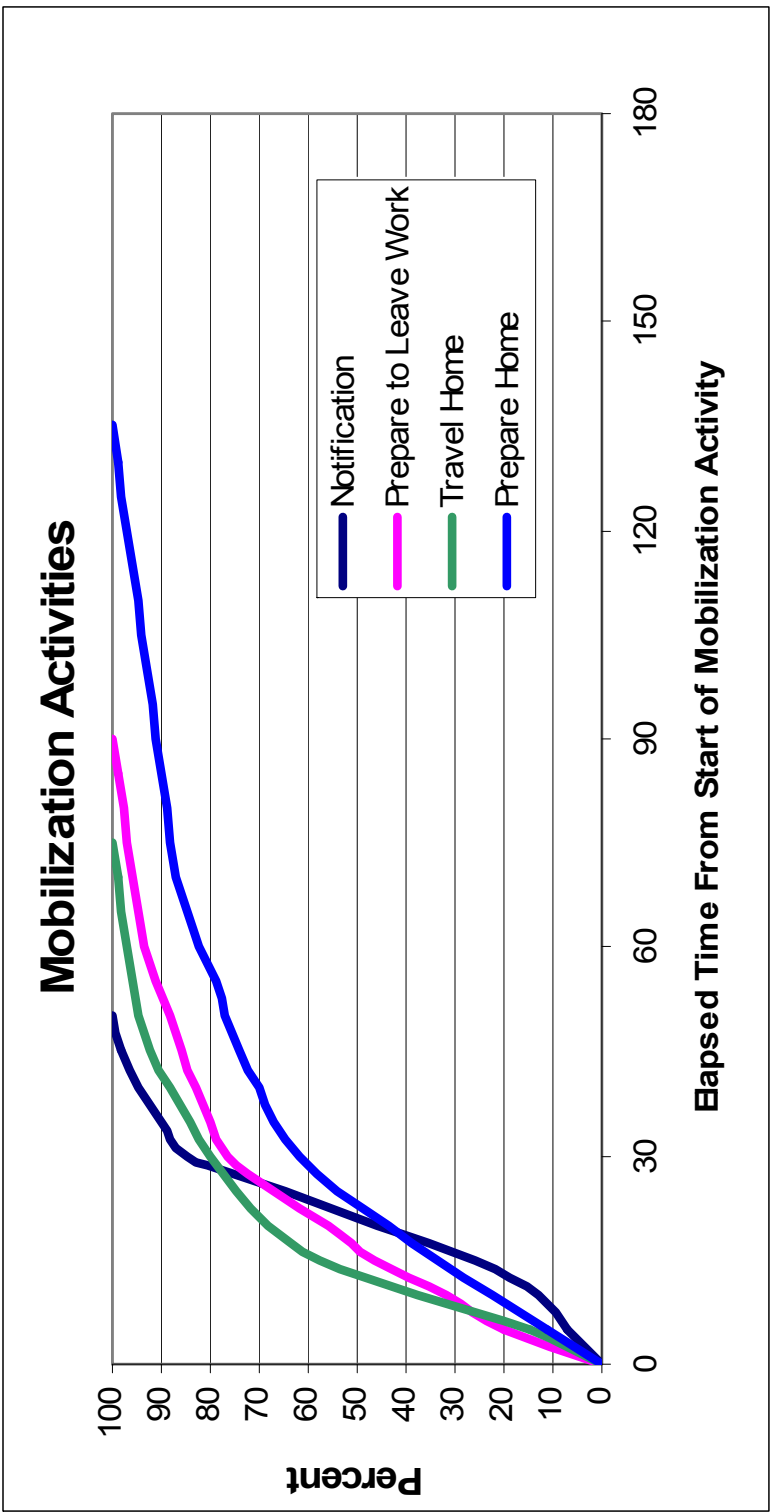


Figure 5-2. Evacuation Mobilization Activities

Calculation of Trip Generation Time Distribution

The time distributions for each of the mobilization activities presented herein must be combined to form the appropriate Trip Generation Distributions. We assume that the stated events take place in sequence such that all preceding events must be completed before the current event can occur. For example, if a household awaits the return of a commuter, the work-to-home trip (Activity 3 → 4) must precede Activity 4 → 5.

To calculate the time distribution of an event that is dependent on two sequential activities, it is necessary to “sum” the distributions associated with these prior activities. The distribution summing algorithm is applied repeatedly as shown to form the required distribution. As an outcome of this procedure, new time distributions are formed; we assign “letter” designations to these intermediate distributions to describe the procedure.

Table 5-6. Mapping Distributions to Events

Apply “Summing” Algorithm To:		
Distributions 1 and 2	To Obtain Distribution A	That defines Event 3
Distributions A and 3	To Obtain Distribution B	That defines Event 4
Distributions B and 4	To Obtain Distribution C	That defines Event 5
Distributions 1 and 4	To Obtain Distribution D	That defines Event 5

Table 5-7. Description of the Distributions

Distribution	Description
A	Time distribution of commuters departing place of work (Event 3). Also applies to employees who work within the EPZ who live outside, and to Transients within the EPZ.
B	Time distribution of commuters arriving home.
C	Time distribution of residents with commuters leaving home to begin the evacuation trip.
D	Time distribution of residents without commuters returning home to begin the evacuation trip.

Figure 5-3 presents the combined trip generation distributions designated A, C, and D. These distributions are presented on the same time scale. The PC-DYNEV simulation model is designed to accept varying rates of vehicle trip generation for each origin centroid, expressed in the form of histograms.

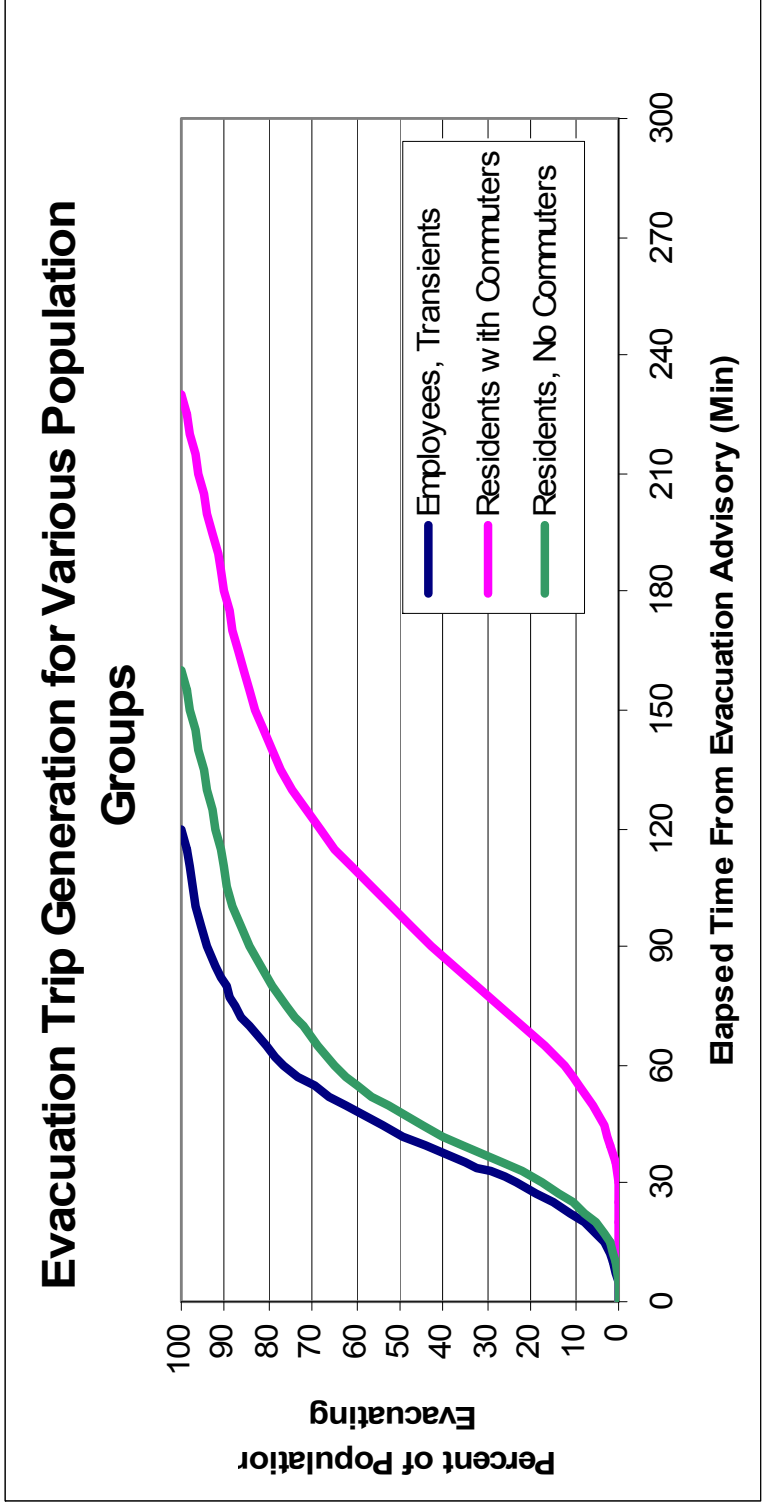


Figure 5-3. Comparison of Trip Generation Distributions

Table 5-8. Trip Generation for the EPZ Population					
Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period			
		Residents With Commuters (Distribution C)	Residents Without Commuters (Distribution D)	Employees (Distribution A)	Transients (Distribution A)
1	15	0	2	3	3
2	15	0	15	20	20
3	30	12	48	53	53
4	30	30	20	18	18
5	30	26	8	6	6
6	30	15	6	0	0
7	30	7	1	0	0
8	30	6	0	0	0
9	30	4	0	0	0
10	600	0	0	0	0