A

FEASIBILITY REPORT

on Evacuation

of the

Area around the

HADDAM NECK

NUCLEAR POWER STATION

Prepared By

STORCH ENGINEERS

161 Main Street

Wethersfield, Connecticut 06109

and

NORTHEAST UTILITIES SERVICE COMPANY

for

Connecticut Yankee Atomic Power Company

P.O. Box 270

Hartford, Connecticut 06101

March, 1980

A

FEASIBILITY REPORT

on Evacuation

of the

Area around the

HADDAM NECK

NUCLEAR POWER STATION

Prepared By

STORCH ENGINEERS

161 Main Street

Wethersfield, Connecticut 06109

and

NORTHEAST UTILITIES SERVICE COMPANY

for

Connecticut Yankee Atomic Power Company

P.O. Box 270

Hartford, Connecticut 06101

March, 1980

ACKNOWLEDGMENT

This report was prepared by by Lionel M. Rodgers, P.E., Director, Transportation Engineering and Barry M. Pell, P.E., Senior Engineer of Storch Engineers. Mr. Edward J. Molloy of Northeast Utilities Service Company (NUSCO) prepared the Notification Time portion of Section II, "Methodology and Assumptions" and "Public Authority Notification Time" and "Public Notification Time Analysis" of Section III, "Zone by Zone Analyses".

The input and review of the Connecticut Department of Transportation (ConnDOT), Connecticut State Police and Office of Civil Preparedness of the State of Connecticut provided a valuable resource base without which the time frame to complete this report would have been extended considerably.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

FIGURES

TABLES

APPENDIX

I. INTRODUCTION

General

On December 10, 1979, Northeast Utilities received a letter from the United States Nuclear Regulatory Commission (USNRC) Office of Nuclear Reactor Regulation requesting information on times required both to notify people and evacuate them (inclusive of special groups; i.e., schools, recreational areas, hospitals, etc) from the following areas during normal and adverse weather conditions:

Distance	Area
0-2 Miles	Two 180° Sectors
0-5 Miles	Four 90° Sectors
0-10 Miles	Four 90° Sectors

In order to accomplish this task by the specified date of January 31, 1980, Northeast Utilities Service Company (NUSCO) retained the services of the Consulting Engineering Firm of Storch Engineers of Wethersfield, Connecticut.

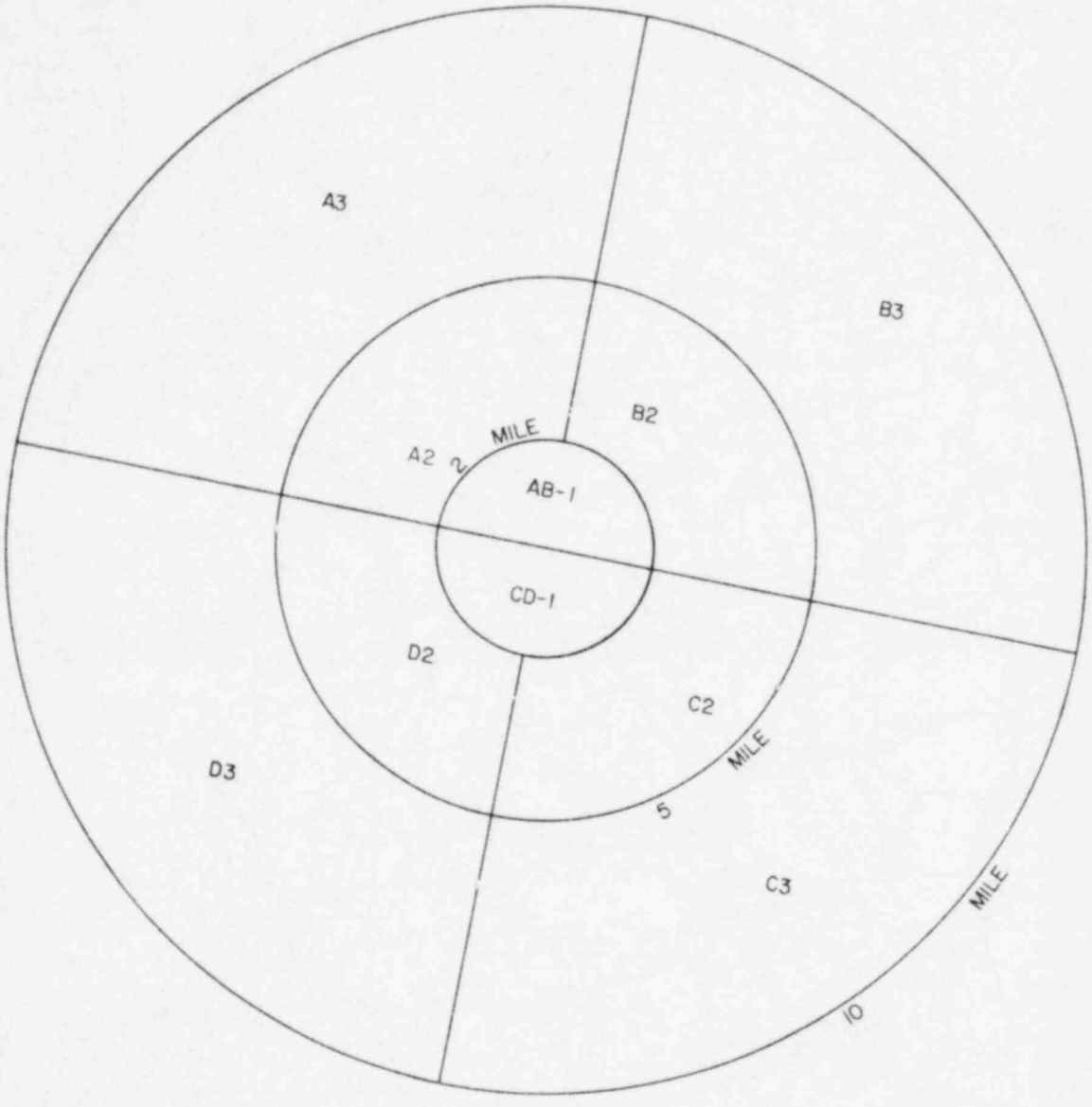
It was felt that a time frame in excess of that permitted by the January 31st deadline was justified, and accordingly, a time extension was requested.

While an even greater time could result in refinement of the evacuation times, it was felt that the use of worst case conditions, giving times longer than those which could be realistically expected, would develop a usable study within the allowed time frame.

In the course of developing the evacuation times, meetings were held with administrative heads of all areas in ConnDOT, including the manager of the bus transportation system, with commanding officers of area State Police Troops and with other officials. The purpose of these meetings was to identify evacuation routes, the capacities of such routes, and the availability of

personnel to control the evacuation movements. It is expected that meetings will be held with local officials during the upgrading of the State of Connecticut Radiological Emergency Response Plan (RERP) in mid 1980-1981. No doubt, these meetings should refine the public notification methods and optimize the evacuation routes and procedures for mobilizing resources. It is expected that these planning efforts will result in reduced notification and evacuation times.

Studies such as these generally do not distinguished between the time required for notification, the time required to implement evacuation, and the time required to confirm that an evacuation has taken place. In an effort to distinguish between these components, the current study has employed methods as outlined in Section II to determine the time required to notify public authorities of an evacuation and the time required to implement evacuation. Therefore, in conformance with the USNRC request, this study was undertaken to determine the time estimates for an area within a 10-mile radius of the Haddam Neck Nuclear Power Station as shown in Figure 1. Further, the study also provides an estimate of the time required to notify public authorities prior to actual evacuation. For the purposes of notification and evacuation time estimate analyses, the 10-mile radius study area has been divided into four, 90 degree sectors and further defined by distance from the power station as 0-2 miles, 0-5 miles, and 0-10 miles. For the 2-mile radius area, two, 180 degree zones were considered. Particular attention has been directed to the needs of special facilities such as schools and hospitals. Separate evacuation time estimates have been prepared for good and adverse weather conditions.



HORIZONTAL SCALE IN MILES

NORTHEAST UTILITIES
SERVICE COMPANY

EVACUABILITY STUDY AT
HADDAM NECK NUCLEAR POWER STATION

AREA MAP — SECTOR ANALYSIS

FIGURE NO. 1

Prepared By
STORCH ENGINEERS
161 MAIN STREET - WETHERSFIELD, CONNECTICUT

Scope of Study

For each of the ten defined zones comprising the study area, the following scope of work has been performed:

1. Obtain and review data -- Information was collected from NUSCO including area population densities, previous reports and area mapping.
2. Prepare preliminary evacuation routings -- Evacuation routings, out to a distance of about 8 miles, were obtained from the State of Connecticut RERP. With the use of area mapping provided by NUSCO, additional preliminary routings from 8 to 10 miles were prepared for the Haddam Neck study area.
3. Collect plans and analyze preliminary findings -- Meetings with State of Connecticut officials were conducted to obtain existing mapping, traffic counts and opinions of routing suitability. Furthermore, each routing was reviewed in the field and a tabulation made of items restricting traffic flow.
4. Prepare initial time estimates -- With the use of the preliminary routings and with the knowledge of the physical limiting factors of each, evacuation time estimates were prepared. In addition, based upon information collected from State officials, in coordination with the results of a drill held in the Town of Haddam, estimates were made of the time required to notify all persons in each zone.
5. Hold meetings and coordinate -- Review and comment on the preliminary evacuation routings and initial time estimates were obtained from ConnDOT and the Connecticut State Police.

6. Modify and finalize initial evaluations -- Based upon the review comments, revisions were made in the preliminary routings, additional field reviews were conducted and restrictions were tabulated. The routing plans were finalized and notification and evacuation time estimates were prepared for the final routings.

7. Prepare Report -- All of the data collection and analyses are presented in the following sections of this report. The text describes the methodology developed to calculate the estimates and all assumptions used. The report includes a graphic presentation of routings for each of the ten zones within the 10-mile radius study area.

8. Obtain final written comments -- The report will be reviewed with State and local officials to obtain their comments.

II. METHODOLOGY AND ASSUMPTIONS

Notification Time

It is recognized that a smooth and timely evacuation will in part depend upon the time required to notify the population to evacuate. As stated in the current State of Connecticut RERP, notification of the public will be made by means of town and State vehicles having public address (PA) capability. Based on the available PA vehicles in each town, an analysis was also undertaken to determine the Notification Time.

The following methodology was developed to determine Notification Time. This methodology is largely based on information obtained during a drill conducted at the Haddam Neck Nuclear Station.

$$NT = \frac{(60)\ (\Sigma Mi)}{(Z)\ (V)}$$

where:

NT = Notification Time in minutes for affected zones in the study area

Mi = Square mile area of any town in zone being analyzed

ΣMi = Summation of square miles for towns within the zone being analyzed.

Ni = Number of public notification vehicles in a particular town for each zone studied

Z = The sum of the products of each town's number of vehicles Ni multiplied by the percentage of the zone which that town occupies

$$\left[N_1 \left(\frac{M_1}{\Sigma M_i}\right) + N_2 \left(\frac{M_2}{\Sigma M_i}\right) + \cdots\ N_i \left(\frac{M_i}{\Sigma M_i}\right) \right]$$

Only town vehicles equipped with PA systems are to be considered in this formula. $\left(\frac{Mi}{\Sigma M}\right)$ is a weighting factor which proportions vehicles by the percent of the zone area occupied by a given town. Therefore, the town with the largest area within a given zone would have a greater percentage of its vehicles committed than other towns; conversely, the town with the smallest area within a given zone would have a smaller percentage of its vehicles committed than other towns within a particular zone

V = Number of square miles covered by each public notification vehicle within one hour. This factor was determined as a result of a drill held in the Town of Haddam on November 14, 1979. This factor is equivalent to 1.237 mi^2/hour-vehicle.

The above methodology is extremely conservative in that it entails the following assumptions:

a. Not all of the town's vehicles are committed to notify people within a given zone since some of these vehicles would be necessary for other functions (i.e., law enforcement etc.) as illustrated in the State of Connecticut RERP.

b. Only vehicles within a particular town boundary plus available vehicles from State Police Troops K and F (both troops have jurisdiction within the affected area) are used to notify the public who live within the affected zone. Of course, as a result of mutual agreements among towns (as well as aid available from the other State Police Troops), the number of available public notification vehicles would increase greatly. This would reduce the notification time proportionately.

c. Radio and television notification is not considered, which would also reduce, to a great degree, the notification times.

Evacuation Time

In order to develop the evacuation time estimates, a methodology was formulated based upon currently adopted traffic engineering principles. In addition, the methodology incorporates a set of site data inputs and/or assumptions which reflect the roadway conditions of the particular geographical area surrounding the nuclear power station.

For the purposes of this report, evacuability is defined as the capability of the road system to accommodate the departure of all persons present within a specific area. A circular area 10 miles in radius, with the Haddam Neck Power Station located at the center, was divided into four equal 90 degree sectors identified as Sectors A through D. The sector boundaries were selected so as not to divide concentrations of population. Each sector was divided into three annuli, called zones, covering the area between 0 and 2 mile radius, 2 and 5 mile radius and 5 and 10 mile radius (Figure 1). These zones are numbered consecutively from 1 to 3 with zone 1 being nearest to the plant site (i.e., the 0-2 mile zone). For the circular area with a radius of 2 miles from the power station, the analysis required only two, 180 degree zones; thus, for this distance only, the four, 90 degree zones were aggregated into two, 180 degree zones and identified as Zone AB1 and Zone CD1.

The Evacuation Time is the time required for the available road system to pass the expected number of vehicles evacuating each zone. The methodology used the following data to determine the evacuation time:

1. Evacuation routes and roadway link capacities.
2. Population within each sector to be evacuated.
3. Average car occupancy for each population group.

In addition, the analysis considered specific limitations such as the special requirements and constraints of schools, hospitals, etc. located within a specific zone. While the analysis resulted in a best estimate for evacuation time during normal weather conditions, a second set of calculations was also performed for estimated evacuation times during adverse weather conditions.

Once the above information was determined, the evacuation time for each specified zone was calculated using the following formula:

$$EVT = (Pr/Fr + Pt/Ft + N)(60/C)$$

where:

EVT = Evacuation time, in minutes

Pr = Residential population

Pt = Transient population

N = Number of additional vehicles; i.e. school buses

C = Capacity of roadway in vehicles per hour

60 = Converts the capacity to vehicles per minute

Fr = Average number of people in a car for residents

Ft = Average number of people in a car for transients

Travel time within a zone has not been considered by this formula because it is less than 10 minutes; hence, it is not significant in comparison with the delays resulting from limited capacity of links.

The evacuation time has been calculated with the above formula for each of the two, 180 degree zones within a 2-mile radius and then for each of the four, 90 degree zones considering the 0-5 mile radius and 0-10 mile radius. In the evacuation of the outer zones, it is assumed that the inner adjacent zones are being evacuated simultaneously.

If the evacuation time for any zone is less than 15 minutes, a minimum of 15 minutes will be used. It must be recognized that in the complete absence of any congestion, people will require time to gather their belongings, load their cars and travel out of the evacuation area. A time of 15 minutes is believed to be required for this. Therefore, whenever the calculated time is less than 15 minutes, this minimum will be used.

The discussions below describe the methods used for each step in the determination of the Evacuation Time.

a. Evacuation Routes and Roadway Link Capacities

Evacuation routes, out to a distance of an 8-mile radius, were taken from the State of Connecticut RERP - Figure 402.2-1. Based upon field reconnaissance and review of ConnDOT roadway data and knowledge of the study area's transportation system, evacuation routes from 8 to 10 miles were selected based on their capacity and accessibility for people within the study area. State and federal designated roadways were used in most cases, since these routes incorporate the best design features. Also, they are well posted and provide the greatest capacity, continuity and connection to other major routes leaving the area to be evacuated. Total capacity estimates were the less of the major routes leading from the zone or the sum of the feeder routes within the zone to the major routes. However, capacity estimates were added for the major routes within each zone limit. The Connecticut State Police reviewed and concurred with the route selection.

After the selection of available evacuation routes, the specific characteristics of each roadway were evaluated by segment with consideration of limiting conditions such as pavement width, lateral clearance and grade. For each of these roadway segments, the capacity was calculated. The roadway capacity is defined as the maximum number of vehicles per hour that can be accommodated on a particular street or highway with existing conditions.

The method utilized for determining capacity is described in the subsection of Chapter 10 of the 1965 Highway Capacity Manual entitled "Two Lane Highways" and Chapter 9 entitled "Freeways and Other Expressways". With the exception of Route 9, all roads to be used for evacuation are two-lane

highways. This method assumes the maximum capacity of a two-lane road to be 2,000 vehicles per hour and develops two modifying factors (each having a numerical value of less than one) for use in calculating the estimated capacity of the road in question. The first factor, W_c, is determined from the pavement width and lateral clearance and includes the effect of opposing traffic flows. For this study, lateral clearances and pavement widths for each segment of roadway were obtained from our field investigations and from data in the form of roadway photologs (i.e., pictures of roadway clearances every 100 feet) provided by ConnDOT. The numerical value of factor W_c was then determined by use of Table 10.8 of the 1965 Highway Capacity Manual.

The second factor, T_c, takes into account the effect of truck traffic and is a function of terrain. It was conservatively estimated that trucks will not exceed 10 percent of the total traffic, and this figure has been used. The character of the terrain (rolling or level) is that identified from field investigations or from data of ConnDOT. The numerical value of this factor was determined by using Table 10.9b of the 1965 Highway Capacity Manual.

A listing of the sections of evacuation route roadways of particular interest, their characteristics and W_c and T_c factors are summarized in Table 1. A map which highlights these roads is given in Figure 2.

The capacity obtained by the above procedure for two-lane roadways is an estimate of the number of vehicles which can pass over a segment of road (called a link) in an hour. It is the number of vehicles traveling in one direction plus the number of vehicles traveling in the opposite direction on the same link. This takes into account the fact that the capacity of a two-

TABLE 1

EVACUATION ROUTE CAPACITY

Street	Limits	Side Clear (ft)	Pavement Width (ft)	Terrain	W_c	T_c	Capacity Vehicle Per Hour (vph) 2-Way	Capacity Vehicle Per Hour (vph) 1-Way
Route 149	Route 609-Route 82	1	21	** R	0.76	0.71	1079	755
Route 82	Route 9A-Route 149	0	20	R	0.71	0.71	1008	706
Route 9A	Route 148-Route 81	4	20	R	0.79	0.71	1122	785
Route 9A	Route 81-Route 410	5	20	R	0.80	0.71	1136	795
Route 9A	Route 148-Route 9	2	22	R	0.81	0.71	1150	805
Route 9	Sector Limit-Sector Limit	8	24	R	1.00	0.77	NA	2772
Route 17	Route 155-Sector Limit	3	20	R	0.77	0.71	1093	765
Route 17	Route 147-Sector Limit	3	22	R	0.83	0.71	1179	825
Route 151	Route 196-Sector Limit	3	22	R	0.83	0.71	1179	825
Route 151	Sector Limit-Route 66	0	22	R	0.77	0.71	1093	765
Route 151	Route 609-Route 196	0	24	R	0.88	0.71	1250	875
Route 196	Route 151-Route 16	0	26	R	0.88	0.71	1250	875
*Route 196	Route 16-Route 66	-	--	-	--	--	--	500
Route 16	Route 196-Sector Limit	0	26	R	0.88	0.71	1250	875
Route 16	Sector Limit-Route 149	3	20	R	0.77	0.71	1093	765
Route 16	Route 149-Route 2	0	26	R	0.88	0.71	1250	875
Route 149	Route 151-Route 16	1	20	R	0.73	0.71	1037	726
Route 149	Route 16-Route 2	0	20	R	0.71	0.71	1008	706
Route 66	Route 196-Route 17	3	24	R	0.95	0.71	1349	944
Route 66	Route 17-Route 17A	4	24	R	0.99	0.77	NA	2744
Route 17	Route 66-Sector Limit	2	20	R	0.75	0.71	1065	746
Route 82	Route 149-Route 151	0	20	R	0.71	0.71	1008	706
Route 434	Route 151-Hopyard Road	1	22	R	0.79	0.71	1122	785
Route 434	Hopyard Road-Route 82	0	16	R	0.66	0.71	937	656
Route 82	Route 151-Route 156	1	20	R	0.73	0.71	1037	726
Route 82	Route 156-Sector Limit	2	22	R	0.81	0.71	1150	805
Route 148	Route 9-Sector Limit	1	20	R	0.73	0.71	1037	726
Route 148	Sector Limit-Route 81	2	22	R	0.81	0.71	1150	805

*Local Road Capacity Estimated as 500 vph.

** Rolling Terrain

TABLE 1

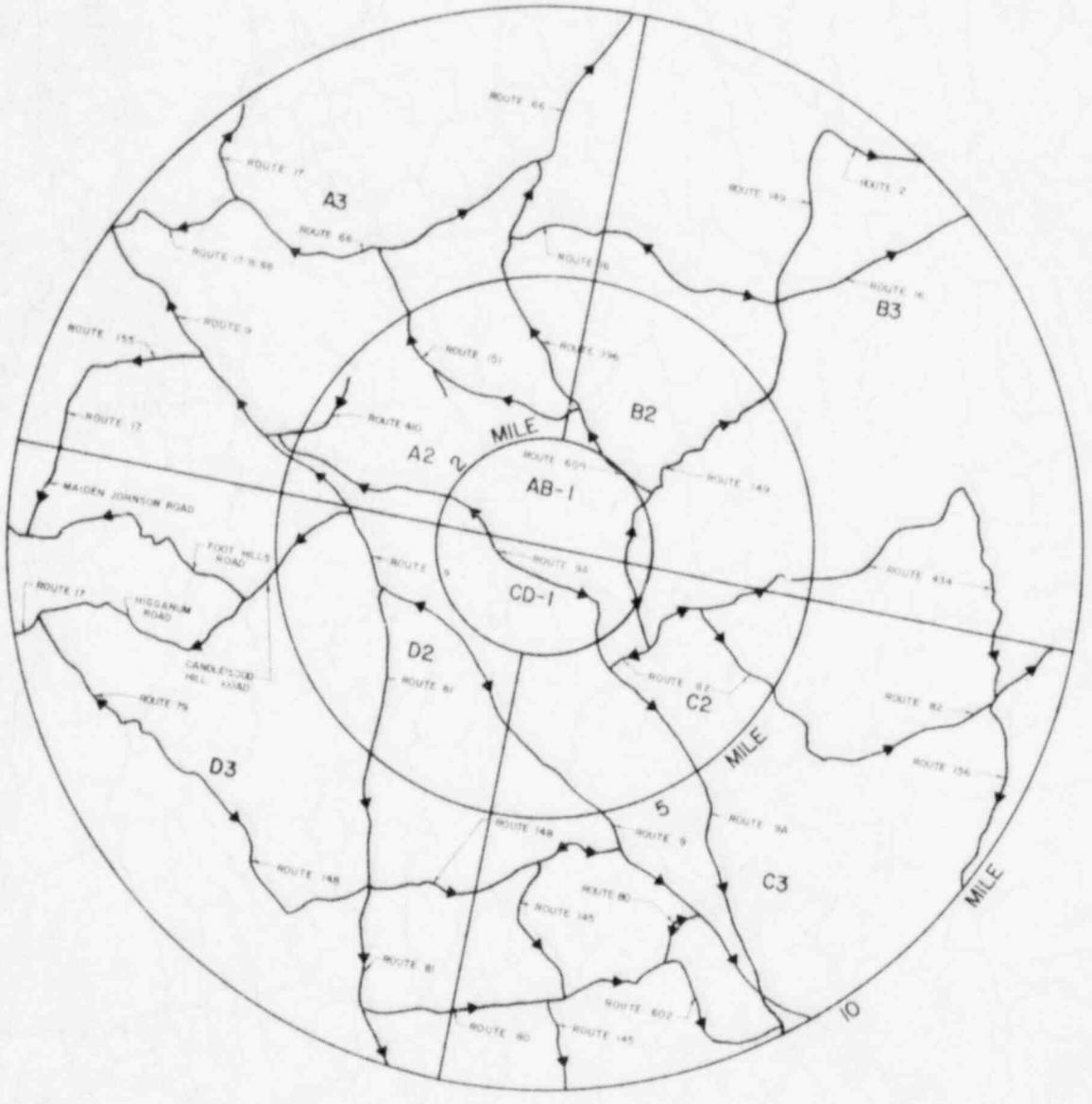
EVACUATION ROUTE CAPACITY

(Continued)

Street	Limits	Side Clear (ft)	Pavement Width (ft)	Terrain	W_c	T_c	Capacity Vehicles Per Hour (vph) 2-Way	Capacity Vehicles Per Hour (vph) 1-Way
Route 148	Route 81-Route 79	1	18	** R	0.68	0.71	956	676
Route 79	Route 148-Route 17	3	24	R	0.95	0.71	1349	944
Higganum/ *Candlewood/Hill Roads	Route 9-Route 17	-	--	-	--	--	--	500
*Maiden/Johnson/ Foothills Roads	Route 17-Candlewood Road	-	--	-	--	--	--	500
Route 17	Route 77-Section Limit	2	24	R	0.93	0.71	1321	925
Route 68	Route 17-Sector Limit	3	22	R	0.83	0.71	1179	825
Route 81	Route 9-Sector Limit	2	20	R	0.75	0.71	1065	746
Route 145	Route 148-Route 80	0	20	R	0.71	0.71	1008	706
Route 145	Route 80-Sector Limit	4	20	R	0.79	0.71	1122	785
Route 80	Route 81-Route 602	3	20	R	0.77	0.71	1093	765
Route 609	Route 149-Route 151	4	22	R	0.85	0.71	1207	845
Route 156	Route 82-Sector Limit	2	20	R	0.75	0.71	1065	746
Route 410	Route 9A-Maromas Road	8	24	R	1.00	0.71	1420	994

*Local Road Capacity Estimated as 500 vph.

** Rolling Terrain



HORIZONTAL SCALE IN MILES

NOTE:
SEE APPENDIX FOR PRINT OF EVACUATION ROUTES AT A SCALE OF 2" = 1 MILE

NORTHEAST UTILITIES SERVICE COMPANY	
EVACUABILITY STUDY AT HADDAM NECK NUCLEAR POWER STATION	
EVACUATION ROUTES	FIGURE NO. 2
Prepared By: STORCH ENGINEERS 161 MAIN STREET - WETHERSFIELD, CONNECTICUT	

lane two-way road is in part a function of the traffic flowing in the opposite direction, since the ability to pass a slower moving vehicle is an important factor for determining the capacity in one direction.

For the purposes of this study, during an evacuation all traffic on a particular roadway segment would necessarily be traveling in the same direction. Nevertheless, it was conservatively estimated that the single directional capacity will be 70 percent of the two-way capacity determined by the Highway Capacity Manual. At a flow rate approaching capacity, the speed of traffic is normally of the order of 20-25 mph on two-lane roads of the type found in the study area.

For the limited access freeway and expressway facilities, capacity is given as 1,800-2,000 vehicles per lane per hour, and the lower figure has been used as the more conservative approach. As with two-lane facilities, downward adjustments have been made for restricted lane width and lateral clearance and for the effect of trucks and terrain. However, no additional adjustment is necessary to account for single direction flow.

In addition to the State Highways and other State maintained roads which comprise the majority of the evacuation facilities, there are locally designated roads and streets which will assist for either direct evacuation or as collectors leading to major routes. For these two-lane roadways, a very conservative figure of 500 vehicles per hour has been used for evacuation capacity.

The capacity figure which is obtained by the above technique is an estimate of the ability of a road link to handle vehicles under normal conditions. It should be recognized that under "forced flow" conditions which occur when vehicles attempting to enter a link exceed its theoretical capacity, the actual number of vehicles moving through a link could be less

than theoretical capacity. Such could be the case at major restrictions to evacuation traffic flow as the river bridges, but it is assumed that adequate police direction will be available to maintain capacity flow through the critical links. In fact, the State of Connecticut RERP has provisions for State and local police control of specific access control points both to aid evacuees and prevent people from entering the affected areas.

Inclement weather may restrict driver visibility and affect speed and vehicle spacing, thus reducing roadway capacity. The extent of the capacity loss can be quite variable and snow and icy pavements can, in the extreme, reduce the capacity of a facility to zero. In such a case as a major snowstorm, emergency response may require alternate protective action if evacuation is unattainable due to impassable roadways. However, consideration and evaluation of average precipitation conditions within the study area, as well as the impact reported by other studies, suggests that a capacity loss of 10 to 20 percent could be anticipated for two-lane roadways and a reduction of 20 to 30 percent would result for freeways and expressways[1]. For this analysis, the more conservative figures were used, namely a reduction in capacity due to inclement weather of 20 percent for two-lane facilities and 30 percent for Route 9.

Catastrophic inclement weather such as major snowfalls or hurricanes, would render certain evacuation routes impassable. In these cases, other protective actions (i.e., notifying people to stay indoors) would be advisable, and no doubt would already be occurring under such conditions.

[1] Transportation and Traffic Engineering Handbook, Institute of Transportation Engineers, 1976.

b. Population To Be Evacuated

Together with the roadway system capacity analysis, the other most important factor affecting evacuation time is the number of persons to be evacuated. In this regard, three separate groups of the population have been identified, namely, residents, transients and school children.

The data used for resident population by annulus zone is given in the 1980 projected population given in Section 108, Figure 2.4 of the State of Connecticut RERP.

The 90 degree wide sectors used in this evacuability study correspond to four of the 22.5 degree wide sectors used in the State of Connecticut RERP from which the resident population was extracted. The boundaries of the sector quadrants were selected by analyzing the combination of consecutive 22.5 degree wide sectors which produced the maximum resident population. The resulting maximum resident population was determined to lie northwest of the nuclear power station with its eastern boundary declined 11.25 degrees east of true north and was established as Sector A. This approach resulted in the "worst case" of maximum population to be evacuated. The remaining three sectors (B, C, and D) were computed based upon the limits established by Sector A.

The transient population consists of workers at their jobs, visitors, and other temporary inhabitants. For the purpose of this study, the predominant transient population groups are employees at industries and other special facilities and the summer population attracted by State and local parks. By evaluation summer population demand, workers and other special groups, the maximum transient population to be evacuated was obtained.

There are three major industries within the study area, with a current total of 4,257 employees. In addition, Middlesex Memorial Hospital, in Zone A3, has a staff of 1,400 persons and an average of 340 patients.

To determine the summer incremental population at recreational areas, attendance figures for State parks and forests were obtained from the State of Connecticut, Department of Environmental Protection, Parks and Recreation Unit. This information was given for total visitors and campers in 1978. By discussions with officials at a number of these facilities, it was determined that 3 percent of annual attendance would be a reasonable, though conservative (high), estimate for peak daily usage.

School populations were determined from the 1979 Connecticut Education Directory of the Connecticut State Department of Education. Current enrollments were used and consideration was not given to design capacity or additional growth since recent demographic trends project smaller families in the future. It was assumed that school locations would remain constant and that the facilities would be capable of handling any increased student populations. It was felt that any alternative approach would be highly speculative.

Based upon the collected and analyzed data, a summary of residential, transient, and school population for each zone is given in Table 2. A detailed breakdown of the affected schools contained within each zone is shown in Table 3. A listing of major employers and recreational facilities is given in Table 4.

To estimate the population to be evacuated for the purpose of this study, an exceptionally conservative methodology was used. It was

TABLE 2

STUDY AREA POPULATION

Zone		Sector A	B	C	D	Total
1(0-2mi)	R	423	881	596	1029	2929
	T	---	---	---	407	407
	S	---	---	---	---	---
2(2-5mi)	R	3119	3144	2040	1606	9909
	T	4317	---	---	1465	5782
	S	332	1098	---	1627	3057
3(5-10mi)	R	34774	3957	13254	7691	59676
	T	1675	7503	10866	3182	23226
	S	6241	---	2388	1566	10195
Total	R	38316	7982	15890	10326	72514
	T	5992	7503	10866	5054	29415
	S	6573	1098	2388	3193	13252

R = Resident T = Transient S = School

TABLE 3

STUDY AREA SCHOOLS

Name of School	Grades	Sector	Zone	Enrollment[2]
Haddam Elementary	K-6	A	2	332
East Hampton Jr. High	7-8	A	3	336
Center	4-6	A	3	428
East Hampton High	9-12	A	3	551
Middle Haddam	PK	A	3	126
Memorial	1-3	A	3	450
Bielefield	K-5	A	3	383
Farm Hill	K-5	A	3	248
Wesley	K-5	A	3	373
Wilson Middle	6-8 & sp.	A	3	714
Wilson High	9-12 & sp.	A	3	799
McDonough	K-5 & sp.	A	3	256
Gildersleeve	K-5	A	3	364
Valleyview	K-5	A	3	298
Portland Jr. High	6-8	A	3	423
Portland High	9-12	A	3	492
East Haddam Elementary	K-6	B	2	617
Nathan Hale Ray High	7-12	B	2	481
Chester Elementary	K-6	C	3	304
Deep River Elementary	K-6	C	3	374
Essex Elementary	K-6	C	3	461
Valley Regional High	9-12	C	3	697
Winthrop Jr. High	7-8	C	3	366
Lyme Consolidated	K-8	C	3	186
Burr District Elementary	K-6	D	2	525
Haddam Killingworth	7-12	D	2	1102
Francis E. Korn Elementary	3-5	D	3	221
Coginchaug Regional High	9-12	D	3	597
Frank Ward Strong	6-8	D	3	281
Killingworth Elementary	K-6	D	3	467

[2] Source: Connecticut State Department of Education
1979 Connecticut Education Directory

TABLE 4

STUDY AREA - MAJOR EMPLOYERS AND RECREATIONAL FACILITIES

Major Employer	Town	Sector	Zone	No. of Employees
Pratt and Whitney	Middletown	A	2	3,600
Russell Manufacturing	Middletown	A	3	275
Middlesex Memorial Hospital	Middletown	A	3	1,400*
UARCO, Inc.	Deep River	C	3	382

Recreational Facility	Sector	Zone	Maximum Daily Visitors
Hurd State Park	A	2	717
Day Pond State Park	B	3	1,043
Devils Hopyard State Park	B	3	4,814
Salmon River State Forest	B	3	1,646
Gillette Castle State Park	C	3	10,484
Chatfield Hollow State Park	D	3	3,182
Haddam Meadows State Park	D	1	407
Cockaponset State Forest	D	2	1,465

*Patients number 340

assumed that, for a given zone, the resident, transient and school populations are all present in the zone simultaneously. This assumption results in a very conservative estimate of zone population. School children are counted in the resident population, and again counted in the school population. Moreover, persons who work or use recreational facilities in the study area are similarly double-counted as both residents and transients. The purpose behind this double-counting of certain groups of people is to assure that evacuation times will provide for any population group which might be in a given area at any time. Account is not taken of the persons who leave the study area for jobs, schools, or any other reason.

The assumption, stated another way, is that all residents are in their homes, and that all transients and school attendees come into the study area from other places. This results in a worst case estimate of population to be evacuated, particularly during adverse weather conditions, when schools are not in session and park use is minimal; and, therefore results in conservatively large traffic volumes and longer evacuation times.

c. Car Occupancy (Load Factor)

The third factor which will determine the total vehicles to be evacuated, and thus the evacuation time, is the average load or number of persons per vehicle. To compute this figure, vehicle registration data was obtained from the State of Connecticut 1978 Assessment Records for each of the individual towns comprising the study area. The resultant average load of 1.82 persons per automobile was determined. Since a

lower load factor would, for the given population, increase vehicular traffic, a load factor of 1.5 was used in calculating traffic due to evacuation of the residential population.

The load factor for the transient population is derived from data shown in the Transportation and Traffic Engineering Handbook, 1976 Edition, of the Institute of Transportation Engineers. Table 5.17 shows the average load factor (called Urban Car Occupancy) for various uses. This factor ranges from a low of 1.1 for work related trips to a high of 2.35 for social or recreational trips. A conservative estimate of 1.5 has been taken for this study.

There will also be personal vehicles at schools belonging to teachers, administrators, and students. These vehicles are assumed to be transporting only the driver.

Assumptions

Innumerable combinations of circumstances are possible during the occurrence of an actual evacuation. Nevertheless, based upon given or collected data and an evaluation of probable events, certain assumptions were incorporated in the development of the preceding formulae and their use in calculating notification and evacuation times. These assumptions are listed below:

1. Only one of the aforementioned sectors is to be evacuated at any one time.
2. Automobiles will continue to be the predominant means of transportation with the exception of the use of school buses to evacuate schools.

3. Future population characteristics such as age distribution, number of cars per family, etc. are not expected to change dramatically. It is recognized that currently discernible trends in demographic data indicate decreases in school age children and in size of families. Therefore, use of this assumption results in conservative estimates.
4. The roadway network is not expected to change, both as to available routes and maintenance.
5. The bus service to the schools will have the same characteristics and number of buses in proportion to students as at present.
6. Traffic controls, such as signals, stop signs, etc. will be removed from service as needed to aid evacuation.
7. It is anticipated that means will be provided to remove disabled vehicles from the roadways and in particular from the bridges used by evacuation traffic.
8. It is expected that sufficient manpower will be available to manage the evacuation routes and to provide access control if the need arises. A reduced evacuation time is possible if, as a result of planning, additional manpower is available to orderly control the flow of vehicles (e.g., setting up control points to allow one-way flows of traffic).

III. ZONE BY ZONE ANALYSES

Each zone will now be discussed in detail. Each will be described, evacuation routes and factors of particular importance considered, and the evacuation and notification times computed.

An important factor affecting all zones is the provision of buses to remove children from schools should schools be in session when notification to evacuate is given. One of the critical aspects of this factor is the need to mobilize bus drivers as well as other emergency workers and have them report to the location where the school buses or other emergency vehicles are garaged. For this study, it has been assumed that all school buses are located at the schools for the computation of evacuation time. Also, mobilization time for other types of emergency workers has not been specifically addressed. As to special facilities which have incapacitated people, the limiting case with the highest staff and patient load within the study area is Middlesex Memorial Hospital in Middletown, Connecticut. The evacuation of this facility is discussed separately in the analysis of Zones A1, A2 and A3.

III.a. PUBLIC AUTHORITY NOTIFICATION TIME

The notification of public authorities by the Haddam Neck Nuclear Power Station is of prime importance. In fact, the Haddam Neck section of the State of Connecticut RERP delineates town agency as well as State agency responsibilities in the notification process. Basically, Haddam Neck Nuclear Power Station is required to notify Connecticut State Police Troop K, who in turn are to notify Connecticut State Police Troop F and the Towns of Colchester, East Haddam, East Hampton, Haddam Neck, Marlborough, Middletown and Portland. Troop F, in turn, is responsible for notifying the Towns of Chester, Deep River, Durham, Haddam, Killingworth and Lyme. In mid 1980-1981, plans will be developed by the State of Connecticut for emergency communications in those towns not listed above but which are within 10 miles of Haddam Neck. It should be pointed out that the communication systems involving the Haddam Neck Nuclear Power Station as well as town and State agencies, rely both on radio and telephone systems.

Although drills have been held which have produced notification time estimates in this communication link, the results of the November 14, 1979 drill in the Town of Haddam will be used as the basis of time estimates in the sector.

In summary, on November 14, 1979, a drill was held in the Town of Haddam. This drill consisted of a State of Connecticut Class B Incident (as per the classification system used in the State of Connecticut RERP) being advised for three zones out to a distance of 4.5 miles from the Haddam Neck Nuclear Power Station.

During the course of the drill, five messages originated from Haddam Neck Nuclear Power Station to the Connecticut State Police who in turn

relayed them to all towns listed above. A log of message origination times and verification times was kept during the drill. It is estimated from the log that it requires approximately 5 to 33 minutes for all affected towns to receive and verify the messages. Since additional towns will be included in the State of Connecticut RERP as indicated above, it is expected that another 10 minutes would be required. Therefore, for purposes of this study, 15 to 43 minutes would be required for each emergency message originating from the plant to be communicated to each town within 10 miles of Haddam Neck. In the course of further development of the State and town RERPs in mid 1980-1981, new or modified methods of communication could reduce this time significantly.

III.b. PUBLIC NOTIFICATION TIME ANALYSIS

Once public authorities have been notified by the Haddam Neck Nuclear Power Station that a State of Connecticut Class A Incident (RERP) is in progress, these public authorities will then be responsible for notifying all residents and transients (at State parks, etc.) to evacuate the affected areas. These authorities will use many types of resources to notify individuals within the affected areas. The main method will consist of announcements and mobile notification by means of town and State vehicles with PA systems as specified in the RERP.

As to confirmation by public authorities that evacuation has actually taken place, the time for its accomplishment is not clearly specified since the methodology (i.e., tieing handkerchiefs on doors, etc.) has not been developed by all towns and cities within 10 miles of Haddam Neck. This information will, no doubt, be provided in the updated State of Connecticut RERP. In general, it may be stated that evacuation could be confirmed by public notification vehicles covering the same area. Therefore, confirmation time may be less than or equal to the time for notification of the public to evacuate.

The methodology used as the basis for determining the Notification Time within zones defined in Part II of this report. This methodology is based on a weighted average of town vehicles available for each zone and the methodology is delineated in Part II. Also described in Part II are the conservative assumptions in this methodology.

In Part IV of this report, a composite of the information in Part III.a. "Notification of Public Authorities" and Part III.b. "Public Notification Time Analysis" will be presented together with the information

contained in Part III.c. "Evacuation Time Analysis". However, Part IV will not provide an addition of notification times from Parts III.a. and b. to the Evacuation Times contained in Part III. c. This latter summary would be erroneous, since it does not consider the fact that the total time to notify the public in outer zones would be simultaneous with the times required by the public to evacuate inner zones.

The following factors were used in the formulae specified in Part II:

1. Summation of Square Miles for Towns within a Specified Zone (Mi)[3]

Zone	Mi	Radius
AB1	6.28 mi^2	2 miles (180°)
CD1	6.28 mi^2	2 miles (180°)
A1, A2	19.63 mi^2	5 miles (90°)
B1, B2	19.63 mi^2	5 miles (90°)
C1, C2	19.63 mi^2	5 miles (90°)
D1, D2	19.63 mi^2	5 miles (90°)
A1, A2, A3	78.53 mi^2	10 miles (90°)
B1, B2, B3	78.53 mi^2	10 miles (90°)
C1, C2, C3	78.53 mi^2	10 miles (90°)
D1, D2, D3	78.53 mi^2	10 miles (90°)

2. Public Address Systems Vehicles Available in Each Town for Public Notification

Town	Vehicles
a. Chester	Fire - 5 Trucks Police - 1 Cruiser Total - 6 Vehicles

[3]Factors of $Mi/\Sigma Mi$ used to calculate Ni were determined from areas illustrated in Figure 402.2-1, Haddam Neck Station, State of Connecticut, RERP.

	Town (Continued)	Vehicles[4]
b.	Colchester	Fire - 5 Trucks Total - 5 Vehicles
c.	Deep River	Fire - 5 Trucks Police - 1 Cruiser Total - 6 Vehicles
d.	Durham	Fire - 4 Trucks Total - 4 Vehicles
e.	East Haddam	Fire - 6 trucks Police - 2 Cruisers Total- 8 Vehicles
f.	East Hampton	Fire - 8 Trucks Police - 4 Curisers Total - 12 Vehicles
g.	Haddam	Resident Trooper/Constables - 2 Cruisers Fire - 6 Trucks Total - 8 Vehicles
h.	Killingworth	Fire - 6 Trucks Police - 1 Cruiser Highway Department - 4 Trucks Total - 11 Vehicles
i.	Lyme	Resident Trooper/Constables - 1 Cruiser Fire - 5 Trucks Total - 6 Vehicles
j.	Marlborough	Resident Trooper/Constables - 1 Cruiser Fire - 4 Trucks Total - 5 Vehicles
k.	Middletown	Fire - 18 Trucks Police - 6 Cruisers Total - 24 Vehicles
l.	Portland	Fire - 8 Trucks Total - 8 Vehicles
m.	Westbrook	Fire - 5 Trucks Police - 2 Cruisers Total - 7 Vehicles

[4]State of Connecticut RERP (Section 500). For towns not included in the RERP, information was either obtained from town agencies (i.e., in the case of Westbrook, Cromwell, Middlefield, Hebron, Guilford, Essex, Madison and Salem).

	Town (Continued)	Vehicles[4]
n.	Cromwell	Fire - 5 Trucks Police - 2 Cruisers Total - 7 Vehicles
o.	Middlefield	Fire - 6 Trucks Police - 2 Cruisers Total - 8 Vehicles
p.	Hebron	Fire - 4 Trucks Police - 2 Cruisers Total - 6 Vehicles
q.	Guilford	Fire - 7 Trucks Police - 6 Cruisers Total - 13 Vehicles
r.	Essex	Fire - 8 Trucks Police - 1 Cruiser Total - 9 Vehicles
s.	Madison	Fire - 6 Trucks Police - 5 Cruiser Total - 11 Vehicles
t.	Salem	Fire - 9 Trucks Police - 1 Cruiser Total - 10 Vehicles

Troop K and Troop F of the Connecticut State Police have 43 and 44 Troopers, respectively, (not inclusive of Resident State Troopers). These troopers have vehicles as identified in the RERP. Assuming three shifts and that 7 vehicles and troopers would be needed for access control, 7 vehicles would remain to notify people to evacuate.

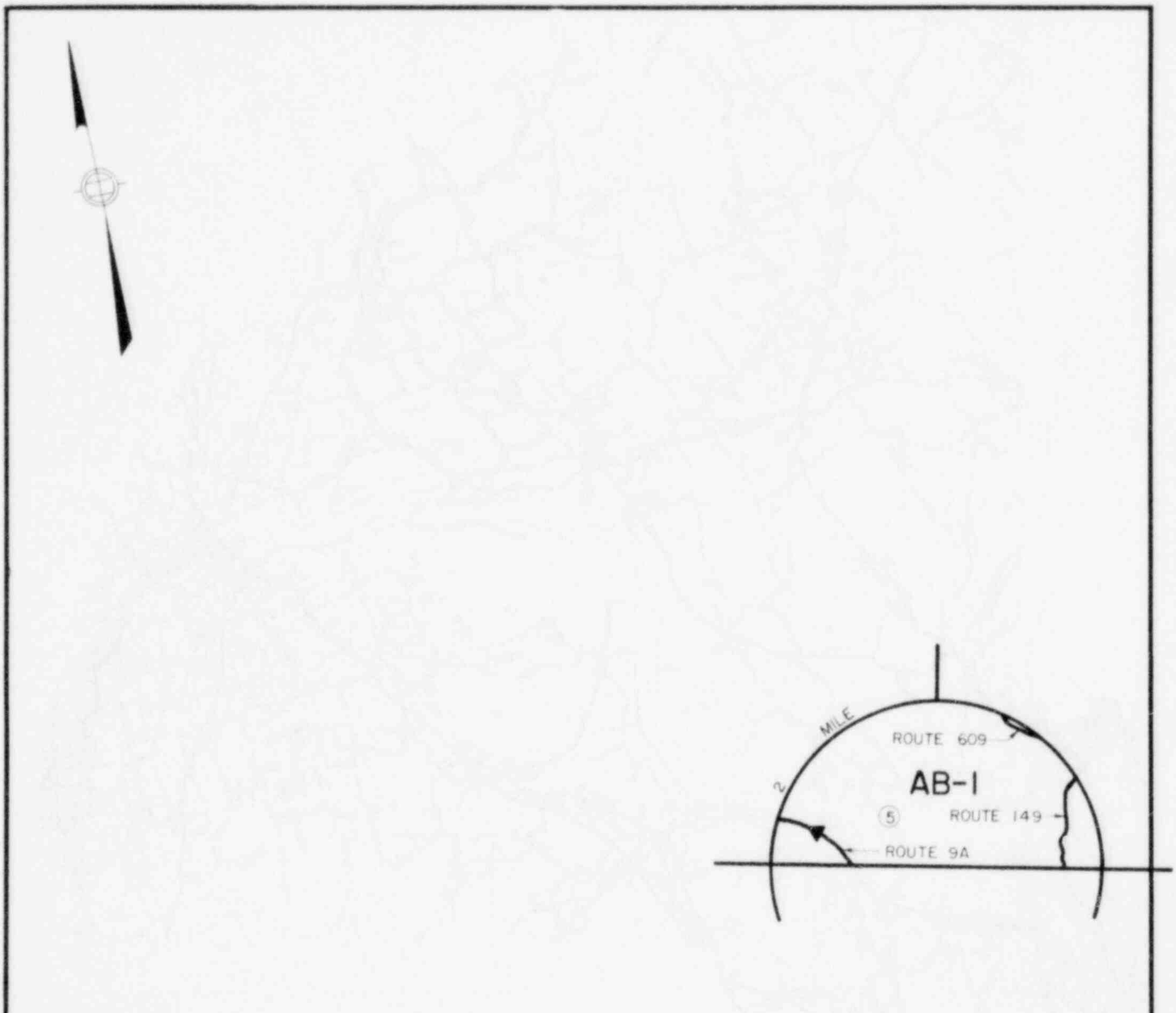
3. Number of Square Miles Covered by Public Notification Vehicles within 1 Hour (V)

V = 1.237 miles^2/hour - vehicle, as determined from a drill held in Haddam, Connecticut on November 14, 1979.

[4]State of Connecticut RERP (Section 500). For towns not included in the RERP, information was either obtained from town agencies (i.e., in the case of Westbrook, Cromwell, Middlefield, Hebron, Guilford, Essex, Madison and Salem).

Based upon the above data, Notification Times were calculated for public authorities to notify the resident and transient population by emergency public address equipped vehicles. The results of these calculations are given in Table 5 of Part IV.

Table 5 is a worst case analysis of Public Notification Time and does not consider other available means of notification; i.e., radios, television and sirens. These other methods should be addressed during the preparation of upgraded RERPs by the State and towns.

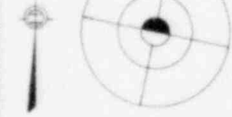


SCHOOLS									
NO.	NAME	ENROLLMENT	GRADES	TOWN	NO.	NAME	ENROLLMENT	GRADES	TOWN
5	Middle Haddam School	[illegible]	PK	East Hampton	21	Moody School	373	K-5	Middletown
9	Memorial School	450	1-5	East Hampton	23	McDonough School	256	K-5 SP	Middletown
10	East Hampton Junior High School	336	7-8	East Hampton	24	[illegible] Middle School [illegible] / [illegible] High School	[illegible]	[illegible]	Middletown
11	Center School	409	4-6	East Hampton	26	Gildersleeve	364	K-5	Portland
[illegible]	East Hampton High School	551	9-12	East Hampton	27	Valleyview	256	K-5	Portland
[illegible]	Haddam Elementary	[illegible]	K-8	Haddam	28	Portland Junior High School	[illegible]	6-8	Portland
20	Wakefield School	383	K-5	Middletown	[illegible]	Portland High School	[illegible]	9-12	Portland
[illegible]	Farm Hill School	248	K-5	Middletown					

MAJOR RECREATION FACILITIES	
NO.	NAME
1	Hurd State Park

HORIZONTAL SCALE IN MILES
0 1 2 3

MAJOR EMPLOYERS			
NO.	NAME	EMPLOYMENT	TOWN
1	Pratt And Whitney	3600	Middletown
2	Middlesex Memorial Hospital	1400	Middletown
3	Russell Manufacturing	275	Middletown



KEY PLAN

NORTHEAST UTILITIES SERVICE COMPANY

EVACUABILITY STUDY AT HADDAM NECK NUCLEAR POWER STATION

ZONE AB-1

FIGURE NO. 3

Prepared By
STORCH ENGINEERS
161 MAIN STREET - WETHERSFIELD, CONNECTICUT

POOR ORIGINAL

III. c. EVACUATION TIME ANALYSIS

ZONE AB1

Reference: Figure 3

Zone AB1, a combination of Zones A1 and B1, encompasses the area from 0-2 miles north (full 180°) of the nuclear power station site in the Towns of Haddam and East Haddam. The zone is divided by both the Connecticut River and Salmon River with no highway river crossings within the zone. Most of the resident population is located northeast of the nulcear power station. There is no significant amount of transient population and no schools are within this zone.

Evacuation Routes

Routes 9A and 149 are the State highway facilities that will serve to evacuate the majority of the residents. Route 9A is located on the west side of the Connecticut River in the western part of the zone and permits travel at 50 mph. Route 149 will serve for northbound evacuation in the eastern part of this zone. However, this facility has a curvilinear design and a 35 mph speed limit, and as a result its capacity is limited. Local roads will adequately serve for egress of the resident population between the Connecticut and Salmon Rivers.

Evacuation Time

West Side of Connecticut River: Evacuation Route 9A

(Capacity = 785 vehicles per hour)

Population = 23 (residents only)

EVT = (23/1.5)(60/785) = 2 minutes

Use minimum EVT = 15 minutes

East Side of Salmon River: Evacuation Route 149

(Capacity = 755 vehicles per hour)

Population = 881 (residents only)

EVT = (881/1.5)(60/755) = 47 minutes

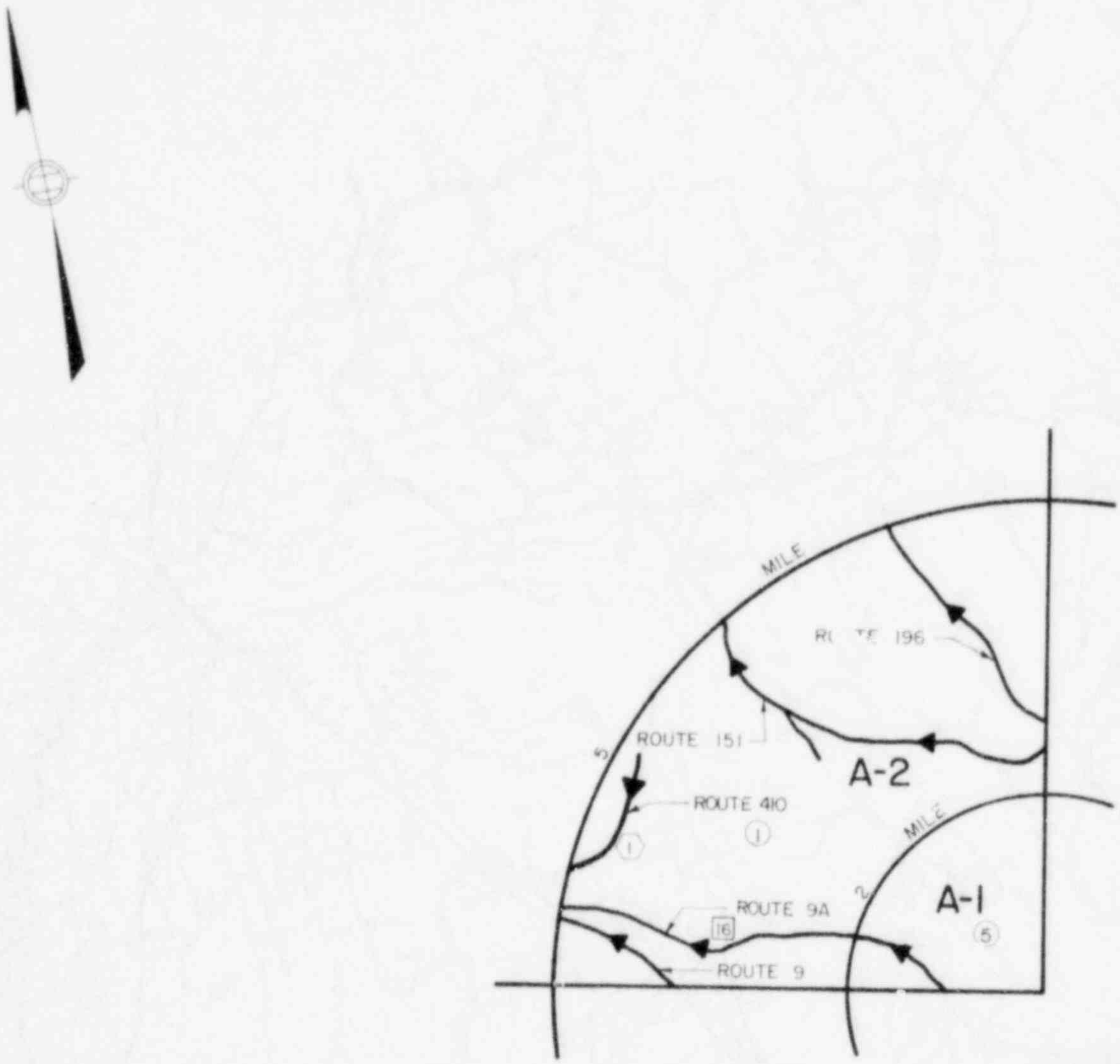
Between Salmon and Connecticut Rivers: Evacuation Route local roads

(Capacity = 500 vehicles per hour)

Population = 400 (residents only)

EVT = (400/1.5)(60/500) = 32 minutes

Thus, the limiting evacuation time for this 0-2 mile, 180 degree Zone AB1 is 47 minutes.



SCHOOLS

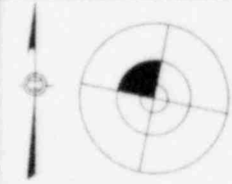
NO	NAME	ENROLLMENT	GRADES	TOWN
[illegible]	Middle Haddam School	[illegible]	[illegible]	East Hampton
[illegible]	Memorial School	[illegible]	[illegible]	East Hampton
[illegible]	East Hampton Junior High School	[illegible]	7-8	East Hampton
[illegible]	Center School	[illegible]	[illegible]	East Hampton
[illegible]	East Hampton High School	[illegible]	[illegible]	East Hampton
[illegible]	Haddam Elementary	[illegible]	[illegible]	Haddam
[illegible]	[illegible]	[illegible]	[illegible]	Middletown
[illegible]	Farm Hill School	[illegible]	[illegible]	Middletown
[illegible]	[illegible]	[illegible]	[illegible]	Middletown
[illegible]	[illegible]	[illegible]	[illegible]	Middletown
[illegible]	[illegible]	[illegible]	[illegible]	Middletown
[illegible]	[illegible]	[illegible]	[illegible]	Portland
[illegible]	[illegible]	[illegible]	[illegible]	Portland
[illegible]	[illegible]	[illegible]	[illegible]	Portland
[illegible]	Portland High School	[illegible]	[illegible]	Portland

MAJOR RECREATION FACILITIES	
NO	NAME
1	Hurd State Park

MAJOR EMPLOYERS			
NO	NAME	EMPLOYMENT	TOWN
1	Pratt And Whitney	3600	Middletown
2	Middlesex Memorial Hospital	1400	Middletown
3	Russell Manufacturing	275	Middletown

HORIZONTAL SCALE IN MILES

0 1 2 3



KEY PLAN

NORTHEAST UTILITIES SERVICE COMPANY

EVACUABILITY STUDY AT HADDAM NECK NUCLEAR POWER STATION

ZONE A-1, A-2

FIGURE NO. 4

Prepared By

STORCH ENGINEERS

161 MAIN STREET - WETHERSFIELD, CONNECTICUT

POOR ORIGINAL

ZONES A1, A2

Reference: Figure 4

Zones A1, A2 encompass a 90 degree sector, 0-5 miles north and west of the nuclear power station site in the Towns of Haddam and East Hampton, and a small portion of Middletown. The Connecticut River passes northwest to southeast through Zones A1, A2. Resident population is greater south of the Connecticut River and is concentrated especially in the Higganum area of Haddam (3-5 miles directly west of the power station site). Transient population consists of workers at the Pratt and Whitney plant at Aircraft Road in Middletown and the maximum summer populaton demand from Hurd State Park located along the east side of the Connecticut River. There is one school, Haddam Elementary, in Higganum with an enrollment of 332 students. School bus service for the Town of Haddam is provided by the Nichols Bus Company, which uses 38 school buses of 44 passengers each.

Evacuation Routes

Since no crossings of the Connecticut River are provided in this zone, evacuation would be performed on separate facilities on either side. South and west of the River, Route 9A passes through Higganum Village and has an average speed limit of 45 mph. There is a traffic signal located at the intersection of Route 9A and Aircraft Road (Route 410). Further, Aircraft Road serves as an egress for the outer edge and particularly for the employees of the Pratt and Whitney plant. North and east of the Connecticut River, evacuation capacity is provided by State Highways 151 and 196. The speed limit for Route 151 is 35 mph while the posted speed for Route 196 is 45 mph. There is a traffic signal at the Hurd Park Road exit onto Route 151.

Evacuation Time

South and West of the Connecticut River: Evacuation Routes 9A and 410

(Capacity = 1,789 vehicles per hour)

Population	Resident	Transient	School
Zone A1	23	---	---
Zone A2	1797	3600	332
TOTAL	1820	3600	332

Available school buses have a seating capacity of 44 passengers. Thus, the number of buses required will be 332/44 = 7.5 or 8 buses. The available buses are more than adequate to provide student transportation.

EVT = (1820/1.5 + 3600/1.5 + 8)(60/189) = 121 minutes

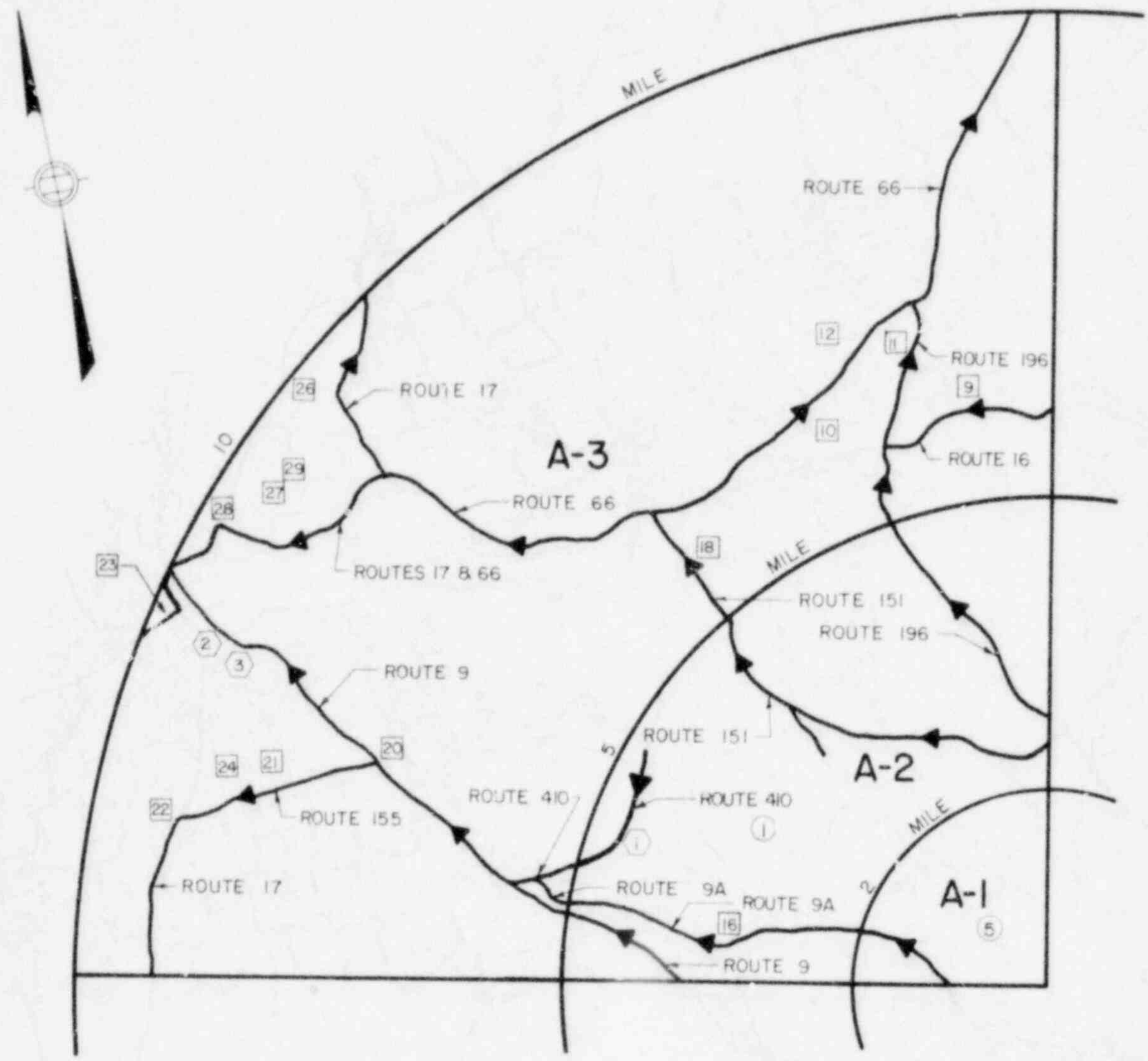
North and East of the Connecticut River: Evacuation Routes 151 and 196

(Capacity = 1,700 vehicles per hour)

Population	Resident	Transient	School
Zone A1	400	---	---
Zone A2	1322	717	---
TOTAL	1722	717	---

EVT = (1722/1.5 + 717/1.5)(60/1700) = 58 minutes

Thus, the limiting evacuation time for this 0-5 mile, 90 degree combination of Zone A1 and Zone A2 is 121 minutes.



SCHOOLS

NO.	NAME	ENROLLMENT	GRADES	TOWN	NO.	NAME	ENROLLMENT	GRADES	TOWN
[illegible]	Middle Haddam School	126	PK	East Hampton	[illegible]	[illegible] School	373	K-5	Middletown
9	Memorial School	490	1-5	East Hampton	[illegible]	McDonough School	256	K-5, SP	Middletown
[illegible]	East Hampton Junior High School	336	7-8	East Hampton	[illegible]	Wilson Middle School and Wilson High School	[illegible]	[illegible]	Middletown
[illegible]	Center School	428	K-4	East Hampton	[illegible]	Gildersleeve	564	K-5	Portland
[illegible]	East Hampton High School	551	9-12	East Hampton	[illegible]	Valleyview	298	K-5	Portland
[illegible]	Haddam Elementary	532	K-6	Haddam	[illegible]	Portland Junior High School	423	6-8	Portland
[illegible]	[illegible] School	385	K-5	Middletown	[illegible]	Portland High School	492	9-12	Portland
[illegible]	Farm Hill School	248	K-5	Middletown					

MAJOR RECREATION FACILITIES

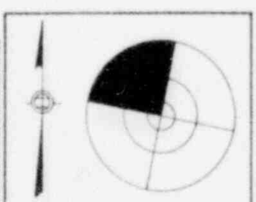
NO.	NAME
1	Hurd State Park

MAJOR EMPLOYERS

NO.	NAME	EMPLOYMENT	TOWN
1	Pratt And Whitney	3600	Middletown
2	Middlesex Memorial Hospital	1400	Middletown
3	Russell Manufacturing	275	Middletown

HORIZONTAL SCALE IN MILES

0 1 2 3



KEY PLAN

NORTHEAST UTILITIES SERVICE COMPANY

EVACUABILITY STUDY AT HADDAM NECK NUCLEAR POWER STATION

Zone A-1, A-2, A-3

FIGURE NO. 5

Prepared By

STORCH ENGINEERS

161 MAIN STREET - WETHERSFIELD, CONNECTICUT

ZONES A1, A2, A3

Reference: Figure 5

Zones A1, A2, A3 encompass the entire 90 degree sector, 0-10 miles north and west of the nuclear power station in the Towns of Haddam, East Hampton, Middletown, Portland and Marlborough. The Connecticut River continues through Zone A3, thus dividing the entire sector into two parts. The only highway river crossing is located near the 10-mile limit at the Routes 66 and 17 connection with Route 9. Resident population is concentrated in the western part, particularly in Middletown between 9 and 10 miles from the nuclear power station site. These are two additional employment centers which generate significant amounts of transient traffic. These are the Russell Manufacturing Company and Middlesex Memorial Hospital, both of which are located in Middletown. As to Middlesex Memorial Hospital, it is estimated by the State of Connecticut Department of Health Office of Emergency Medical Services that it would take four to five hours to evacuate the hospital since one third of the patients are non-ambulatory. The ambulances could be coordinated through the Colchester Office of Emergency Medical Serivces. There are 15 additional schools in Zone A3, or a total of 16 schools with a combined enrollment of 6,573 students in Zones A1, A2, A3.

Evacuation Routes

The evacuation routes for Zones A1, A2, A3 may be divided between those south and north of the Connecticut River. South of the Connecticut River, through Haddam and Middletown, evacuation is available primarily by the limited access highway Route 9. Additional capacity is provided by State Highway 9A, State Highway 66, and the combination of State Highways

155 and 17. Route 9 is a four-lane, divided and grade separated facility built to Interstate highway standards and provides the best grades, alignment, and evacuation capacity. Route 155 is signalized at its intersection with Route 17 and both facilities are designed to permit speeds ranging between 35 and 45 mph.

North of the Connecticut River, evacuation routing will be accomplished by State Highways 156 and 196, as previously described, and Routes 17 and 66 in Zone A3. The use of Route 17A in the Town of Portland has been avoided as it is occasionally closed due to flooding from spring snow melt and heavy summer and fall rains. Route 66 provides good alignment with 2 to 4 foot shoulders through Zones A1, A2, A3. In addition, Route 66 becomes an at-grade divided highway near the outer extremity. There are three intersection traffic signals, one flashing yellow warning signal, and one set of railroad signals along Route 66 within Zones A1, A2, A3.

Evacuation Time

South of the Connecticut River: Evacuation Routes 9A/9 and 155/17

(Capacity = 3,537 vehicles per hour)

Population	Residential	Transient	School
Zone A1	23	---	---
Zone A2	1797	3600	332
Zone A3	19196	1675	2773
TOTAL	21016	5275	3105

The Middletown School District has 15 buses of 66 passenger capacity and also contracts for an additional 25 buses of 66 passengers each. The six Middletown schools consist of four elementary, one junior high, and

one senior high. The Wilson High School enrollment is 799. Assuming that there is one private vehicle for every four students at the high school, the number of school buses required will be (2,773 - 799/4)/66 = 38.6 or 39 buses.

With the 8 buses required (and 38 potentially available) for Haddam Elementary in Zone A2, a total of 47 buses are required south of the Connecticut River. Therefore, the bus transportation is more than adequate to evacuate students.

EVT = (21016/1.5 + 5275/1.5 + 247*)(60/3537) = 302 minutes

* 200 vehicles plus 47 school buses

North of the Connecticut River: Evacuation Routes 17, 151/66 and 196/66 (Capacity = 2,632 vehicles per hour)

Population	Residential	Transient	School
Zone A1	400	---	---
Zone A2	1322	717	---
Zone A3	15578	---	3468
TOTAL	17300	717	3468

The East Hampton School District contracts for bus service with the Nichols Bus Company, which provide 18 vehicles of 44 passengers each. The five schools in East Hampton consist of three elementary, one junior high, and one senior high, with a total of 1,891 students. East Hampton High School has an enrollment of 551 pupils. Assuming a car ownership of one vehicle for every four students at the high school, the number of school buses required will be (1891 - 551/4)/44 = 39.8 or 40 buses[5].

[5]The number of school buses to East Hampton and Portland could undoubtedly be supplemented by school buses from other towns and/or school districts as per Mutual Aid Agreements.

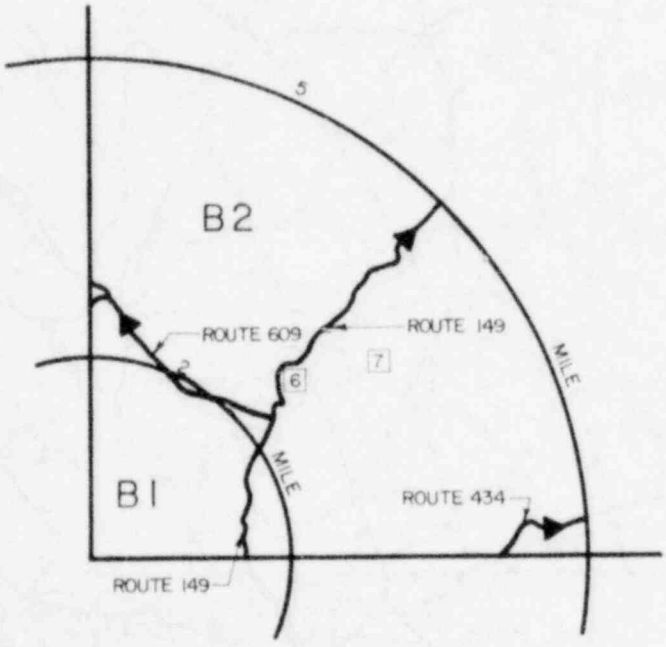
The Portland School District has 10 school buses with seating for 44 passengers each. The four schools in Portland within Zone A3 consist of two elementary, one junior high, and one senior high with a total of 1,577 students. Portland High School has an enrollment of 492 pupils. Assuming that there is one personal vehicle for every four students at the high school, the number of school buses required will be (1577 - 492/4)/44 = 33 buses[5].

EVT = (17300/1.5 + 717/1.5 + 334*)(60/2632) = 282 minutes

*261 vehicles plus 73 school buses

Thus, the evacuation time for this 0-10 mile, 90 degree combination of Zone A1, Zone A2 and Zone A3 is 302 minutes.

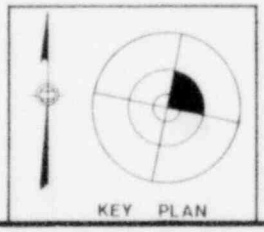
[5]The number of school buses to East Hampton and Portland could undoubtedly be supplemented by school buses from other towns and/or school districts as per Mutual Aid Agreements.



SCHOOLS				
NO.	NAME	ENROLLMENT	GRADES	TOWN
6	Nathan Hale Ray High School	481	7 - 12	East Haddam
7	East Haddam Elementary	617	K - 6	East Haddam

HORIZONTAL SCALE IN MILES
0 1 2 3

MAJOR RECREATION FACILITIES	
NO.	NAME
2	Day Pond State Park
3	Devils Hopyard State Park
4	Salmon River State Forest



NORTHEAST UTILITIES SERVICE COMPANY

EVACUABILITY STUDY AT HADDAM NECK NUCLEAR POWER STATION

ZONE B-1, B-2

FIGURE NO. 6

Prepared By
STORCH ENGINEERS
161 MAIN STREET - WETHERSFIELD, CONNECTICUT

ZONES B1, B2

Reference: Figure 6

Zones B1, B2 encompass a 90 degree sector, 0-5 miles north and east of the nuclear power station in the Towns of East Haddam and East Hampton and a small part of Haddam and Colchester. The Salmon River crosses the southwestern corner. Resident population is concentrated directly northeast of the power station between 2 and 4 miles. There is no significant amount of either employee or recreational transient population generated by the Zones B1, B2. There are two schools, an elementary and a junior/senior high in the Town of East Haddam. The schools have an enrollment of 1,098 students.

Evacuation Routes

Evacuation routing out of the zone is oriented in the northbound direction along State Highway 149 and 151 and Route 609. Route 149 through the zone has an average speed of 30 mph along generally good alignment. Route 609, which connects between State Highways 149 and 151, is posted for 45 mph for its entirety, as is Route 151 within the zone.

Evacuation Time: Evacuation Routes 149 and 609/151

(Capacity = 1,571 vehicles per hour)

Population	Residential	School
Zone B1	881	---
Zone B2	3144	1098
TOTAL	4025	1098

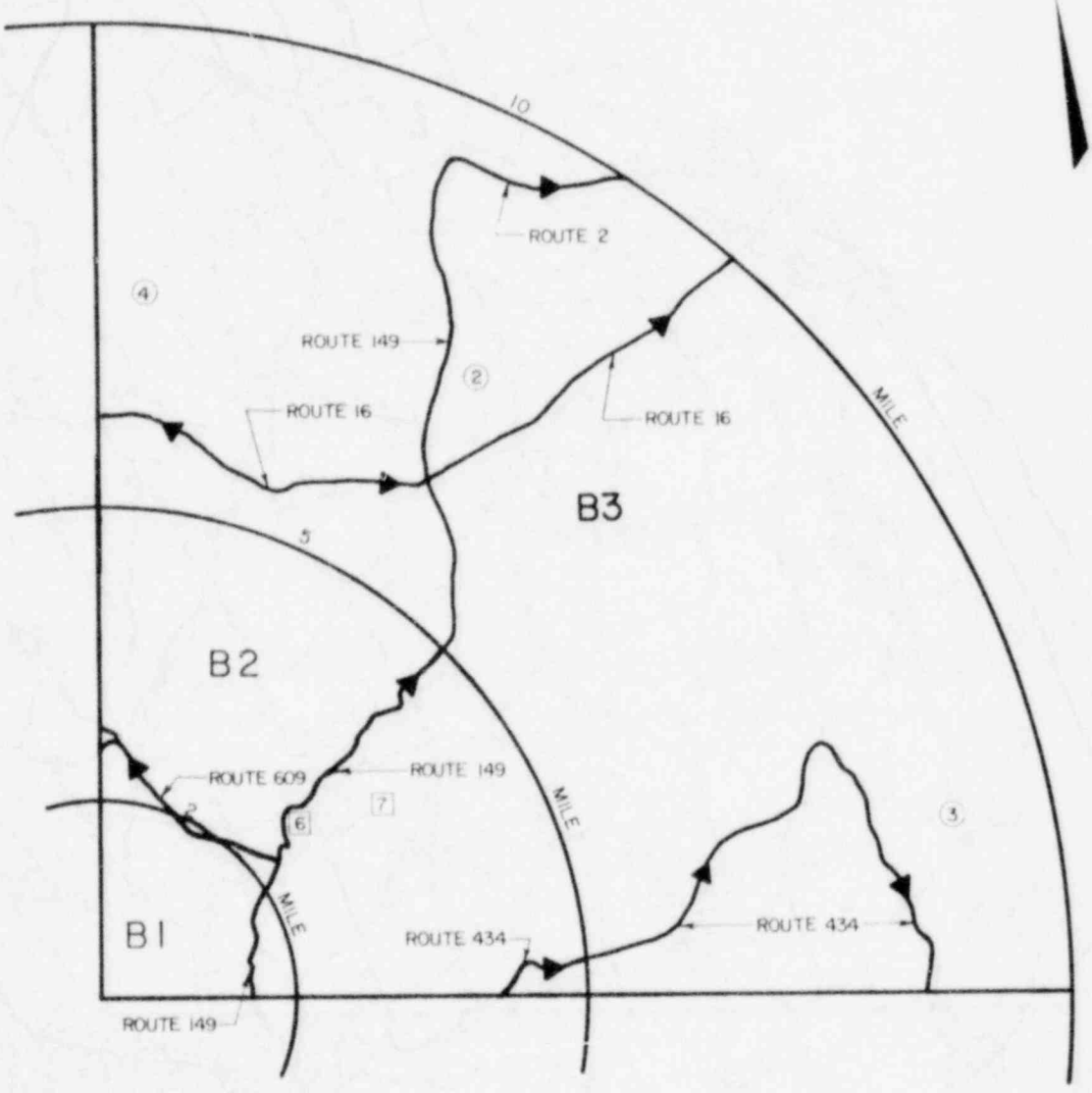
The Town of East Haddam contracts with the Nichols Bus Company, which provides 28 buses of 44 passengers each. Assuming that half of the student

enrollment of the junior/senior high school is eligible to drive and that there is one personal vehicle for every four eligible drivers, the number of school buses required will be [1098 - 481/(2)(4)]/44 = 23.6 or 24 buses.

EVT = (4025/1.5 + 85*)(60/1571) = 106 minutes

*61 vehicles plus 24 buses

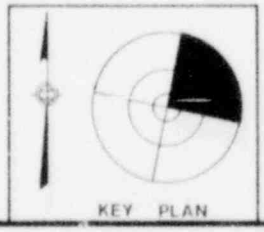
Thus, the evacuation time for this 0-5 mile, 90 degree combination of Zone B1 and Zone B2 is 106 minutes.



SCHOOLS				
NO	NAME	ENROLLMENT	GRADES	TOWN
6	Nathan Hale Ray High School	481	7 - 12	East Haddam
7	East Haddam Elementary	617	K - 6	East Haddam

HORIZONTAL SCALE IN MILES
0 1 2 3

MAJOR RECREATION FACILITIES	
NO	NAME
2	Day Pond State Park
3	Devils Hopyard State Park
4	Salmon River State Forest



NORTHEAST UTILITIES SERVICE COMPANY

EVACUABILITY STUDY AT HADDAM NECK NUCLEAR POWER STATION

Zone B-1, B-2, B-3

FIGURE NO. 7

Prepared by
STORCH ENGINEERS
161 MAIN STREET - WETHERSFIELD, CONNECTICUT

ZONES B1, B2, B3

Reference: Figure 7

Zones B1, B2, B3 encompass the entire 90 degree sector, 0-10 miles north and east of the nuclear power station in the Town of Haddam, East Hampton, East Haddam, Colchester, Marlborough, and a small part of Salem. Zone B3 has a fairly uniform population density and low number of additional residential population, the majority of which is the 8-10 mile annulus ring. Part of the reason for the low residential population is explained by the presence of three State parks and forests within Zone B3, which together add a peak daily transient population of 7,503. There are no major employment centers in Zones B1, B2, B3 and no additional schools in Zone B3.

Evacuation Routes

The principal additional evacuation routes for Zone B3 are State Highways 149, 2, and 16 in the north and west part of the sector and Route 434 in the south and east portion within East Haddam. Routes 149 and 2 have a permissible speed varying between 30 and 40 mph and good alignment. Route 434 which passes through and serves Devils Hopyard State Park is very narrow with numerous curves and a speed limit of only 25 mph along its eastern segment.

Evacuation Time: Evacuation Route 151, Route 149, Route 434 and Route 16 (Capacity = 3,877 vehicles per hour)

Population	Residential	Transient	School
Zone B1	881	---	---
Zone B2	3144	---	1098
Zone B3	3957	7503	---
TOTA	7982	7503	1098

There are no additional school bus requirements for Zone B3. The total school buses need for evacuation of Sector B is therefore 24. Therefore, a more than adequate number of school buses are available to aid in evacuation of students.

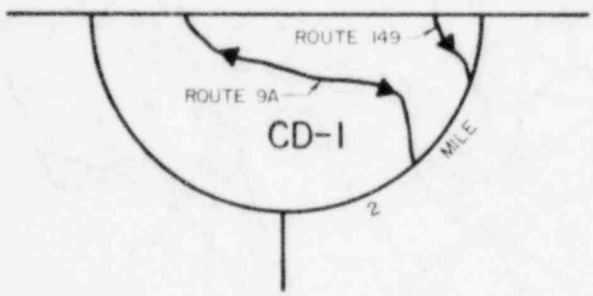
EVT = (7982/1.5 + 7503/1.5 + 85)(60/3877) = 161 minutes

Thus, the evacuation time for this 0-10 mile, 90 degree combination of Zone B1, Zone B2 and Zone B3 is 161 minutes.

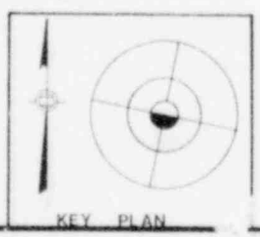
MAJOR RECREATION FACILITIES	
NO.	NAME
⑤	Haddam Meadows State Park
⑥	Gillette Castle State Park

SCHOOLS				
NO.	NAME	ENROLLMENT	GRADES	TOWN
1	Chester Elementary School	304	K-6	Chester
2	Deep River Elementary School	374	K-6	Deep River
13	Essex Elementary	461	K-6	Essex
14	Valley Regional High School	697	9-12	Deep River
15	Winthrop Junior High School	366	7-18	Deep River
25	Lyme Consolidated School	186	K-8	Lyme

MAJOR EMPLOYERS			
NO.	NAME	EMPLOYMENT	TOWN
④	UARCO, Inc.	382	Deep River



HORIZONTAL SCALE IN MILES
0 1 2 3



NORTHEAST UTILITIES SERVICE COMPANY

EVACUABILITY STUDY AT HADDAM NECK NUCLEAR POWER STATION

ZONE CD-1 | FIGURE NO. 8

Prepared By
STORCH ENGINEERS
161 MAIN STREET - WETHERSFIELD, CONNECTICUT

ZONE CD1

Reference: Figure 8

Zone CD1, a combination of Zones C1 and D1, encompasses the area from 0-2 miles south (full 180°) of the nuclear power station site primarily in the Town of Haddam, with a small area in the Town of East Haddam. The zone is divided diagonally by the Connecticut River. Nearly all of the zone population is south of the Connecticut River in the Town of Haddam and most of the resident population is centered directly west of the nuclear power station. Transient population is generated by the presence of Haddam Meadows State Park located in the western half of the zone (Zone D1). It is estimated that this park attracts 407 visitors during its peak summer day. There are no schools within Zone CD1.

Evacuation Routes

Route 9A, which approximately follows the course of the Connecticut River on its south side, provides the main evacuation routing out of this zone. The portion of Route 9A through Zone CD1 has good alignment and a speed limit varying between 40 and 50 mph. Due to the orientation of Route 9A within the zone, half of the population to be evacuated would travel in a northbound direction while the other half would be directed southbound. Thus, the effective capacity is twice the computed one-way capacity. In addition, it is likely that some of the local streets would be utilized in the southbound direction to egress beyond the 2-mile limit of this zone. However, to be conservative, only the capacity of Route 9A has been included in the evacuation clear time calculation.

To evacuate the small area of East Haddam in Zone CD1, Route 149 would be utilized. Route 149 has limited capacity due to its curvilinear design and is posted for 35 mph.

Evacuation Time

North and East of Connecticut River: Evacuation Route 149

(Capacity = 755 vehicles per hour)

Population = 48 (residents only)

EVT = (48/1.5)(60/755) = 3 minutes

Use Minimum Time = 15 minutes

South and West of Connecticut River: Evacuation Route 9A

(Capacity = 1,570 vehicles per hour)

Resident Population = 1,568

Transient Population = 407

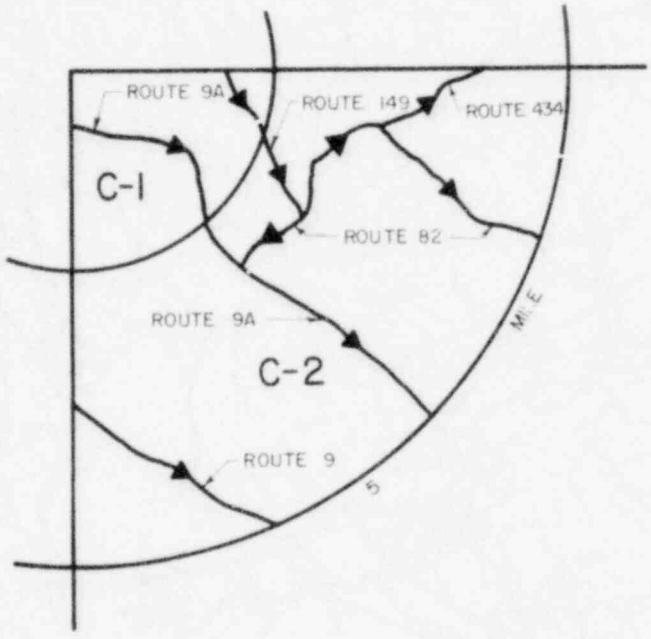
EVT = (1568/1.5 + 407/1.5)(60/1570) = 51 minutes

Thus, the limiting evacuation time for this 0-2 mile, 180 degree Zone CD1 is 51 minutes.

MAJOR RECREATION FACILITIES	
NO.	NAME
⑤	Haddam Meadows State Park
⑥	Gillette Castle State Park

SCHOOLS				
NO.	NAME	ENROLLMENT	GRADES	TOWN
1	Chester Elementary School	304	K-6	Chester
2	Deep River Elementary School	374	K-6	Deep River
13	Essex Elementary	461	K-6	Essex
14	Valley Regional High School	697	9-12	Deep River
15	Winthrop Junior High School	366	7-18	Deep River
25	Lyme Consolidated School	186	K-8	Lyme

MAJOR EMPLOYERS			
NO.	NAME	EMPLOYMENT	TOWN
④	UARCO, Inc.	382	Deep River



HORIZONTAL SCALE IN MILES
0 1 2 3

KEY PLAN

NORTHEAST UTILITIES SERVICE COMPANY

EVACUABILITY STUDY AT HADDAM NECK NUCLEAR POWER STATION

ZONE C-1, C-2

FIGURE NO. 9

Prepared By
STORCH ENGINEERS
MAIN STREET - WETHERSFIELD, CONNECTICUT

ZONES C1, C2

Reference: Figure 9

Zones C1, C2 encompass a 90 degree sector, 0-5 miles south and east of the nuclear power station in the Towns of Chester, Haddam, and East Haddam. The Connecticut River passes diagonally through Zones C1, C2 and divides it into approximately two equal parts. Route 82 provides the only vehicular river crossing and the bridge is located about 2-1/2 miles from the nuclear power station. Residential population is concentrated directly southeast of the power station site in the village of East Haddam. There are no major employment centers or recreational areas generating significant amounts of transient population. There are no schools in Zone C1, C2.

Evacuation Routes

Evacuation routes are generally divided between those on either side of the Connecticut River, with Route 82 providing connecting capacity across the River. South of the Connecticut River, Route 9A provides evacuation capacity, while north of the River the evacuation roadways are Routes 149, 82, and 434. Route 9A travels approximately in the direction of the Connecticut River with a good alignment and a speed limit between 45 and 50 mph. Route 82 has numerous curves in its alignment which restrict capacity and limit speeds between 35 and 40 mph.

Evacuation Time

South of the Connecticut River: Evacuation Route 9A

(Capacity = 785 vehicles per hour)

Population (residential only)	Zone C1	347
	Zone C2	785
	TOTAL	1132

EVT = (1132/1.5)(60/785) = 59 minutes

North of the Connecticut River: Evacuation Routes 149/82, and 434

(Capacity = 1,491 vehicles per hour)

Population (residential only)	Zone C1	249
	Zone C2	1255
	TOTAL	1504

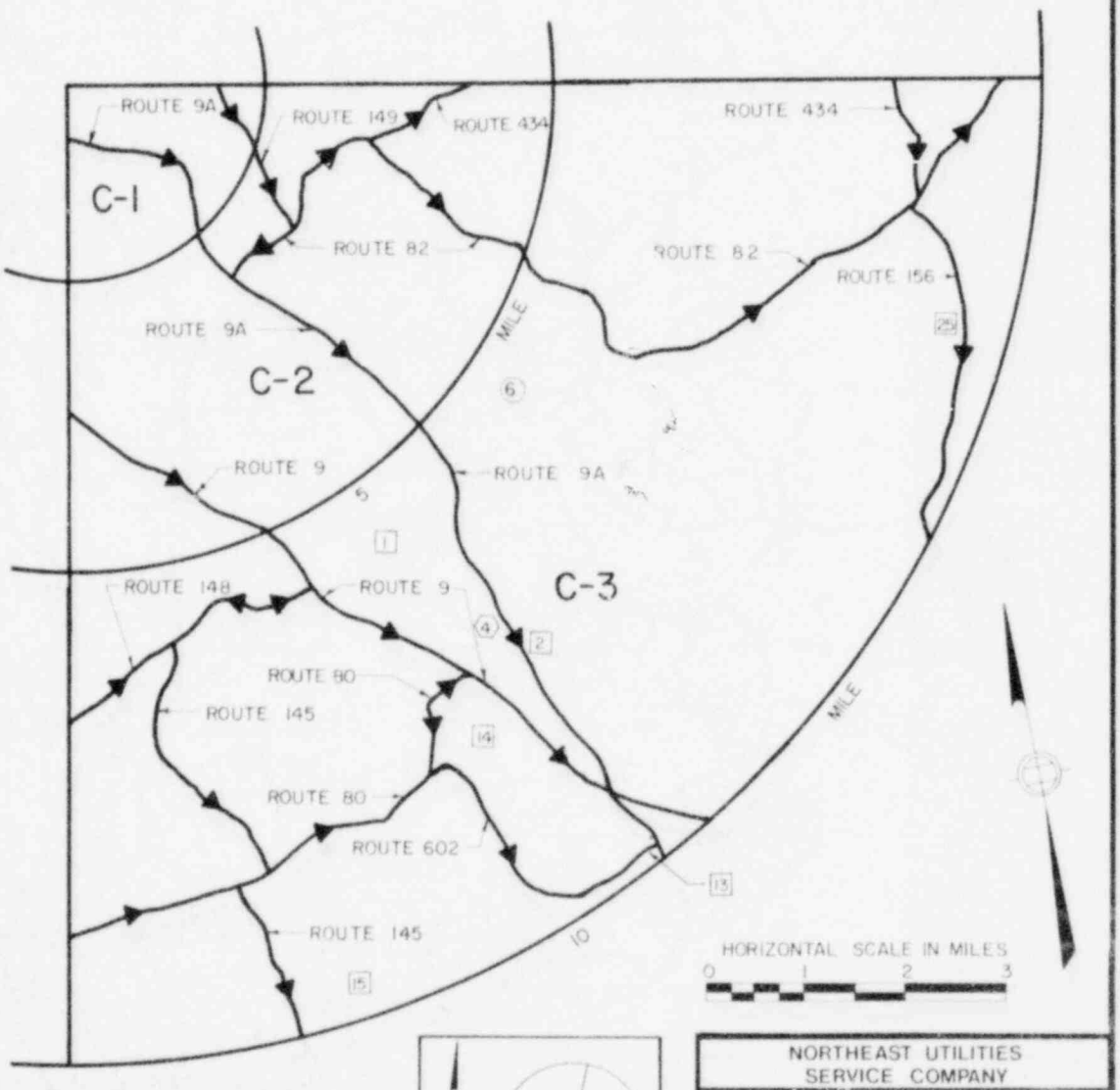
EVT = (1504/1.5)(60/1491) = 41 minutes

Thus, the limiting evacuation time for this 0-5 mile, 90 degree combination of Zone C1 and Zone C2 is 59 minutes.

MAJOR RECREATION FACILITIES	
NO.	NAME
⑤	Haddam Meadows State Park
⑥	Gillette Castle State Park

SCHOOLS				
NO.	NAME	ENROLLMENT	GRADES	TOWN
1	Chester Elementary School	304	K-6	Chester
2	Deep River Elementary School	374	K-6	Deep River
13	Essex Elementary	461	K-6	Essex
14	Valley Regional High School	697	9-12	Deep River
15	Winthrop Junior High School	366	7-18	Deep River
25	Lyme Consolidated School	186	K-8	Lyme

MAJOR EMPLOYERS			
NO.	NAME	EMPLOYMENT	TOWN
④	UARCO, Inc.	382	Deep River



NORTHEAST UTILITIES SERVICE COMPANY

EVACUABILITY STUDY AT HADDAM NECK NUCLEAR POWER STATION

Zone C-1, C-2, C-3

FIGURE NO. 10

Prepared by:
STORCH ENGINEERS
161 MAIN STREET - WETHERSFIELD, CONNECTICUT

ZONES C1, C2, C3

Reference: Figure 10

Zones C1, C2, C3 encompass the entire 90 degree sector, 0-10 miles south and east of the nuclear power station in the Towns of Haddam, Chester, East Haddam, Lyme, Deep River, Essex and smaller parts of Killingworth, Westbrook, and Clinton. The Connecticut River divides Zones C1, C2, C3 with no additional vehicular river crossings. Residential population is concentrated primarily south of the River in the Towns of Deep River and Chester. In Deep River there is also one major industry, UARCO, which employees 382 persons. Additional transient population derives from Gillette Castle State Park, which is major recreational use area adjacent to the north side of the Connecticut River. There are five schools, all within Zone C3, with a total enrollment of 2,014 students.

Evacuation Routes

Additional evacuation capacity in Zone C3 is divided between the north and south sides of the Connecticut River. Route 9 and 9A proceed in a southeast direction out of Zones C1, C2, C3. Route 9 is a limited access facility designed to Interstate highway standards with interchanges at Routes 82, 148, 80 and 9A. The capacity provided by these two facilities is supplemented by Routes 148, 145, 80, and 602. On the north side of the River, there are only three evacuation routes, namely State Highways 82 and 156 and Route 434. The two-lane roadways south of the Connecticut River are typically designed for speeds of 35 to 40 mph. Traffic signals are located at the intersection of Route 9A at Routes 82, 148, 658, and 80. There is also a traffic signal at Route 80 and Cedar Swamp Road.

Evacuation Time

South of the Connecticut River: Evacuation Routes 9, 9A, 148/145 and 80

(Capacity = 5,048 vehicles per hour)

Population	Residential	Transient	School
Zone C1	347	---	---
Zone C2	785	---	---
Zone C3	11517	382	2202
TOTAL	12649	382	2202

The Towns of Chester, Essex, and Deep River contract for school bus service with Liberty Bus Lines, which provide a total of 11 buses, each with a capacity of 66 passengers. The five schools in Zone C3 south of the Connecticut River include elementary schools in Chester, Deep River, and Essex and a junior high school and senior high school in Deep River. Assuming that there is one private vehicle for every four students at the high school, the number of school buses required will be (2202 - 697/4)/66 = 30.7 or 31 buses[6].

EVT = (12649/1.5 + 382/1.5 + 205*)(60/5048) = 106 minutes

*174 vehicles plus 31 school buses

North of the Connecticut River: Evacuation Routes 156, 82, and 434

(Capacity = 2,336 vehicles per hour)

Population	Residential	Transient	School
Zone C1	249	---	---
Zone C2	1255	---	---
Zone C3	1737	10484	186
TOTAL	3241	10484	186

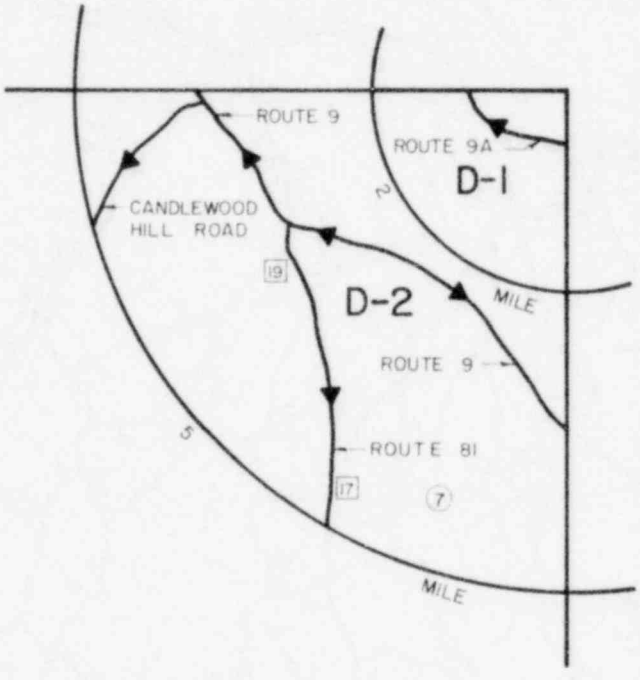
[6]The number of school buses to these towns would undoubtedly be supplemented by other Mutual Aid Agreement towns.

The Town of Lyme utilizes 4 buses of 44 passenger capacity for the transport of students. The only school within the sector north of the Connecticut River is Lyme Consolidated, an elementary school with 186 pupils. The number of school buses required is 186/44 = 4.22 or 5 buses.

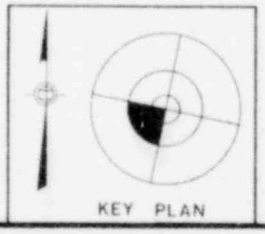
EVT = (3241/1.5 + 10484/1.5 + 5)(60/2336) = 235 minutes

Thus, the limiting evacuation time for this 0-10 miles, 90 degree combination of Zone C1, Zone C2 and Zone C3 is 235 minutes.

SCHOOLS				
NO.	NAME	ENROLLMENT	GRADES	TOWN
3	Francis E. Korn Elementary	221	3-5	Durham
4	Coginchaug Reg. High School	597	9-12	Durham
5	Frank Ward Strong	281	6-8	Durham
17	Burr District Elementary	525	K-6	Haddam
18	Killingworth Elementary	467	K-6	Killingworth
19	Haddam Killingworth Junior High/Senior High School	1102	7-12	Haddam



MAJOR RECREATION FACILITIES	
NO.	NAME
7	Cockaponset State Forest
8	Chatfield Hollow State Park



HORIZONTAL SCALE IN MILES
0 1 2 3

NORTHEAST UTILITIES SERVICE COMPANY

EVACUABILITY STUDY AT HADDAM NECK NUCLEAR POWER STATION

ZONE D-1, D-2

FIGURE NO. 11

Prepared By
STORCH ENGINEERS
161 MAIN STREET - WETHERSFIELD, CONNECTICUT

ZONES D1, D2

Reference: Figure 11

Zones D1, D2 encompass a 90 degree sector, 0-5 miles south and west of the nuclear power station in the Town of Haddam and a small part of Killingworth and Chester. Resident population is low, with the greatest density located directly west of the nuclear power station. There are no major employment centers in Zones D1, D2, however, transient population is generated by Haddam Meadows State Park and Cockaponset State Forest. Together, these recreational areas are estimated to generate 1,872 visitors during the peak summer day. There are two schools in the Zone D2, namely, an elementary and a junior/senior high school. Both schools are located in the Town of Haddam and the enrollment totals 1,627 students.

Evacuation Routes

Evacuation routing is oriented to the northwest/southeast along State Highway 9, and southbound on State Highway 81. Route 9 is a limited access four-lane facility and provides interchanges in Zone D2 at Killingworth and Beaver Meadow Roads. Route 81 is a two-lane highway with a speed limit of 45 mph through the zone.

Evacuation Time: Evacuation Routes 9 and 81

(Capacity = 6,290 vehicles per hour)

Population	Residential	Transient	School
Zone D1	1029	407	---
Zone D2	1606	1465	1627
TOTAL	2635	1872	1627

The Town of Haddam contracts for bus service with the Nichols Bus Company, which provides 38 buses with a capacity of 44 passengers each.

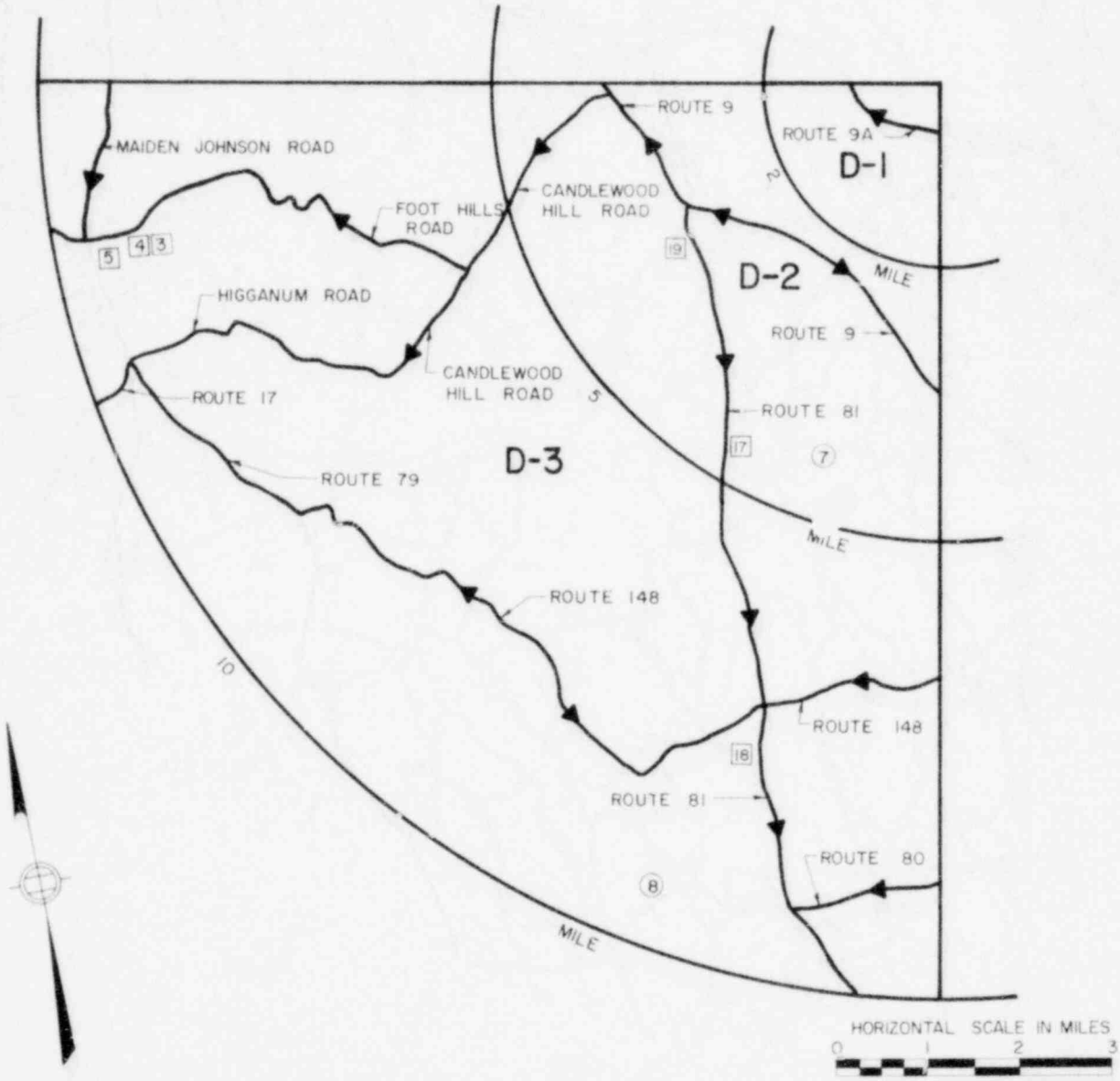
Assuming that one half of the students at Haddam Killingworth Junior/Senior High School are eligible to drive and that there is one private vehicle for every four eligible drivers, the number of school buses required will be [1627 - 1102/(2)(4)]/44 = 33.8 or 34 buses. Therefore, a more than adequate number of school buses are available to evacuate students.

EVT = (2635/1.5 + 1872/1.5 + 172*)(60/6290) = 31 minutes

*138 vehicles plus 34 school buses

Thus, the evacuation time for this 0-5 mile, 90 deg combination of Zone D1 and Zone D2 is 31 minutes.

SCHOOLS				
NO.	NAME	ENROLLMENT	GRADES	TOWN
3	Francis E Korn Elementary	221	3-5	Durham
4	Coginchaug Reg High School	597	9-12	Durham
5	Frank Ward Strong	281	6-8	Durham
17	Burr District Elementary	525	K-6	Haddam
18	Killingworth Elementary	467	K-6	Killingworth
19	Haddam Killingworth Junior High/Senior High School	1102	7-12	Haddam



MAJOR RECREATION FACILITIES	
NO.	NAME
7	Cockaponset State Forest
8	Chatfield Hollow State Park

KEY PLAN

NORTHEAST UTILITIES SERVICE COMPANY

EVACUABILITY STUDY AT HADDAM NECK NUCLEAR POWER STATION

Zone D-1, D-2, D-3 — FIGURE NO. 12

Prepared By
STORCH ENGINEERS
161 MAIN STREET - WETHERSFIELD, CONNECTICUT

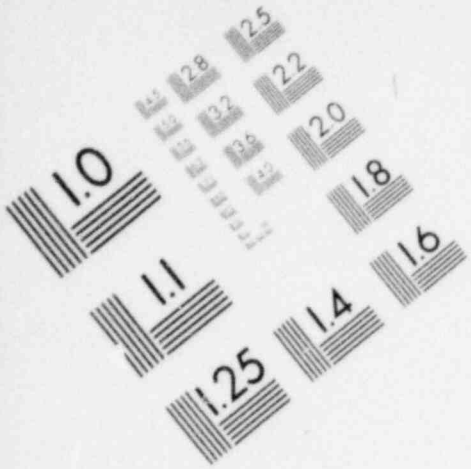
ZONES D1, D2, D3

Reference: Figure 12

Zones D1, D2, D3 encompass the entire 90 degree sector, 0-10 miles south and west of the nuclear power station in the Towns of Haddam, Durham, Killingworth, and Madison, and smaller portions of Middlefield, Middletown, and Chester. Residential population increases substantially in Zone D3, and the greatest population concentrations are to be found within the 9-10 mile annulus ring directly west of the nuclear power station in the Town of Durham. Additional transient population in Zone D3 is generated by Chatfield Hollow State Park in Killingworth, which accounts for 3,182 visitors during its peak summer day. There are four additional schools in Zone D3, an elementary, junior high, and senior high in Durham and an elementary school in Killingworth. Thus, Zones D1, D2, D3 contains a total of six schools with a combined enrollment of 3,193 students.

Evacuation Routes

State Highways 17, 79, and 148 form a circumferential evacuation route near the outer edge. Routes 17 and 79 have good alignment with a speed limit of from 40 to 45 mph. Route 148 has narrow travel lanes and many curves which restrict capacity and result in a maximum speed limit of 25 mph. Roadways which intersect the circumferential route are available for use in evacuation. These radial routes are State Highways 147, 68, and 17 in Durham, the southbound extension of State Highway 79 in Madison, and the southbound extension of State Highway 81 in Killingworth. There are traffic signals at the intersection of Route 17 with Routes 68 and 79 and a flashing yellow signal at Routes 17 and 147. The speed limit on Route 81 is 45 mph and there is a traffic rotary at its junction with State Highway 80 near the outer limit of Zones D1, D2, D3.



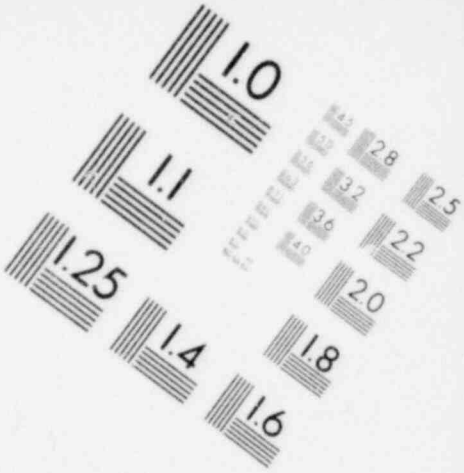
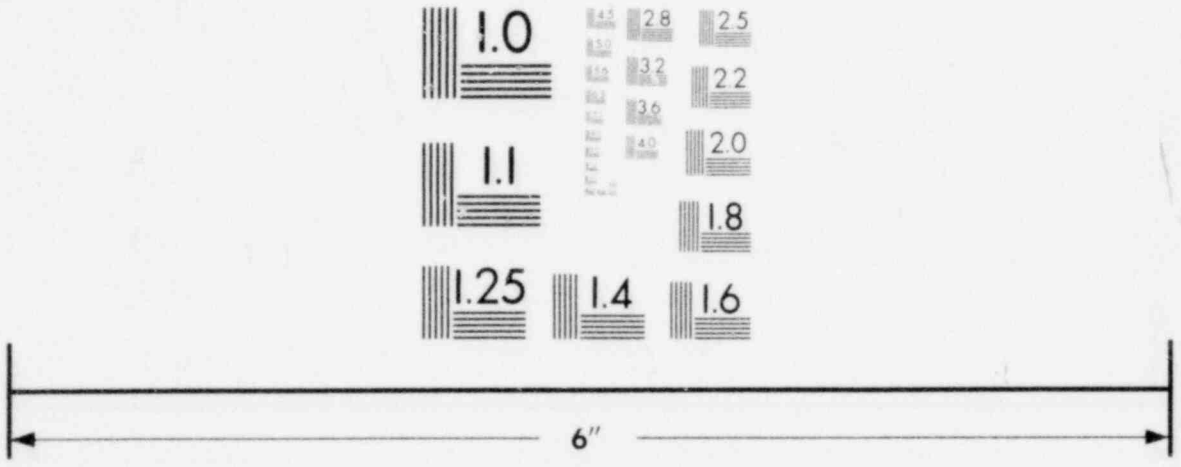
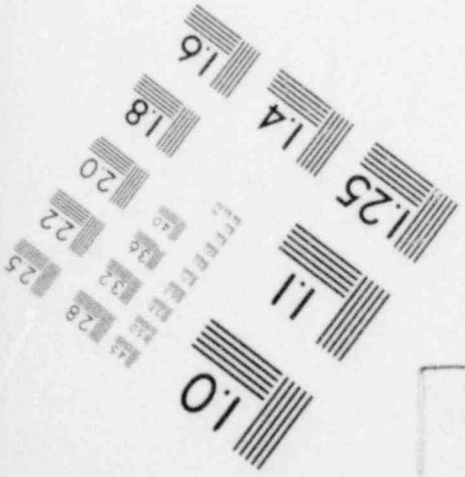
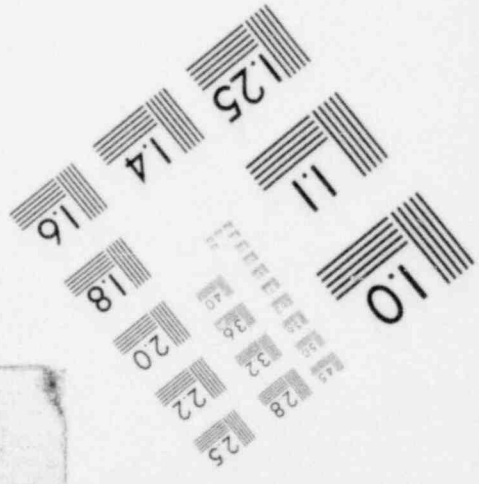


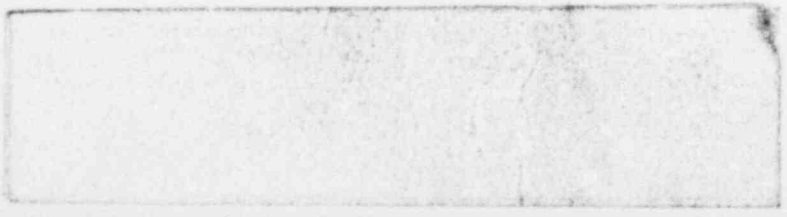
IMAGE EVALUATION
TEST TARGET (MT-3)



MICROCOPY RESOLUTION TEST CHART







For evacuation near the center of Zones D1, D2, D3, there are two local roads which are adequately designed to serve for additional capacity. These streets are the combination of Higganum/Candlewood/Hill Roads and Maiden/ Johnson/Foothills Roads.

Evacuation Time Evacuation Routes 9, 81, Higganum/Candlewood/Hill Roads, Maiden/Johnson/Foothills Roads, Route 17, Routes 148 and 79 (Capacity = 8,791 vehicles per hour)

Population	Residential	Transient	School
Zone D1	1029	407	---
Zone D2	1606	1465	1627
Zone D3	7691	3182	1566
TOTAL	10326	5054	3193

The Town of Durham has 19 school buses of 44 passengers each. Assuming that there is one personal vehicle for every four students at Coginchaug Regional High School in Durham, the number of school buses required will be (1566 - 597/4)/44 = 32.2 or 33 buses[7].

The Town of Killingworth provides 30 buses of 44 passengers each. The number of buses required for the 467 students at Killingworth Elementary School in Zone D3 is 467/44 = 10.6 or 11 buses.

Combining the school bus requirements for Zone D3 with the previously computed number of school buses for Zone D1, D2 results in 78 buses to evacuate students from Zones D1, D2, D3.

EVT = (10326/1.5 + 5054/1.5 + 366*)(60/8791) = 73 minutes

[7]The number of school buses to Durham would be undoubtedly supplemented by Killingworth as per the Mutal Aid Agreement between these towns.

*Zone D2 = 138 vehicles plus 34 school buses = 172

Zone D3 = 150 vehicles plus 44 school buses = 194

366

Thus, the evacuation time for this 0-10 mile 90 degree combination of Zone D1, Zone D2 and Zone D3 is 366 minutes.

IV. CONCLUSIONS

The objective of this study of the transportation system of the area around the Haddam Neck Nuclear Power Station in the Town of Haddam, Connecticut has been to determine the notification and evacuation times for various designated zones of the area within a 10-mile radius.

While much of the study area is not densely populated, there are concentrated centers of residential development, primarily in Middletown, which substantially increase the evacuation time for Zones A1, A2, A3 (north and west of the nuclear power station). The residential population in these zones is over half the total residential population for the entire 10-mile study area circle. Furthermore, Zones A1, A2, A3 contain three of the four major employers within the study area, accounting for over 90 percent of the transient major employer population. There are eight major recreational State parks and forests within the study area, which account for an estimated total of 23,758 visitors on their peak demand summer day. Three of these recreational facilities are within Zones B1, B2, B3 which generate 7,503 visitors. However, the greatest recreational demand impact on evacuation time is from Zones C1, C2, C3, in that Gillette Castle State Park could potentially attract 10,484 persons during a peak summer day. However, visitors at this location are transient, with probably less than one third of the daily visitors on the grounds at any one time.

The high residential population in Zones A1, A2, A3 is accompanied by a proportionally large school enrollment, particularly in Middletown. In Zones A1, A2, A3 there are six schools, all in Middletown, which together comprise 2,773 students, or one fifth of the total study area pupils. According to the evacuation analysis, more school buses would be required to

evacuate this zone of schools were in session. This may require reassignment of school buses from one school system to another and also involves control of vehicle departure to insure that all buses are fully loaded. It should also be pointed out that the number of students per personal vehicle (assumed to be one) used in the evacuation time calculation is extremely conservative.

The major roadway network available for evacuation has a basic northwest/southeast orientation, dictated by the Connecticut River which passes in this direction through the entire study area. There are only two vehicular crossings of the Connecticut River in the study area, and, as a result, Zones in Sectors A and C required separate analyses for evacuation on either side of the River. The key evacuation route providing the greatest evacuation capacity is Route 9, which is a limited access, grade separated, four-lane divided highway built to Interstate highway standards and posted for 55 mph speed. To supplement the capacity of Route 9, numerous two-lane State highways as well as certain connecting local feeder roadways are present in each of the four sectors to carry evacuating traffic. The exception is within Sector C on the north side of the Connecticut River, where the combination of limited evacuation routes and substantial demand from Gillette Castle State Park results in a relatively high evacuation clear time estimate.

As previously discussed, adverse weather conditions would reduce capacity and increase evacuation time by 20 to 30 percent for average precipitation conditions.

Table 5 summarizes the evacuation times for the ten zones analyzed during good and adverse weather conditions. In those cases where the zone

was divided into two parts for analysis purposes, the evacuation time in the Table is the maximum time computed. A review of this data shows that the longest evacuation time will be 5 hours, 2 minutes for Zones A1, A2, A3 in good weather, and this will be increased to 6 hours, 58 minutes for adverse weather conditions.

It is highly emphasized that this report addresses notification times and evacuation times using very conservative assumptions. For example, the calculation of the public notification times relies on mobile vehicles equipped with PA systems, although radio and television would certainly be available for notification. Moreover, the public notification analysis relied on using only town and some State Police vehicles (from nearby Troops), even though the Connecticut State Police Headquarters, the National Guard and other towns could also be able to provide vehicles. With regard to evacuation time estimates, as previously pointed out, the same individual is, in some cases, counted both in the resident and transient (workers and recreational) population which increases the number of vehicles to be evacuated and the total evacuation time. Further, it is very conservative to assume that the transient population (70 percent of the resident population) is present in its entirety during adverse weather conditions when recreational areas would probably not be in use. To add workers into the transient population is again conservative since major industrial plants would be closed on holiday weekends when peak recreation population occurs.

Towns may elect to have embarkation/debarkation points established for the orderly movement of people during an evacuation and this arrangement should considerably reduce evacuation times due to less reliance on privately

owned vehicles. Roadways used for evacuation during this study could change based upon State and local input during the upgrading of the State of Connecticut RERP expected to take place in mid 1980-1981. Thus, Table 5 times are the expected worst case evacuation times for all zones within the study area.

In summary, while all of the assumed conditions have resulted in a high estimate of the public notification and evacuation times, they are a basis for optimizing future emergency planning efforts.

TABLE 5

NOTIFICATION AND EVACUATION TIME[4]

Zone	Maximum Population*	Notification Time (Minutes[1,2])	Evacuation Time[3] Good Weather	Evacuation Time[3] Adverse Weather
AB1	904	20	47	59
A1, A2	8,191	57	121	152
A1, A2, A3	50,881	175[5]	302	418
B1, B2	5,123	59	106	133
B1, B2, B3	16,583	325	161	202
CD1	1,616	22	51	64
C1, C2	2,636	65	59	74
C1, C2, C3	29,144	260	235	294
D1, D2	6,134	65	31	44
D1, D2, D3	18,573	208	73	99

[1]The Notification Time does not include 15 to 43 minutes to notify public authorities

[2]Notification Time could increase by 10 percent during adverse weather in line with evacuation time, both of which in this study rely on the use of vehicles

[3]Inclusive of special facilities (i.e., parks, schools, industries and hospitals)

[4]The Notification and Evacuation Times may overlap and are not directly additive

[5]Inclusive of Middlesex Memorial Hospital

*Residents, transients and school children

APPENDIX

DOCUMENT/ PAGE PULLED

ANO. 8004020424

NO. OF PAGES 1

REASON:

☐ PAGE ILLEGIBLE:

☐ HARD COPY FILED AT: PDR CF

OTHER _____

☐ BETTER COPY REQUESTED ON ____/____/____

☒ PAGE TOO LARGE TO FILM:

☒ HARD COPY FILED AT: (PDR) CF

OTHER _____

☒ FILMED ON APERTURE CARD NO. 8004020424