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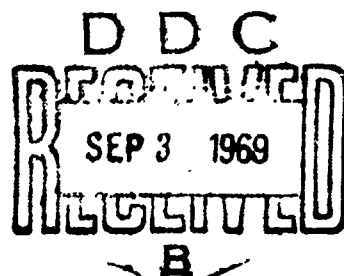
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DAMAGE TO AND ANALYSIS OF  
FIRE DEPARTMENT CAPABILITIES,  
CITY OF PROVIDENCE

Final Report  
March 1969

Contract No. N00228-68-C-1793  
OCD Work Unit 2522H



URS RESEARCH COMPANY



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*Wash, DC. 20310*

DAMAGE TO AND ANALYSIS OF  
FIRE DEPARTMENT CAPABILITIES,  
CITY OF PROVIDENCE

Final Report  
March 1969

by

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for

OFFICE OF CIVIL DEFENSE  
Office of the Secretary of the Army  
Washington, D.C. 20310

through

U.S. Naval Radiological Defense Laboratory  
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Contract N00228-68-C-1793  
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Five-City Study

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CONTENTS

<u>Section</u>	<u>Page</u>
Acknowledgements . . . . .	ii
Illustrations . . . . .	iv
Tables . . . . .	iv
Abstract . . . . .	v
Summary . . . . .	vi
1 INTRODUCTION . . . . .	1-1
Background . . . . .	1-1
Scope of Work . . . . .	1-1
2 PREATTACK DISTRIBUTION OF RESOURCES . . . . .	2-1
3 POSTATTACK CONDITION OF ALL FIRE-SERVICE PERSONNEL . . . . .	3-1
4 DAMAGE ESTIMATES FOR FIRE-SERVICE FACILITIES . . . . .	4-1
5 DAMAGE ESTIMATES FOR FIRE-SERVICE TRUCKS . . . . .	5-1
6 OTHER FIRE DEPARTMENTS IN THE PROVIDENCE AREA . . . . .	6-1
7 ANALYSIS OF REMAINING FIRE DEPARTMENT CAPABILITIES . . . . .	7-1
Personnel . . . . .	7-1
Facilities . . . . .	7-1
Trucks . . . . .	7-2
Demands on the Fire-Services . . . . .	7-2
Obstacles to Fire-Service Activities . . . . .	7-2
Potential Fire-Service Activities . . . . .	7-3
8 REFERENCES . . . . .	8-1

ILLUSTRATIONS

<u>Figure</u>		<u>Page</u>
1	Location of Providence Fire Department Facilities . . . . .	2-2

TABLES

<u>Table</u>		<u>Page</u>
1	Locations of Providence Fire Department Personnel, Trucks, and Facilities at Postulated Attack Time . . . . .	2-4
2	Condition and Location of Providence Fire Department Personnel After Postulated Attack . . . . .	3-2
3	Summary of Condition of Providence Fire Department Personnel After Attack . . . . .	3-3
4	Summary of Fire-Service Trucks . . . . .	5-2
5	Postattack Location and Condition of Resources for Other Fire Departments in the Providence Area . . . . .	6-2

ABSTRACT

This study examines damage to the Providence Fire Department as a result of the Five-City-Study attack and analyzes the capabilities of the Fire Department in dealing with the postattack fire situation. After reviewing damage incurred by personnel, facilities and trucks, the remaining fire-service resources were evaluated with respect to the magnitude of the demand situation and obstacles preventing the satisfaction of the demands.

## SUMMARY

The role of the Five-City-Study fire services in dealing with situations following nuclear attack will depend on how well the fire-service resources survive the attack and the magnitude and kinds of demands placed upon them. The demands facing the fire services are being analyzed in other research efforts. The study reported here evaluated damage to the fire departments of each city produced by the Five-City-Study attack. The evaluation proceeded through consideration of the following:

1. Strength and location of the fire services prior to the attack.
2. Casualties and damage incurred in the fire services as a result of the attack.
3. Analysis of the remaining capabilities in the postattack period.

Briefly summarized, the research reported here is for the city of Providence under conditions of the current plan, which calls for on-duty personnel moving to shelters near the fire stations and off-duty personnel moving to shelters located randomly around the city. The research yielded the following findings:

1. Firefighting personnel would experience total casualties on the order of 45% of their number. Of the remaining uninjured personnel only about one-third would be located with their officers and near their assigned fire stations. All of the casualties would be fallout injuries and almost all such personnel would be available for immediate postattack firefighting activities before complete incapacitation.
2. All the fire stations would be usable after the attack, but might require decontamination of radioactive fallout first. The Water Supply System would be essentially intact.
3. All fire-service trucks would be usable after the attack with the possible exception of those requiring decontamination.
4. The fire services would probably not be overwhelmed by the postattack fire situation. Potential activities which the fire services should consider include the following:
  - a. Patrolling missions, during which fire companies cruise around neighborhoods to discover and extinguish any structural fires.



- b. Aiding evacuation from areas where inadequate fallout protection threatens population survival.
- c. Performing selective radioactive decontamination of crucial areas to reduce the threat to sheltered population.
- d. Sending a portion of the fire services to other nearby communities in a mutual aid program to assist areas where the firefighting demands exceed the local capabilities to handle them.

Section 1  
INTRODUCTION

This report is one of five similar reports which are submitted under the provisions of Contract Number N000228-68-C-1793 between U.S. Naval Radiological Defense Laboratory and URS Research Company. The purpose of this report is to calculate the damage to the Providence Fire Department produced by a postulated nuclear weapon detonation (Ref. 1). The research effort of all five reports represents a component study (OCD Work Unit 2522H) of the Five-City Study being conducted by the Office of Civil Defense.

BACKGROUND

Previous research concerning fire-service capabilities was performed by URS under Contract N00228-67-C-0694 (OCD Work Units 2512A and 2522E). Work under this contract was primarily devoted to developing a generalized analytic scheme for evaluating the probable effectiveness of the fire services in handling requirements for damage control and rescue after nuclear attack (Ref. 2). In addition, the preattack distribution of fire-service resources for the five cities was determined and a preliminary analysis of the damage to the fire services for downtown San Jose was performed (Ref. 3). Other research work concerning fire-service capabilities was performed under Contract N00228-67-C-0710 (OCD Work Unit 2538C - Ref. 4). Under this contract, effort was directed at the development of an interim general model for calculation of the buildup and spread of fire in selected cities as a result of the nuclear attack specified in the Five-City Study. The results of all of the above efforts have been utilized as appropriate in the production of this report.

SCOPE OF WORK

The five reports submitted under the contract encompass the calculation and analysis of the damage to the fire departments in the cities of San Jose, Albuquerque, New Orleans, Providence, and Detroit as a result of the

Five-City-Study attack (Ref. 1). The output includes the following items for each city:

1. An analysis of the damage to and remaining capabilities of each fire department in the area.
2. A map overlay showing surviving usable facilities and the nature of damage to unusable facilities.
3. Tabulations of surviving usable equipment (trucks) and of the unusable equipment with the nature of damage indicated.

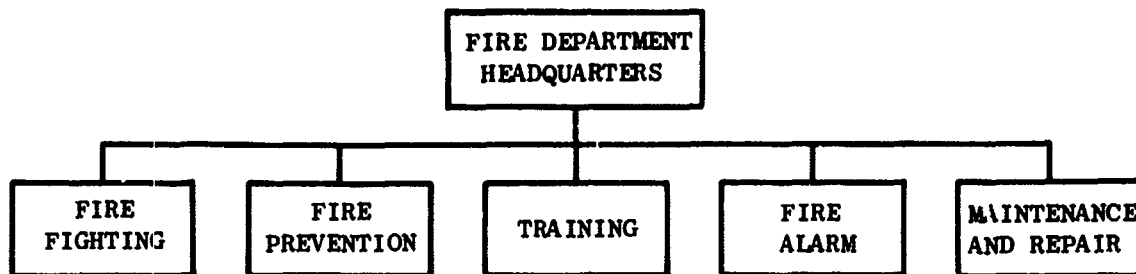
Reports for each of the five cities are bound separately. This report presents the results for the city of Providence.

Section 2  
PREATTACK DISTRIBUTION OF RESOURCES

The actual location of the various fire department resources at the time of the postulated attack is determined by the situation established in the Providence attack preparation scenario (Ref. 5), and the current roster of resources of the Providence Fire Department.

According to the attack preparation scenario (Ref. 5), Providence has been brought by a series of steps up to the highest level of preparedness for nuclear attack, with an estimated 90% of the population sheltered according to plan. No general evacuation has been ordered or has taken place.

Given the crisis buildup period as described in the above scenario, Fire Department responses to the situation have been identified (Ref. 6). The Providence Fire Department is organized basically as depicted below:



The locations of all Fire Department facilities are shown in Fig. 1, which also indicates the overpressure contours of interest associated with the postulated attack.

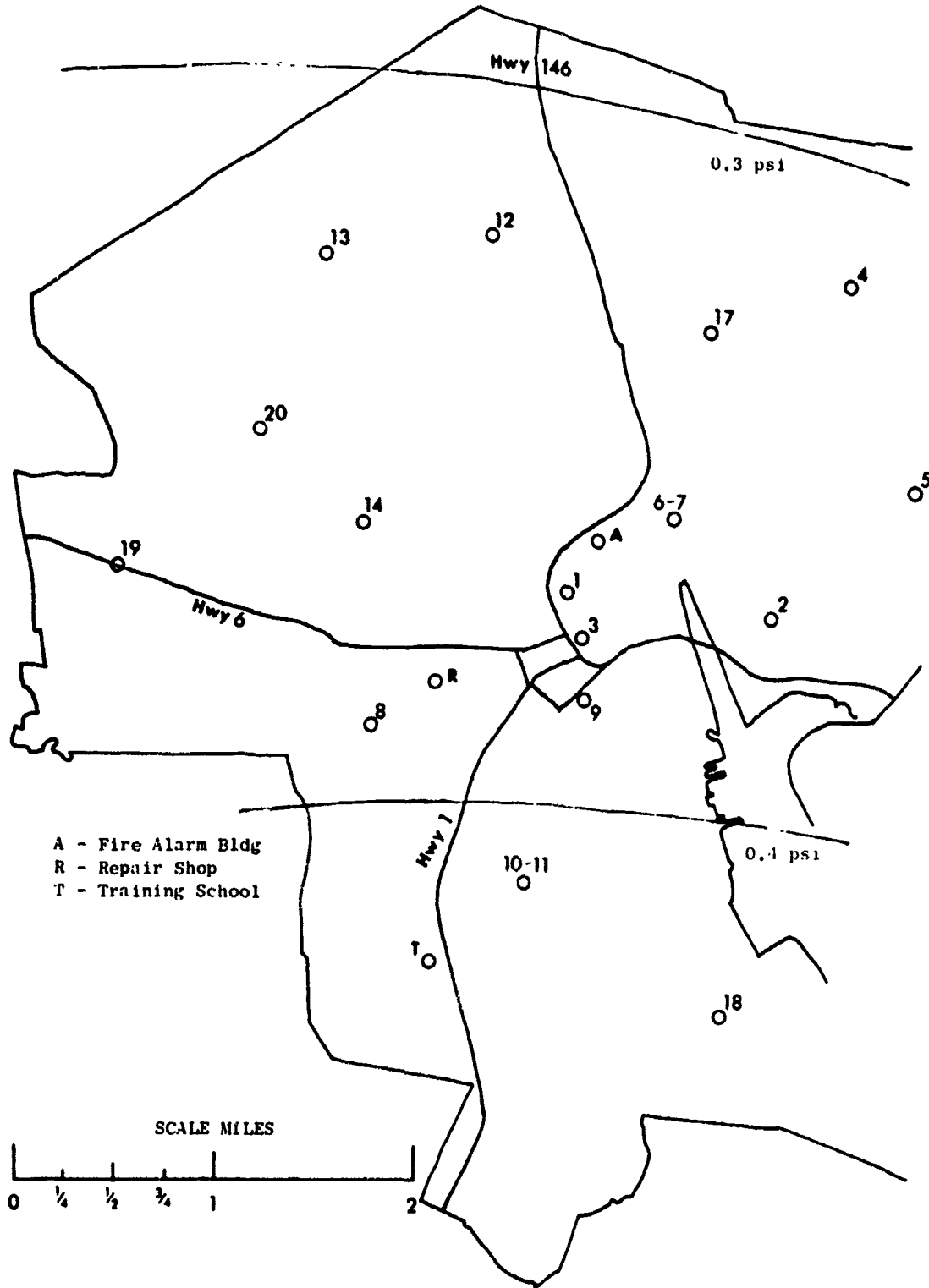


Fig. 1. Location of Providence Fire Department Facilities

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The locations of all personnel, trucks, and facilities at the time of the postulated attack are given in Table 1. It is assumed that all fire stations are being manned on a normal duty basis. The on-duty personnel will find shelter at attack time either in their facilities or in shelters located in the local Standard Location Area of their facility. The off-duty personnel are assumed to find shelter at random in shelters across the city.

Table 1  
 LOCATIONS OF PROVIDENCE FIRE DEPARTMENT PERSONNEL,  
 TRUCKS AND FACILITIES AT POSTULATED ATTACK TIME

FACILITY LOCATION	ADDRESS	PERSONNEL	TRUCKS
Fire Alarm & Signal Bldg.	Kinsley and Gaspee	6	-
Repair Shop	382 Dexter Street	-	-
Training School	274 Reservoir Avenue	-	1 pumper
ENGINE CO. NUMBER:			
1 *	209 Fountain Street	16	2 pumpers 1 ladder truck 1 rescue truck
2	Brook and Williams Streets	5	2 pumpers 1 ladder truck
3	33 Franklin Street	5	2 pumpers 1 ladder truck
4	220 Rochawocau Avenue	5	2 pumpers 2 ladder trucks
5	155 Humboldt Avenue	5	2 pumpers 1 ladder truck
6 & 7	151 North Main Street	15	3 pumpers 2 ladder trucks
8	201 Messer Street	14	1 pumper 1 ladder truck 1 rescue truck
9	350 Point Street	12	1 pumper 1 ladder truck 1 salvage truck
10 & 11	847 Broad Street	15	2 pumpers 1 ladder truck
12	426 Admiral Street	10	2 pumpers 1 rescue truck

\* Fire Department Headquarters.

Table 1, cont.

FACILITY LOCATION	ADDRESS	PERSONNEL	TRUCKS
13	673 Academy Avenue	5	1 pumper
14	630 Atwells Avenue	12	2 pumpers
17	10 Branch Avenue	16	2 pumpers 2 rescue trucks
18	776 Allen Avenue	5	1 pumper 1 foam truck
19	489 Hartford Avenue	5	2 pumpers 1 ladder truck
20	136 Mt. Pleasant Avenue	5	2 pumpers
In shelters located randomly around the city:			
	Administration	26	
	Fire Alarm	12	
	Repair	13	
	Fire Prevention	14	
	Training	3	
	Firefighting	301	



Section 3  
POSTATTACK CONDITION OF ALL FIRE-SERVICE PERSONNEL

Casualty curves have been developed for various building types by several investigators (Refs. 2, 7, and 8). By means of these curves, the number of survivors and their condition may be estimated for the shelter buildings of interest. It has been assumed that fire department personnel suffer casualties in the same ratio as the general population. Wherever necessary, specific mortalities and casualties in a group of personnel were assigned randomly. Overpressure levels associated with locations may be seen on Fig. 1.

It has generally been assumed that the only personnel available for duty after the hypothetical attack are those in the uninjured category. Some of the injured personnel, however, could be available for duty after a short period of medical treatment, and in some cases even injured firemen may be capable of performing normally.

Table 2 presents the location and condition of all fire-service personnel after the attack. A summary of the condition of all personnel is given in Table 3.

The casualty numbers given in Tables 2 and 3 are for fallout effects only since blast effects are too slight to cause casualties. Preliminary casualty estimates have been made by Dikewood (Ref. 9) for fallout effects and these estimates were applied to fire-service personnel. Injuries due to fallout effects would generally not become apparent for some time, and thus it is expected that firemen in this category would be available for duty in the immediate postattack period. Assuming that fire department personnel are affected in a manner similar to the general Providence population results in an estimated 200 fallout injuries for the fire-service personnel.

Table 2

CONDITION AND LOCATION OF PROVIDENCE  
FIRE DEPARTMENT PERSONNEL AFTER POSTULATED ATTACK

SHELTER LOCATION (Near the facility indicated)	CONDITION		
	KILLED	INJURED	UNINJURED
Fire Alarm & Signal Building	-	1	5
ENGINE COMPANY NUMBER:			
1*	-	6	10
2	-	2	3
3	-	2	3
4	-	2	3
5	-	2	3
6 & 7	1	8	6
8	1	8	5
9	1	5	6
10 & 11	-	5	10
12	-	4	6
13	-	2	3
14	-	5	7
17	3	9	4
18	-	2	3
19	-	2	3
20	-	1	4
Shelters located randomly throughout the city:			
Administration	1	10	15
Fire Alarm	1	5	6
Repair	-	5	8
Fire Prevention	-	5	9
Training	-	1	2
Firefighting	9	117	175

\* Fire Department Headquarters.

Table 3  
 SUMMARY OF CONDITION OF PROVIDENCE  
 FIRE DEPARTMENT PERSONNEL AFTER ATTACK

FIRE DEPARTMENT DIVISION	KILLED	INJURED	UNINJURED
Administration	1	10	15
Fire Alarm	1	6	11
Repair	-	5	8
Fire Prevention	-	5	9
Training	-	1	2
Firefighting	<u>15</u>	<u>182</u>	<u>254</u>
TOTALS	17	209	299

Section 4

DAMAGE ESTIMATES FOR FIRE-SERVICE FACILITIES

Facilities of the Providence Fire Department include Fire Department Headquarters, Fire Stations, the Fire Alarm and Signal Building, the Training School, the Repair Shop, and the Water Supply System.

The Water Supply System is actually under the jurisdiction of the Providence Water Supply Board (Ref. 10) but is vital to effective Fire Department operations and is therefore included. A preliminary evaluation indicates that the Water Supply System would be essentially intact.

Damage estimates for the various Fire Department facilities have been made utilizing the URS building damage prediction methods (Ref. 11). The facilities are primarily brick load-bearing buildings with similar response characteristics. On a gross basis, buildings experiencing less than 1-1/2 psi are considered completely operable since the only damage would be some broken windows. Buildings exposed to greater than 1-1/2 psi overpressure are of no concern to this report since overpressures this high would not occur in Providence for the postulated attack.

Section 5  
DAMAGE ESTIMATES FOR FIRE-SERVICE TRUCKS

Damage to fire-service mobile equipment must be estimated for two distinct categories. First, mobile equipment located inside (or immediately adjacent to) the fire department facilities. Damage in this category depends almost totally on damage to the facility itself. Second, mobile equipment located outside (and sufficiently separated from surrounding structures to be unaffected by damage to the structures). For this category a separate damage function related to overpressure is used (Ref. 2).

For vehicles inside facilities, the following damage levels apply:

OVERPRESSURE (psi)	DAMAGE DESCRIPTION
0 - 1-1/2	Completely operable; some windows broken
1-3/2 - 2-1/2	Light damage such as broken windows, bent and dented hood, fenders and compartment doors (up to 1/2 hour may be needed to restore operability)
2-1/2 - 4	Moderate damage such as wheels and/or engine damaged (1 to 2 hours required to restore operability)
4 - 5	Destroyed (or at least trapped in damaged building)

The trucks of the Providence Fire Department are assumed to be all stationed inside their normal facilities.

Since no more than 1-1/2 psi overpressure would be experienced in Providence, all Fire Department trucks indicated in Table 1 would be completely operable after the attack, suffering only some broken windows.

A summary of all Fire-Service trucks is given in Table 4. This summary indicates the number of various types of trucks which would be available for use after the postulated attack in Providence.

Table 4  
SUMMARY OF FIRE-SERVICE TRUCKS

TYPE OF TRUCK	NUMBER AVAILABLE
Pumpers	30
Ladder trucks	12
Rescue trucks	5
Foam trucks	1
Salvage trucks	<u>1</u>
TOTAL TRUCKS	49

Section 6

OTHER FIRE DEPARTMENTS IN THE PROVIDENCE AREA

In addition to the City of Providence, a number of other cities outside of Providence have professional fire departments which should be considered. Only those cities within 10 miles of the Providence city limits have been included since the Providence Fire Department would require excessive time to respond to the immediate needs of more distant cities\* and operational problems (command decisions and fallout levels) will probably prohibit travel to even this distance.\*\* It appears that the nearest significant firefighting demands would occur in the southern portion of Warwick City bordering Greenwich Bay. This area is about 6 to 7 miles from the Providence City Limits.

Table 5 presents a summary of the personnel, facilities, and trucks for the fire departments of each of the cities (Ref. 12). Damage estimates for these fire departments have been conducted using the following assumptions in the absence of detailed information for the cities involved:

1. Fire stations are located randomly in the cities, but those of each city are assigned equal areas to protect.
2. Fire stations are all assumed to be of brick load-bearing construction.
3. All fire-service personnel are located at or near the fire stations and experience casualties similar to the Providence general population located at corresponding overpressure levels.
4. All fire department vehicles are located within the fire stations.

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\* This had been done in spite of any mutual aid agreements with cities more distant than 10 miles.

\*\* A further discussion of these points will be made in Section 7.

Table 5  
 POSTATTACK LOCATION AND CONDITION OF RESOURCES FOR OTHER FIRE DEPARTMENTS IN THE  
 PROVIDENCE AREA

CITY	TOTAL PERSONNEL	CASUALTIES		FIRE STATIONS		VEHICLES	
		KILLED	INJURED	NUMBER	CONDITION	NUMBER	CONDITION
Central Falls	30	1	11	2	operable	6	operable
Cranston	106	3	41	8	operable	28	operable
East Providence	103	3	40	4	operable	22	operable
Pawtucket	145	4	56	8	operable	17	operable
Warwick	119	4	59	8	6 operable 2 lightly damaged	35	26 operable 9 lightly damaged



## Section 7

### ANALYSIS OF REMAINING FIRE DEPARTMENT CAPABILITIES

This section will summarize the results of previous sections and attempt to analyze the remaining capabilities of the Providence Fire Department. This analysis will include considerations of the magnitude of the demands on the Fire Department, obstacles hampering fire-service performance, and alternative actions by the fire department.

#### PERSONNEL

Top management personnel of the fire department would survive fairly well. The Fire Chief and 60% of the Battalion Chiefs would be uninjured. Communications and repair personnel similarly would escape with over 60% of their numbers uninjured. The Firefighting Division would have about 45% casualties,\* with only 3% killed. The uninjured 55% comprise two groups. Just under one-third of them are located with their officers near their assigned fire stations, which would facilitate appropriate actions being taken by these men. The remainder are located randomly around the city and could not immediately reach their assigned stations.

The 79 men of the Firefighting Division who are located near their assigned fire stations represent about one-half of the normal on-duty strength for these stations.

#### FACILITIES

No facility would be rendered inoperable by blast damage. However, because of the radioactive fallout which Providence would experience, the fire stations and other facilities could require considerable decontamination, before they could be safely used.

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\* It should be noted that all of these casualties are fallout injuries, and such injuries would not become apparent until some time after the attack.

## TRUCKS

All fire-service trucks would be completely operable after the postulated attack. This is a consequence of the minor blast damage which the city would experience. Considerable decontamination of the trucks could be required, however, before they could be safely used.

## DEMANDS ON THE FIRE SERVICES

An examination of the applicable Fire-Behavior Model\* (Ref. 4) indicates that Providence would probably not experience any structural fires ascribable to weapon effects. The only fires which the fire department would be faced with would be those of conventional origin and those resulting from the fact that buildings are left unattended. One measure of the potential fire problem can be obtained from the Providence Fire Department Annual Report (Ref. 13). Under normal circumstances an average of 17 fire alarms were received per day in 1965. This figure would be reduced during a nuclear attack situation due to the lack of industrial and other activity, but might be increased due to unattended sources. It appears that the number of fires would probably not be beyond the capabilities of the Fire Department.

## OBSTACLES TO FIRE-SERVICE ACTIVITIES

Fire-service activities performed in the immediate postattack period would be hampered only by the possible need to remove fallout contamination from facilities and equipment.

As indicated previously, the fire department would ultimately experience over 200 casualties from fallout effects. This is based on the average fallout injury rate in the Providence area. With firefighters working outside in response to demands on the fire services, it could be expected that an even greater injury rate would be noted. The magnitude of the effect has, however,

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\* The analogy with the results of the New Orleans attack (also a ground burst) is made in order to infer results in Providence.

not even been estimated since it is expected that fire-service personnel will proceed with their duties, and such injuries will probably not become evident until after urgent transattack activities have been completed.

#### POTENTIAL FIRE-SERVICE ACTIVITIES

Immediately after the postulated attack on Providence, the fire services, along with the general population, would be located inside their assigned fallout shelters. Radioactive fallout levels would be quite significant. In spite of the lack of immediate local demands for firefighting, there are a number of beneficial activities which the fire services could perform. Among such activities are the following:

1. Periodic patrols could be conducted around the various areas of the city to discover and extinguish any structural fires. Such patrolling would spot fires in structures whose occupants are sheltered elsewhere and would enable the extinguishment of fires before major involvements occurred. The benefits derived from this activity would have to be balanced against the adverse effects of exposing the firefighters to radioactive fallout. A rotation of patrol crews could be instituted to keep this problem to a minimum.
2. The fire services could assist in evacuation of personnel to more adequate fallout shelters, i.e., shelters capable of withstanding the radiation threat.
3. The fire services could perform selective fallout decontamination around shelters in order to reduce the radiation threat.
4. The fire services could send a portion of their forces to the nearby communities of Cranston and Warwick, to the south of Providence. These forces would be acting in a mutual aid program directed towards providing assistance to the area around Greenwich Bay, where the firefighting demands could exceed local firefighting capability. Such activity would require careful arrangement of forces to ensure that no areas within Providence were left without some firefighting protection. Consideration would also have to be given to the problem of radiation exposure associated with the travel involved.

It must be recognized that all of the above activities would require pre-planning on the part of the fire services. Under the present strategy the fire services would remain in the shelters until higher authority gives them specific orders to do otherwise or until fires resulting from natural causes or

non-attendance posed an obvious threat to the survival of the sheltered population. To correct this situation, if indeed it needs correcting, requires careful consideration of what combination of circumstances justify exposing the fire services to the risks involved in leaving shelter to perform essential tasks.

Section 8

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