GEOGRAPHIC INFORMATION SYSTEM (GIS)
FIRE SUPPRESSION AND
EMERGENCY MEDICAL SERVICES
RESPONSE CAPABILITIES ANALYSIS

International Association of Fire Fighters
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FAIRVIEW FIRE DISTRICT

FAIRVIEW, NEW YORK

OCTOBER 22, 2004

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ABSTRACT

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In February of 2004, the International Association of Fire Fighters (IAFF) was contacted by the Dutchess-Fairview Professional Fire Fighter's Association, IAFF Local 2623, to perform a Geographic Information System (GIS) analysis of the Fairview Fire District. Local 2623 requested that the GIS study evaluate the 4- and 8-minute response capabilities of fire department units deploying from existing fire station locations, and examine staffing conditions that prevail in the department. The Fire Fighter's Association requested that the results of the GIS mapping be assessed against existing National Fire Protection Association (NFPA) professional standards and Occupational Safety & Health Administration (OSHA) safety regulations, including compliance with NFPA 1710 staffing performance objectives and the OSHA "2 In/2 Out" regulation. The procedures involved in this analysis consisted of the generation of GIS mapping response scenarios under the existing staffing and deployment configuration, a statistical analysis of fire department response capabilities, and an evaluation of GIS outcomes measured against NFPA standards and OSHA regulations.

Findings

Analysis of existing Fairview Fire District staffing and deployment practices reveals that only four firefighters are on duty at any given time to respond to emergencies within the response jurisdiction. These four personnel staff and deploy a fire engine, ladder truck, and two ambulances. At no time, however, do these units deploy with more than two career firefighters. As a result, the fire department does not meet compliance with the company staffing objectives outlined in NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, and NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations and Special Operations to the Public by Career Fire Departments*. Each of these professional standards require that in order to safely and effectively deliver the range of emergency services provided by the fire department, **all fire suppression companies should deploy with at least four firefighters.**

The deployment of fire suppression companies staffed with less than four firefighters is a regular occurrence. Normally, the department responds with only two career people on an apparatus for each alarm. For example, two career staff respond the ambulance to a medical emergency. This depletes available staffing to only two firefighters available to respond to simultaneously occurring alarms. There are many times when an apparatus deploys with only a single firefighter while other on-duty personnel are engaged on a simultaneously occurring alarm. Overlapping incidents account for approximately 16% of all alarms, deplete available on-duty staffing, and often result in no personnel remaining at the station to respond to other emergencies or to fulfill contractual mutual aid obligations. Personnel performing regularly-assigned duties, such as building inspection and fire prevention, also result in firefighter unavailability and exacerbate existing staffing deficiencies.

The practice of cross-staffing emergency response units further compounds existing staffing deficiencies. Cross-staffing is a practice whereby emergency responders staff several types of emergency response vehicles simultaneously in a work period. The type and scope of an emergency (i.e., structure fire, vehicle accident) dictate which type of emergency response vehicle (i.e., engine, ambulance) the emergency responders staff for an incident. The fire department currently requires that engine company personnel cross-staff a ladder truck, an ambulance, and secondary units housed at that station. In order to effect a response of the ambulance, fire department personnel are required to abandon their primary (frontline)

apparatus and deploy the ambulance. The benefit of this arrangement is that it provides the community with the resources of an ambulance. The overriding drawback, however, is that it results in staffing deficiencies that undermine firefighter efficiency, and compromise the safety of firefighters and citizens living in the communities they protect.

Recommendations

The IAFF's GIS-based recommendations are rooted in the safe and efficient delivery of the range of emergency services to citizens living within the Fairview Fire District, and include maintaining dedicated staffing of *at least* four multi-role fire fighters, in compliance with NFPA 1710 and NFPA 1500, on all engine and truck companies. The ambulance should be provided with dedicated staffing, and the practice of cross-staffing said unit with engine company personnel should be discontinued. It is also recommended that the Fairview Fire District make efforts to enhance EMS capabilities by ensuring that all fire fighters are trained *at least* to the "Basic" level of Emergency Medical Technician (EMT-B).

A synopsis of the major findings and recommendations is included at the end of this study as "Appendix A".

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This report summarizes the results of a station location, staffing, and emergency vehicle response time analysis for the Fairview Fire District and IAFF Local 2623. This computer-based analytical study examines predicted response times and geographic coverage areas for emergency response units deployed from the central fire station of the Fairview Fire District.

The Fairview Fire District is the primary provider of fire, rescue, and disaster and emergency services in the Fairview section of the Town of Poughkeepsie and Hyde Park, in the State of New York. Currently, the fire district does not meet compliance with the company staffing objectives of national industry standards, which require all fire suppression companies to deploy as four-person crews. Rather, the department cross-staffs its emergency units, dividing engine company personnel between an ambulance and ladder truck. Cross-staffing the four on-duty personnel between the three frontline units- the engine, the truck, and the ambulance- results in the frequent deployment of emergency units staffed with only two firefighters. If, however, all four on-duty firefighters are not immediately available to respond, staffing can (and does) fall as low as a single firefighter on the engine and the ladder truck.

The practice of deploying fire companies with *less than* four fire fighters puts public safety at a greater risk for the loss of life and property. Assessment of the critical tasks required for an interior fire attack establishes the impact that reduced staffing has on the effectiveness of fireground operations involving a single-family residential structure.

TABLE 1:

IMPACT OF CREW SIZE ON FIRE ATTACK IN A RESIDENTIAL STRUCTURE[1]
(First Alarm Assignment)

Apparatus	1st Engine Company		2nd Engine Company		Ladder Company		
Fireground Tasks	Charge Initial Interior Line and Advance	Locate and Rescue Victim(s)	Charge Interior Support Line and Advance	Charge Exterior Line and Advance	Roof Ventilation	Search & Rescue	Check Exposures for Fire Extension
5 Firefighters	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
4 Firefighters	84.7%	96.1%	77.9%	72.9%	79.0%	90.3%	80.2%
3 Firefighters	71.3%	82.8%	**0.0%**	**0.0%**	**0.0%**	79.6%	**0.0%**

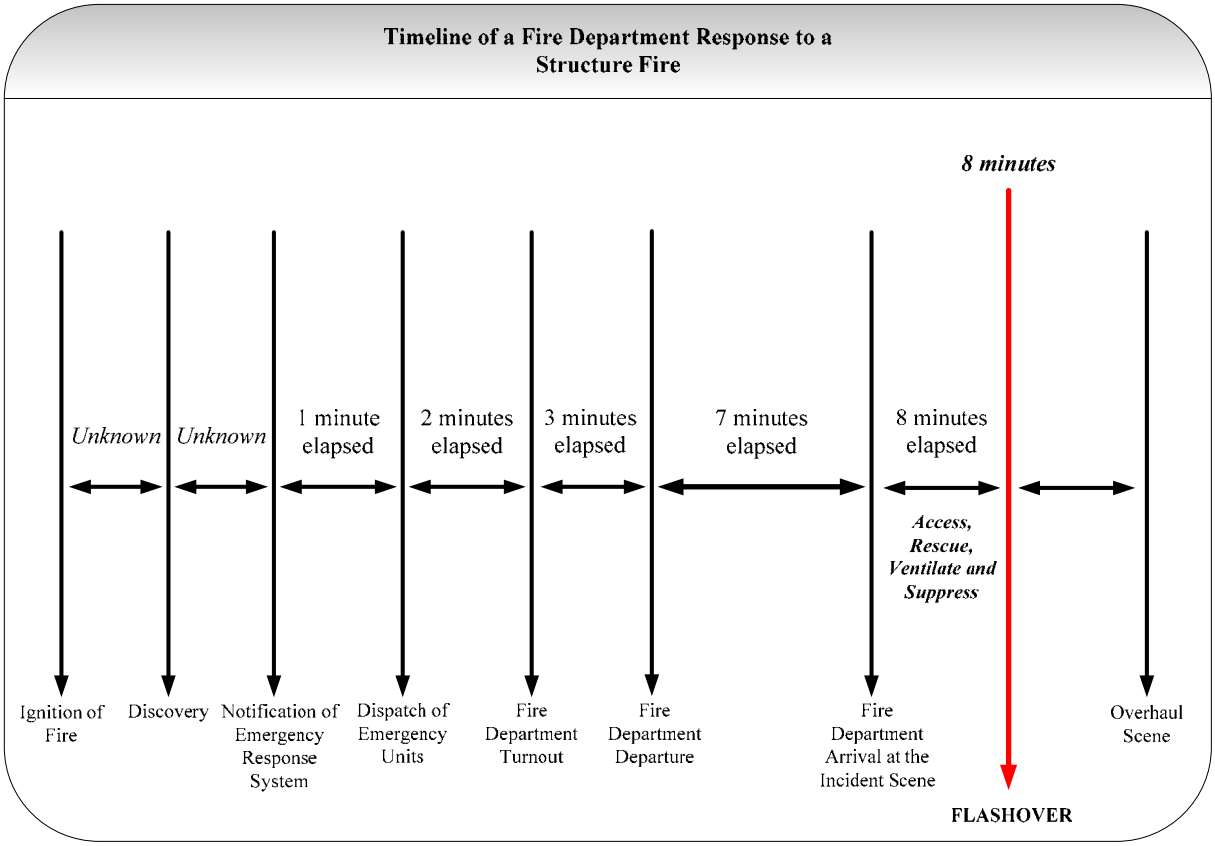
Staffing deficiencies negatively impact the ability of the fire department to safely and effectively mitigate emergencies, and correlate directly with an increase in expected life, property, and economic losses. Fire growth- the rate of spread and the intensity of the fire- is directly linked to the time it takes to initiate fire suppression operations. As is indicated in Table 1, companies staffed with four firefighters are capable of initiating critical fireground tasks in significantly less time than those staffed below national standards.

As rule, a fire doubles in size for every minute that passes without the application of aggressive fire suppression measures. In less than 30 seconds a small flame can rage completely out of

[1] McManis Associates and John T. O'Hagan & Associates, Dallas Fire Department Staffing Level Study, (June 1984); pp. 1-2 and II-1 through II-7; Richard C. Morrison, Manning Levels for Engine and Ladder Companies in Small Fire Departments, (1990)

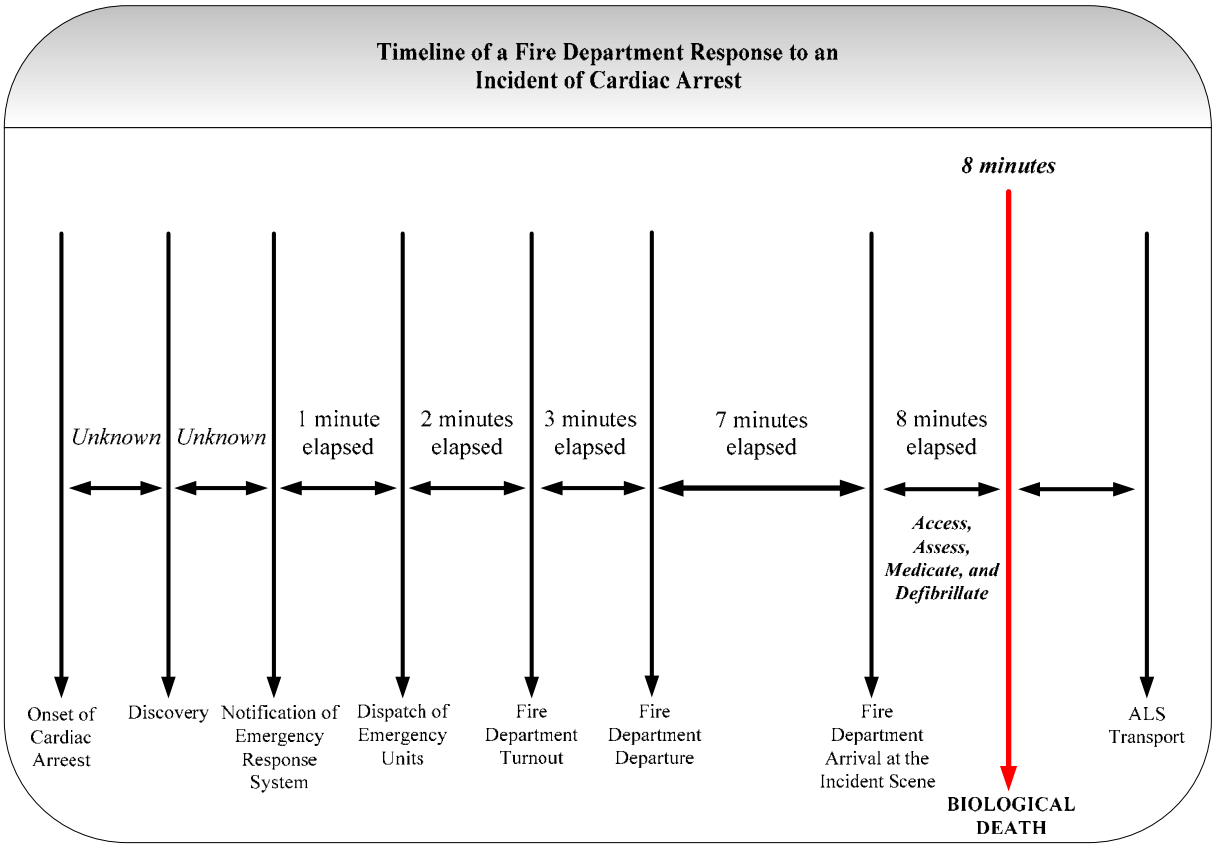
control and turn into a major fire. During fire growth, the temperature of a fire rises to 1,000° to 1,200° F. Flashover at 1,100° to 1,200° F. may occur in a burning room within four minutes. At this point, the odds of survival for individuals inside the structure- both victim and rescuer- are virtually non-existent. The rapid response of an appropriate number of firefighters is therefore essential in initiating fire suppression and rescue operations.

FIGURE 1:



The response to medical emergencies such as a cardiac arrest mirrors the time-temperature curve for fire growth. Cardiac arrest is one of the most time-critical medical emergencies that can be treated in the field. The highest hospital discharge rate has been achieved in patients in whom CPR was initiated within 4 minutes of arrest and advanced cardiac life support within 8 minutes. Fast emergency medical response is therefore essential not only in initiating fire suppression and rescue operations, but in improving survival rates for medical emergencies, as well.

FIGURE 2:



Units staffed with less than four firefighters also drain limited fire department resources, as an increased number of emergency units are required to be allocated to an incident in an effort to achieve appropriate on-scene staffing. The allocation of a greater number of mobile resources (i.e., fire engines and trucks) to an incident in an effort to assemble an appropriate number of human resources (i.e., firefighters) stresses the emergency response system. This condition, a direct result of inadequate staffing, is exacerbated by current cross-staffing practices, and could be further compounded by response delays due to unit unavailability. Innumerable studies validate similar findings: adequately staffed fire suppression companies responding in a timely fashion are able to initiate and perform emergency scene operations more safely, more effectively, and with greater success than under-staffed companies. Furthermore, adequately-staffed emergency units support the overall integrity of the response system by ensuring that sufficient resources, both mobile and human, are available to respond to multiple incidents occurring simultaneously. Insufficient resources, as exist currently in the Fairview Fire District, result in rapid resource depletion, stressing the emergency response system and increasing the risk of the loss of life and property.

The primary conclusion drawn from analysis of the Fairview Fire District is that the fire department does not reliably meet compliance with existing national standards. Existing staffing and deployment policies negatively impact the ability of rescue personnel to provide the safe and effective delivery of fire suppression and rescue services, increasing the risk posed to firefighters and civilians.

Specific recommendations begin on Page 10 of this report.

RECOMMENDATIONS

RECOMMENDATIONS

Based on the findings discussed in this document, the following recommendations are made:

- **The Fairview Fire District should pursue efforts to staff an engine company on a 24-hour basis with *at least* four multi-role fire fighters cross-trained as emergency medical service (EMS) providers.**[2] NFPA Standard 1710 recommends "fire companies, whose primary functions are to pump and deliver water and perform basic fire fighting at fires, including search and rescue… shall be staffed with a minimum of four on-duty personnel."[3] Recent studies indicate that four fire fighters are capable of performing the rescue of potential victims 80% faster than a crew of three fire fighters. *Currently, no engine company is consistently staffed in compliance with NFPA 1710 company staffing objectives.*

- **The Fairview Fire District should pursue efforts to staff the ladder truck on a 24-hour basis with *at least* four multi-role fire fighters cross-trained as emergency medical service (EMS) providers.**[4] NFPA Standard 1710 recommends "fire companies whose primary functions are to perform the variety of services associated with truck work, such as forcible entry, ventilation, search and rescue, aerial operations for water delivery and rescue, utility control, illumination, overhaul and salvage work… shall [also] be staffed with a minimum of four on-duty personnel."[5] *Currently, the ladder company is not consistently staffed in compliance with NFPA 1710 company staffing objectives.*

- **The Fairview Fire District should staff the ambulance on a 24-hour basis with two multi-role fire fighters cross-trained as emergency medical service (EMS) providers.**[6] *Currently, the ambulance is cross-staffed with on-duty personnel, who, as a result of cross-staffing, are not always available to deploy the ambulance.*

These measures will work to ensure that the Fairview Fire District evolves into compliance with established OSHA regulations and NFPA industry standards. Moreover, it promotes safer and more effective fire suppression and disaster incident mitigation, while expediting the delivery of essential emergency medical services to those residing in and visiting the Fairview Fire District.

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[2] NFPA Standard 1710, §5.2.2.1.2 and §5.2.2.2.2, recommends that: "In jurisdictions with tactical hazards, high hazard occupancies, high incident frequencies, geographical restrictions, or other pertinent factors as identified by the authority having jurisdiction, these companies shall be staffed with a minimum of five or six on-duty members."

[3] NFPA 1710, §5.2.2.1 and §5.2.2.1.1

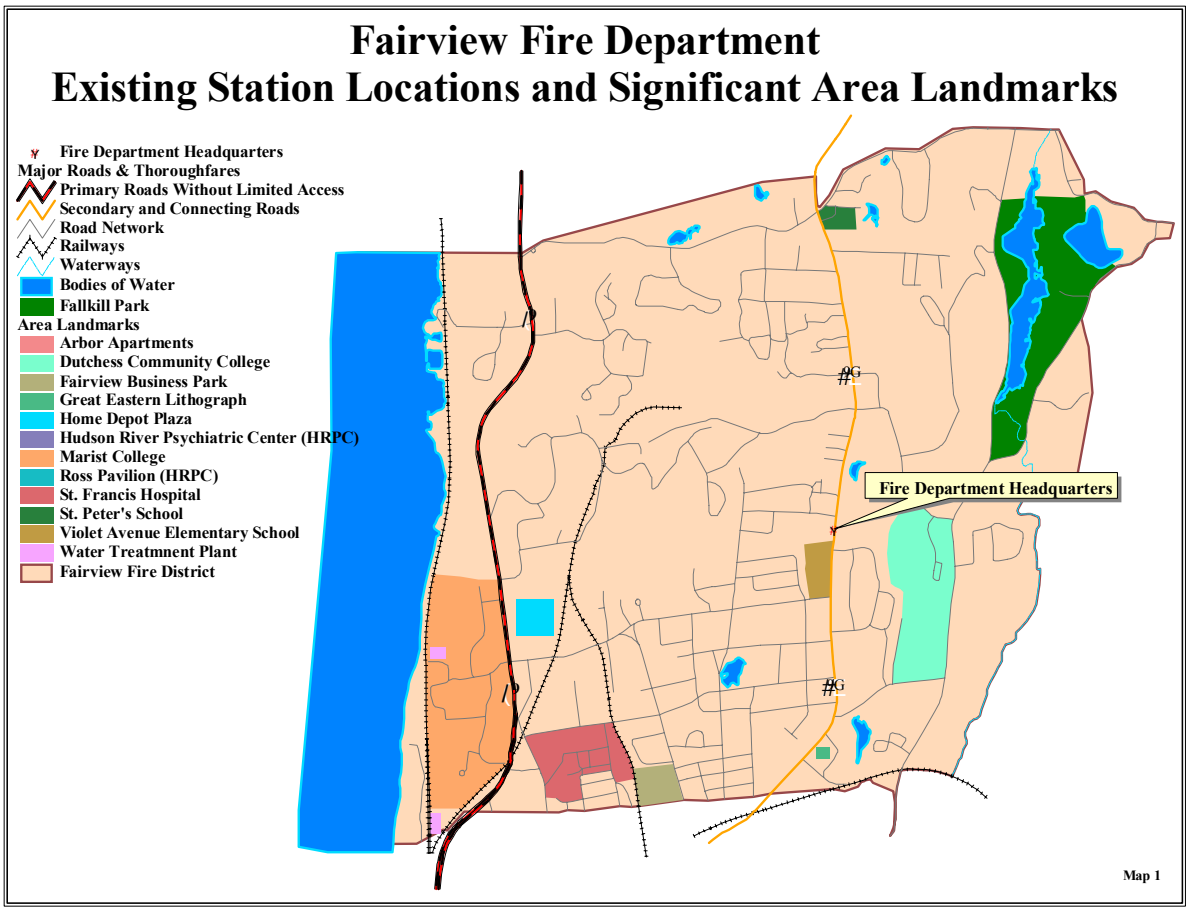
[4] NFPA 1710, §5.2.2.1.2 and §5.2.2.2.2

[5] NFPA 1710, §5.2.2.2 and §5.2.2.2.1

[6] NFPA 1710, §5.2.2.1.2 and §5.2.2.2.2

CITY OVERVIEW

MAP 1



Map 1 indicates the Fairview Fire District's response jurisdiction, noting major roads and highways, railways, waterways, and the locations of significant area landmarks and fire department headquarters. Fairview Fire Headquarters is located in the Town of Poughkeepsie in Dutchess County, in the State of New York. The response jurisdiction covers an area of 8 square miles, and encompasses the entirety of the Towns of Poughkeepsie and Hyde Park.

GEOGRAPHY[7]

Dutchess County is located in eastern New York State, between the Hudson River on its west and the New York-Connecticut border on its east, about halfway between the cities of Albany and New York. It contains two cities: Beacon and Poughkeepsie. The fire department's response jurisdiction encomapsses parts of both Poughkeepsie and Hyde Park.

DEMOGRAPHICS[8]

As of the census of 2000, there are 280,150 people, 99,536 households, and 69,177 families residing in the county. The population density is 350 per square mile. There are 106,103 housing units at an average density of 132 per square mile. The racial makeup of the county is 83.7% White, 9.3% Black or African American, 0.2% Native American, 2.5% Asian, 0.03%

[7] Wikipedia.org < http://en.wikipedia.org/wiki/Dutchess_County > Site visited July 21, 2004.
[8] Ibid.

Pacific Islander, 2.4% from other races, and 1. 9% from two or more races. Six and one-half percent of the population are Hispanic or Latino of any race.

There are 99,536 households out of which 34.5% have children under the age of 18 living with them, 55.5% are married couples living together, 10.3% have a female householder with no husband present, and 30.5% are non-families. Approximately 25% of all households are made up of individuals and 9% have someone living alone who is 65 years of age or older. The average household size is 2.63 and the average family size is 3.16.

In the county the population is spread out with 25.1% under the age of 18, 9.4% from 18 to 24, 30.2% from 25 to 44, 23.2% from 45 to 64, and 12% who are 65 years of age or older. The median age is 37 years. For every 100 females there are 100.1 males. For every 100 females age 18 and over, there are 98.2 males.

The median income for a household in the county is $53,086, and the median income for a family is $63,254. Males have a median income of $45,576 versus $30,706 for females. The per capita income for the county is $23,940. Seven and one-half percent of the population and 5% of families are below the poverty line. Out of the total people living in poverty, 8.5% are under the age of 18 and 6.5% are 65 or older.

FIRE DEPARTMENT OVERVIEW

OVERVIEW OF FIRE DEPARTMENT OPERATIONS

The Fairview Fire Department consists of seventeen uniformed personnel who cross-staff and deploy two engines, an ambulance, and a ladder truck. The fire chief deploys from a staff vehicle. Although the station is staffed by four career firefighters, fire suppression companies routinely deploy with less than four firefighters due to staffing inadequacies, and out of compliance with NFPA standards for the safe and effective delivery of emergency services. An additional ambulance and an additional utility vehicle are staffed by on-duty personnel and/or volunteers, assuming they are available to respond immediately upon dispatch.

The career members of the Fairview Fire Department who staff the emergency response units housed at Fairview Fire Headquarters provide fire suppression, disaster incident mitigation, technical rescue and essential emergency medical services to those residing within the Fairview Fire District 24 hours a day, 7 days a week.

The primary emergency services provided by the Fairview Fire Department include:

1. Fire Suppression
2. Fire Prevention & Fire Investigation
3. Technical Rescue
4. Emergency Medical Services
5. Hazardous Materials Response

Each operational program, as described below, has unique responsibilities that support the overall function of the Fairview Fire Department.

FIRE SUPPRESSION

Fire departments in the United States respond to an average of 2 million fire calls each year. This fire problem, on a per capita basis, is one of the worst in the industrial world. Thousands of Americans die each year, tens of thousands of people are injured, and property losses reach billions of dollars. There are huge indirect costs of fire as well – temporary lodging, lost business, medical expenses, psychological damage, pets killed, and others. To put this in context, **the annual losses from floods, hurricanes, tornadoes, earthquakes, and other natural disasters combined in the United States average just a fraction of the casualties from fires.**[9]

[9] U.S. Fire Administration, A Profile of Fire in the United States: 1989-1998, 12th Ed. (Washington, D.C.: 1999)

TABLE 2:
"THE U.S. FIRE PROBLEM"[10]

YEAR	TOTAL FIRES	CIVILIAN DEATHS	CIVILIAN INJURIES	FIREFIGHTER DEATHS	FIREFIGHTER INJURIES	DIRECT PROPERTY DAMAGE[11]
1977	3,264,000	7,395	31,190	157	112,540	$4,709,000,000
1978	2,817,500	7,710	29,825	172	101,100	$4,498,000,000
1979	2,845,500	7,575	31,325	125	95,780	$5,750,000,000
1980	2,988,000	6,505	30,200	138	98,070	$6,254,000,000
1981	2,893,500	6,700	30,450	136	103,340	$6,676,000,000
1982	2,538,000	6,020	30,525	127	98,150	$6,432,000,000
1983	2,326,500	5,920	31,275	113	103,150	$6,598,000,000
1984	2,343,000	5,240	28,125	119	102,300	$6,707,000,000
1985	2,371,000	6,185	28,425	128	100,900	$7,324,000,000
1986	2,271,500	5,850	26,825	120	96,450	$6,709,000,000
1987	2,330,000	5,810	28,215	131	102,600	$7,159,000,000
1988	2,436,500	6,215	30,800	136	102,900	$8,352,000,000
1989	2,115,000	5,410	28,250	118	100,700	$8,655,000,000
1990	2,019,000	5,195	28,600	107	100,300	$7,818,000,000
1991	2,041,500	4,465	29,375	108	103,300	$9,467,000,000
1992	1,964,500	4,730	28,700	75	97,700	$8,295,000,000
1993	1,952,500	4,635	30,475	79	101,500	$8,546,000,000
1994	2,054,500	4,275	27,250	104	95,400	$8,151,000,000
1995	1,965,500	4,585	25,775	97	94,500	$8,918,000,000
1996	1,975,000	4,990	25,550	96	87,150	$9,406,000,000
1997	1,795,000	4,050	23,750	98	85,400	$8,525,000,000
1998	1,755,500	4,035	23,100	91	87,500	$8,629,000,000
1999	1,823,000	3,570	21,875	112	88,500	$10,024,000,000
2000	1,708,000	4,045	22,350	103	84,550	$11,207,000,000
2001	1,734,500	6,196[12]	21,100[13]	439[14]	82,250	$44,023,000,000
2002	1,687,500	3,380	18,425	97		$10,337,000,000
2003	*Data not yet available*	*Data not yet available*	*Data not yet available*	105[15]	*Data not yet available*	*Data not yet available*

Every year, fires injure more than 20,000 people, and every year more than 3,000 Americans die in building fires. Every 19 seconds, in the year 2002, a fire department responded to a fire somewhere in the United States. A fire occurs in a structure at the rate of one every 61 seconds, and in particular a residential fire occurs every 79 seconds. Fires occur in vehicles at the rate of 1 every 96 seconds, and there's a fire in an outside property every 38 seconds.

Eighteen thousand, four hundred and twenty-five civilian fire injuries occurred in 2002. (This estimate for civilian injuries is on the low side, due to under-reporting of civilian injuries to the fire service.) Out of all civilian injuries, 14,050 occurred in residential properties, while 1,550

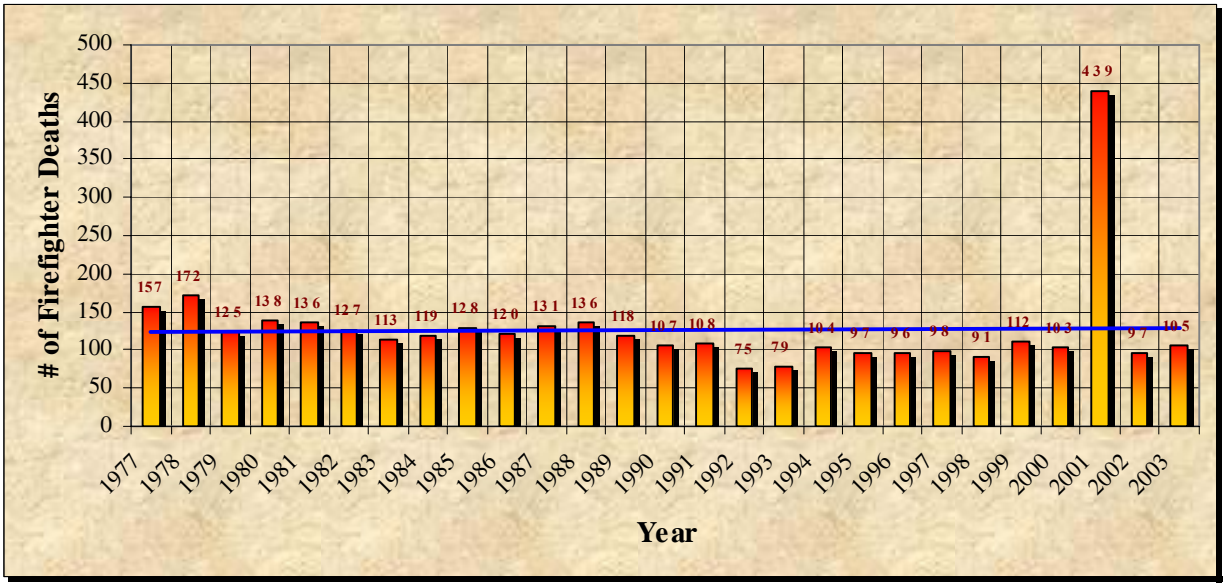
[10] NFPA survey, NFPA's Fire Incident Data Organization (FIDO).
[11] Direct property damage figures do not include indirect losses, like business interruption, and have not been adjusted for inflation.
[12] This includes 2,451 civilian deaths that occurred from the events of 9/11/01.
[13] This includes 800 civilian injuries that occurred from the events of 9/11/01.
[14] Includes 340 firefighters at the World Trade Center, September 11, 2001.
[15] Paul R. LeBlanc and Rita F. Fahy, "Firefighter Fatalities in the United States - 2003," National Fire Protection Association (Quincy, MA: 2004).

occurred in nonresidential structure fires. Three thousand, three hundred and eighty civilian fire deaths occurred in 2002; 2,670 (79 percent) of those occurred in the home. Nationwide, there was a civilian fire injury every 28 minutes, and a civilian fire death every 156 minutes.[16]

Furthermore, each year in the United States and its protectorates, approximately 100 firefighters are killed while on-duty, and tens of thousands more are injured. According to the Federal Emergency Management Agency:

> **While the total number of firefighter fatalities has been decreasing over the past 20 years, the number of firefighter deaths per fire incident has actually risen. Despite a downward dip in the early 1990s, the level of firefighter fatalities is back up to the same levels experienced in the 1980s. If the firefighter deaths at the World Trade Center are included in the 2001 data, the number rises to 23.1 firefighter fatalities per 100,000 fires.**[17]

FIGURE 3:
"ON-DUTY FIRE FIGHTER FATALITIES"
(1977 – 2003)



The Fairview Fire District's Fire Suppression Division is responsible for fire suppression and the mitigation of disasters. Primary operations units include fire suppression, rescue, and emergency medical services delivered from a single firehouse. In 2003, the fire department responded to 1,660 requests for emergency assistance. In that same year, the Fairview Fire District received mutual aid approximately 64 times and provided mutual aid approximately 153 times – nearly three times what it received. This fact speaks volumes about the role the Fairview Fire Department assumes in providing emergency services not only within its response jurisdiction, but to the surrounding areas, as well.

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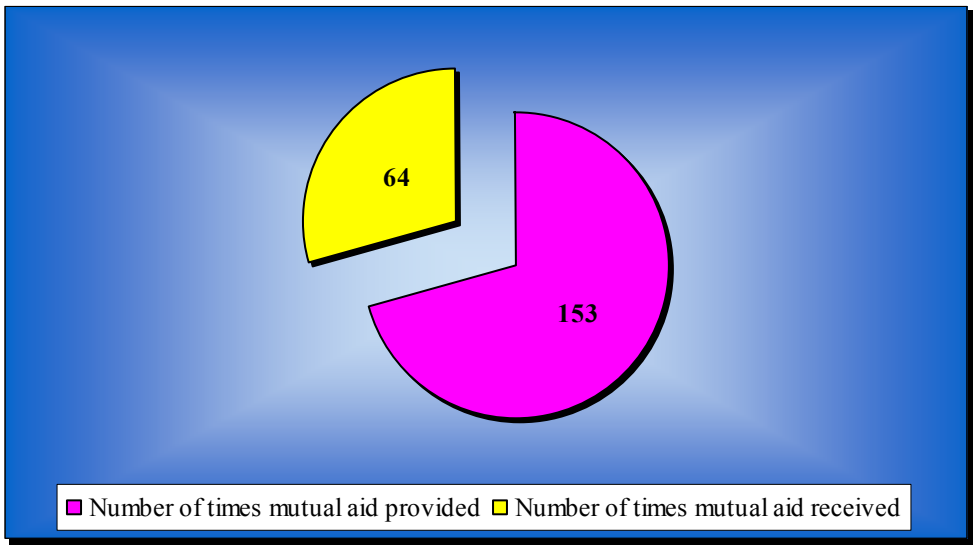
[16] Michael J. Karter, Jr., Fire Loss in the United States During 2002, (Quincy, MA: National Fire Protection Association, 2002), ii.

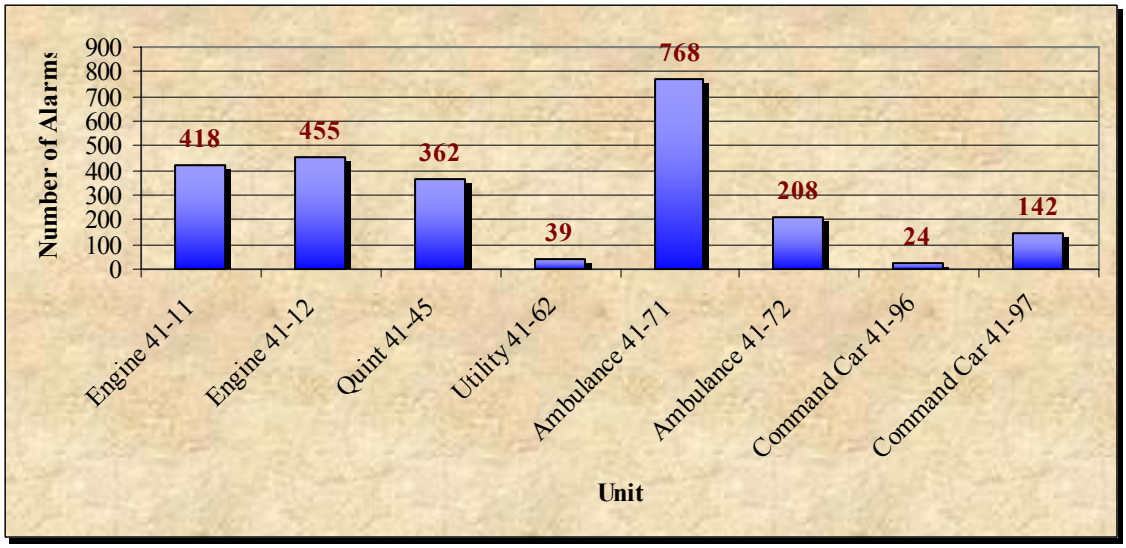
[17] "Firefighter Fatalities in the United States in 2002," Federal Emergency Management Agency (Washington, D.C.: July, 2003), 8.

FIGURE 4:
"YEAR 2003 MUTUAL AID RUN VOLUMES"



Emergency run totals for the year 2003 are delineated in the following graph.

FIGURE 5:
"YEAR 2003 RUN VOLUMES BY UNIT"



To effectively respond to these emergencies, all firefighters are trained in the latest fire suppression techniques, hazardous material recognition, medical first response and basic rescue techniques. A firefighter's base of knowledge must cover the areas of building construction, hydraulics, medical treatment, fire sprinkler design, safe driving practices and vehicle extrication techniques, to name but a few. Each one of these areas, and others, is continually changing with new research and technology utilized in the public and private sectors. A firefighter receives rigorous and continuous training to keep him/her abreast of changes in these areas.

The Role of the National Fire Protection Association (NFPA)

The mission of the NFPA is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating scientifically-based consensus codes and standards, research, training, and education, and recommends that all fire departments establish a policy of providing and operating with "the highest possible levels of safety and health for all members."[18] The recommendations and analysis contained in this study are guided by NFPA standards for several reasons. First, NFPA standards provide fire departments with a measure of "interoperability." Interoperability enables fire service personnel in the chain of command to speak the same language and conform to the same operational guidelines. NFPA standards provide the fire service with a common language, common definitions, and common requirements that are meant to foster the *safe* and *effective* delivery of fire suppression, rescue, EMS, and special services to a given community. Second, NFPA standards are formulated via consensus development. Development of NFPA standards are the result of scientific research, empirical studies, and consensus among technical experts and the organizations they are affiliated with. Combined, these factors lend validity to the NFPA standards that serve as the yardstick by which fire departments are measured internationally.

Examples of some NFPA standards include:

• NFPA 1404, *Standard for Fire Service Respiratory Protection Training*, which specifies the minimum requirements for a fire service respiratory protection program (NFPA 1989). This standard concentrates on the training component of a respiratory protection program, including the evolution of respiratory protection training, current equipment, and recent fire experience.[19]

• NFPA 1561, *Standard on Fire Department Incident Management System*, which provides minimum criteria for emergency incident management. Such incident management systems are intended to provide structure, coordination, and effectiveness during emergency incidents to enhance safety and health of fire department members and other persons involved.

• NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*, which specifies minimum requirements for the design, performance, testing, and certification of the elements of the protective ensemble including coats, trousers, helmets, gloves, footwear, and interface items for protection from the hazards of structural fire fighting operations.

• NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service*, which specifies minimum requirements for the design, performance, testing, and certification of self-contained breathing apparatus (SCBA) respirators used by the fire service. Requirements are in addition to U.S. OSHA respirator certification under 42 CFR 84.

• NFPA 1982, *Standard on Personal Alert Safety Systems*, which specifies minimum requirements for the design, performance, testing, and certification of personal alert safety systems (PASS) that monitor a fire fighter's motion and automatically emit an alarm if a fire fighter becomes incapacitated.

On account of their emphasis on safe and effective fire suppression and rescue operations, the two standards that will be referenced most often throughout this analysis are NFPA 1500 and

[18] NFPA Mission Statement

[19] Reference NFPA 1500 for requirements concerning use of SCBA in fire fighting operations and NFPA 1852 for the selection, care, and maintenance of SCBA, and respiratory breathing air quality content.

NFPA 1710. NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, specifies (1) the minimum requirements for a fire department's occupational safety and health program, and (2) the safety procedures for members involved in rescue, fire suppression, and related activities. This standard addresses organization, training and education, vehicles, equipment, protective clothing, emergency operations, facilities, medical and physical criteria, and member assistance programs. NFPA 1500 recommends that a "**minimum acceptable fire company staffing level should be four members responding on or arriving with each engine and each ladder company responding to any type of fire**."

The purpose of NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations and Special Operations to the Public by Career Fire Departments*, is "to specify the minimum criteria addressing the effectiveness and efficiency of the career public fire suppression operations, emergency medical service, and special operations delivery in protecting the public of the jurisdiction and the occupational safety and health of fire department employees."[20] The standard recommends "fire companies, whose primary functions are to pump and deliver water and perform basic fire fighting at fires, including search and rescue… shall be staffed with a **minimum of four on-duty personnel**.[21] Fire companies whose primary functions are to perform the variety of services associated with truck work, such as forcible entry, ventilation, search and rescue, aerial operations for water delivery and rescue, utility control, illumination, overhaul and salvage work… shall [also] be staffed with a **minimum of four on-duty personnel**.[22] In jurisdictions with tactical hazards, high hazard occupancies, high incident frequencies, geographical restrictions, or other pertinent factors as identified by the authority having jurisdiction, these companies shall be staffed with a minimum of five or six on-duty members."[23]

NFPA 1710 and the Law

NFPA standards protect communities against liability. In the United States, by law- specifically, the General Duties clause of the Occupational Safety and Health Administration Act- if Congress fails to pass legislation setting industry safety standards, municipal governments nationwide are mandated to follow standards promulgated by an industry-wide trade group, such as the NFPA. Many NFPA standards have been enacted into law at the federal, state, provincial and local levels. Although jurisdictions having authority are not required to automatically enact a particular NFPA standard, courts frequently rely upon NFPA standards to determine the "industry standard" for fire protection and safety measures. Judicial reliance on NFPA doctrines is most frequently found in common law negligence claims. To prevail in a common law negligence claim, the plaintiff must show that the defendant owed a duty of care to the plaintiff, that the defendant breached this duty of care and that this breach was the cause of the plaintiff's injury. Hence, although adoption is not required, **the NFPA 1710 standard could be found highly relevant to the question of whether a jurisdiction has negligently failed to provide adequate fire or emergency medical protection to an individual harmed in a fire or medical emergency. Furthermore, any local government that fails to follow the NFPA 1710 Standard could be subject to liability claims in the event of fire fighter injuries or death.**

[20] NFPA 1710, § 1.2.1
[21] NFPA 1710, § 5.2.2.1 and § 5.2.2.1.1
[22] NFPA 1710, § 5.2.2.2 and § 5.2.2.2.1
[23] NFPA 1710, § 5.2.2.1.2 and § 5.2.2.2.2

FIRE PREVENTION, CODE ENFORCEMENT, PUBLIC EDUCATION & FIRE INVESTIGATION

Fire prevention is an important component in all aspects of fire department operations, including education, training, fire cause investigation and determination, support for the preparation of litigation pertaining to arson, and victim assistance. Some of the greatest value delivered by the U.S. fire service comes in activities that prevent fire and other emergencies from occurring or that moderate their severity when they do occur.[24] Fire prevention efforts pursued by the Fairview Fire District are aimed at reducing the factors which contribute to the cause and spread of fire. These efforts include consultations with the public, the issuance of permits, and building inspection to ensure fire code and hazardous materials compliance. Public education programs targeted towards schoolchildren and seniors compliment fire prevention efforts.

The Value and Purpose of Fire Inspection & Prevention Programs

Fire prevention consists of three elements: codes and code enforcement, fire prevention inspections, and fire education. The American Insurance Association lists the value and purpose of fire department inspections and fire prevention programs as follows:

1. *To obtain proper life safety conditions.* Life safety inspections call for attention to the adequacy of exits, obstructions to rapid and orderly egress at time of fire, the adequacy of building evacuation plans, and the determination of the number of occupants permitted in a place of public assembly.

2. *To keep fires from starting.* Fire inspectors are specifically trained to identify fire hazards and can point out hazardous conditions and explain their seriousness to those who work among materials or situations which are hazardous.

3. *To keep fires from spreading.* Most people have little appreciation of the value that structural features (stair and elevator enclosures, fire doors and fire partitions) have in preventing the spread of fire. Inspectors educate owners and occupants in the value of proper maintenance of such structural members and have additional features installed, when necessary.

4. *To determine the adequacy and maintenance of fire protection equipment.* Private fire protection equipment such as extinguishers, standpipes, hose systems, automatic sprinkler systems, private water supplies, and alarm systems are installed to alert and protect building occupants and to aid in fire department operations. Under normal conditions this equipment is seldom used. Frequent inspections therefore are necessary to insure that the equipment will always be in proper working order.

5. *To pre-plan fire fighting procedures.* The "pre-fire plan" of a particular building calls for a knowledge of the building's fire hazards, fire protection equipment, construction features affecting the spread of fire, exposures, and exit facilities. Pre-planning is necessary for the protection of fire fighters as well as the occupants, and aids in efficient extinguishment. Fire department personnel conduct inspections and incident pre-planning on specific residential properties, including triplexes and larger dwellings, in addition to all commercial businesses in the community. Personnel are responsible for checking business licenses in all commercial

[24] National Fire Protection Association/U.S. Fire Administration, A Needs Assessment of the U.S. Fire Service: A Cooperative Study Authorized by U.S. Public Law 106-938, (Washington, D.C.: December 2002).

occupancies during the course of their regular building inspection tours, and for checking permits for hazardous processes, special occupancies and any activity that may produce conditions hazardous to life or property. Regular inspections and pre-planning provide for the systematic inspection of all commercial occupancies, and help to reduce the loss of life and property due to fire and other hazards.

6. *To stimulate cooperation between the fire department and owners and occupants.* Inspectors provide valuable advice on problems of fire protection and prevention. Such advice fosters cooperation between the community and the fire department, and serves to increase the standing of the department within the community.

7. *To assure compliance with fire codes, laws, and regulations.* Inspectors are trained to recognize and correct violations, and are empowered to enforce fire code regulations.

Arson Investigation

Arson is the leading cause of fire in the United States. Each year, an estimated 267,000 fires are attributed to arson, which result in $1.4 billion in property loss and cause over 2,000 injuries and 475 deaths. As a result, arson prevention and investigation have become the focus of increased attention within the federal government, the fire service, and the criminal justice system.[25]

The general public typically views arson as an insurance concern – primarily a "paper" crime of fraud mostly affecting insurance companies. Arsonists, however, kill and injure both civilians and firefighters. Increasingly, set fires motivated by spite and revenge are used as weapons. Such fires tend to be more deadly because they are targeted specifically to inflict personal harm.

Arson investigation involves review of all investigative and evidentiary materials associated with code enforcement and arson investigation. The fire department pursues investigations should the fire cause be "undetermined" or "suspicious in origin," "incendiary in origin," or result in serious injury or death. The Fairview Fire District works aggressively with local law enforcement agencies in prosecuting individuals who commit the crime of arson.

Public Education

The Fairview Fire District realizes that the most effective way to reduce the tragedies due to fire is to provide the proper fire safety tools to the community. The fire department strives to achieve this by conducting station tours to different groups within the community, and by providing education programs in local schools.

Children are naturally curious about fire. Some studies suggest that interest in fire develops even before age three.[26] However, whether a child actually sets fires depends on a variety of factors, including their exposure to fire and the availability of fire supplies. Although some children who set fires are unaware of the potentially tragic consequences of their actions and are simply curious, others are fully aware of the ramifications of their actions and purposely intend to cause damage.

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[25] U.S. Fire Administration, Arson in the United States, Topical Fire Research Series; vol. 1, issue 8 (Washington, D.C.: January 2001)

[26] D.J. Kolko and A.E. Kazdin, "A Conceptualization of Fire-setting in Children and Adolescents," Journal of Abnormal Child Psychology, 14, (1), 49-61, 1999.

Regardless of the motivations underlying juvenile fire-setting, it is a widespread problem that affects not only those children and their families, but all of society. Intentional fires ranked first among the major causes in structure fire dollar loss between 1995 and 1999. There were an estimated 418,000 intentional fires in 1999, resulting in 622 deaths and $2.7 billion in property damage - a 36% increase after adjusting for inflation. For the eighth straight year, juvenile fire-setters accounted for at least half (50%) of those arrested for arson in 2001. Nearly one-third of arrestees were children under the age of 15, and 5% were under the age of 10. According to FBI statistics, only 16% of 2001 arson offenses were solved by arrest. Juvenile offenders accounted for 45% of these arrests.[27] These facts underline the importance of community fire prevention programs, especially in the community's younger population.

Effects of the Fire Prevention Program on Fire Department Response Capabilities

During regular working hours, the Fire Prevention Officer (FPO) performs mandatory inspections at hospitals, child/adult care facilities, correctional institutions, foster homes, preschool facilities, health spas and any businesses that, by decree of state law, require inspection. The FPO is charged with inspecting all new construction, major remodels, and fire protection system revisions to ensure compliance with existing fire codes, the set of fire-safety regulations relating to construction, maintenance of buildings and the use of premises. In addition, this individual delivers "fire safe" instruction in local schools and to community groups throughout the response jurisdiction.

Originally, the FPO was a full-time position. However, due to recent cutbacks in the fire department's budget, the position has been phased out, and a firefighter now performs the range of fire prevention, code enforcement, public education, and fire investigation responsibilities. An assistant to the FPO augments the efforts of these two individuals three days during the week. Such an arrangement presents the fire department with a potentially significant staffing conundrum.

Similar to the fire department's cross-staffing practices, where two firefighters staff both an engine and the ambulance, the FPO fulfills a dual role, as well. Of the fire department's four on-duty personnel, one of them is also the Fire Prevention Officer. The result of this arrangement is that of the four on-duty firefighters, one of them (the FPO) is also assigned to perform the variety of fire prevention duties described above. Thus, this individual spends a significant time away from the fire station, effectively resulting in only three firefighters available at the firehouse. During these times, the FPO must monitor emergency traffic while performing fire prevention and public education efforts. If an emergency occurs, the FPO is expected to abandon the fire prevention tasks underway and respond to the incident scene.

The requirement that the FPO abandon fire prevention efforts to respond to emergencies occurring in the fire district presents two major problems. First, the FPO may not always be available to respond. Effective fire prevention takes time, effort, and a commitment to ensuring that the community is aware of the hazards of fire, and that all businesses are in compliance with state and local fire codes. The performance of effective fire prevention duties dictates that the FPO may not always be available to respond. Requiring the FPO to abandon fire prevention efforts in order to respond to emergencies elsewhere in the community negatively impacts the

[27] John R. Hall, Jr., Intentional Fires and Arson, National Fire Protection Association (Quincy, MA: May 2003).

ability of the FPO to do his/her job, and interferes with thorough and effective fire prevention, education, and inspection efforts.

Second, the FPO, preoccupied with the business of fire code inspections and code enforcement, arson investigations, and public presentations, may experience a significant response delay when responding to an emergency in the district. Unlike the immediately-available firefighters stationed at the firehouse, the FPO is actively engaged in the community, and may not be available to respond immediately upon dispatch. For example, the fire prevention trailer that often accompanies the FPO during community presentations may have to be unhitched from the utility truck before the FPO can respond to an incident. Response delays such as these, in addition to impedances to response while en route to the incident scene, result in increased response times. Increased response times have added importance in the Fairview Fire District due to current staffing practices because the department is only capable of assembling three firefighters on an incident scene in the absence of the FPO. As is discussed in detail throughout this analysis, responding only three firefighters to a fire results in a *decrease* in fire fighter efficiency. Moreover, inadequate staffing relates to an *increase* in the risks posed to firefighters and the public, an *increase* in the likelihood of economic losses, and an *increase* in the likelihood of both fire fighter and civilian casualties.

TECHNICAL RESCUE

The Fairview Fire Department responds to all emergencies in the response jurisdiction necessitating the specialized skills, capabilities, and resources of the fire service. Rigorous, comprehensive, and continuous training enables the fire department to deliver a range of rescue services, including dive & swift water rescue, high and low angle rope rescue, confined space rescue, and trench rescue.

Fire department members train specifically for emergencies requiring technical rescue expertise. Examples include the location, rescue (extrication), and initial medical stabilization of victims trapped in confined spaces. Technical rescue may also include, but is not limited to: patient extrication from a vehicle as a result of a motor vehicle accident; rescue of an individual (or individuals) from structural collapse; victim rescue from an industrial accident, such as may be encountered at a construction site; victim rescue from a trench collapse; or the rescue of an individual from any number of situations requiring technical skills associated with low- and high-angle rope rescue. The skill sets associated with patient extrication may also be needed for earthquakes, storms and tornadoes, floods, dam failures, technological accidents, terrorist activities, and hazardous materials releases. Those individuals requiring the technical rescue services that are provided exclusively by the fire department will also receive initial medical attention by fire department personnel.

EMERGENCY MEDICAL SERVICES

The Fairview Fire District also provides the citizens of and visitors to Fairview with the highest level of quality pre-hospital emergency medical care possible. Each apparatus in the department is equipped with basic life support equipment, including automatic external defibrillators (AEDs) and oxygen. All full-time firefighters are certified as emergency medical technicians (EMTs). Firefighters assigned to the engine company cross-staff a BLS ambulance, which is dispatched on all life-threatening calls and generally arrives before the private ALS ambulance.

EMS constitutes a significant portion of the fire department's call volume. In 2003, the fire department responded to 826 requests for emergency medical assistance. This figure represents 50% of all emergency responses.

HAZARDOUS MATERIALS (HAZMAT) RESPONSE

The fire department is assigned to respond to all hazardous materials incidents that threaten life, property and the environment. Hazardous materials are chemical substances, which if released or misused can pose a threat to the environment or health. These chemicals are used in industry, agriculture, medicine, research, and consumer goods. Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in plants.[28]

A hazardous materials incident is generally described as the intentional or accidental release of toxic, combustible, illegal or dangerous nuclear, biological or chemical agents into the environment, and can be generalized under three categories: Intentional Releases, Accidental Releases, and Domestic Terrorism.

Intentional Releases

This type of hazardous materials response is created when individuals and/or companies knowingly and illegally emit or dump toxic waste into landfills, waterways, the atmosphere and the environment in general. An example of such a release would be the illegal "cooking" of methamphetamine in clandestine drug labs. These labs cause serious health and safety issues within a community and require a large amount of time and resources to safely dismantle them and decontaminate the area.

Accidental Releases

This is the most common type of incident that the fire department responds to. These incidents include the release of all types of spills and leaks of toxic agents resulting from collisions, container breakage or failure, fires, floods and simple human error.

Domestic Terrorism

Domestic terrorism is the intentional release of deadly biological or chemical agents, such as anthrax or nerve gas, into the general population. Terrorist activities that have occurred in past years, such as the bombing of Murrah Federal Building in Oklahoma City, the release of a deadly nerve gas in a Tokyo subway system, terrorist attacks in New York City and Washington, DC, anthrax attacks along the eastern seaboard, and, most recently, the delivery of ricin to the U.S. Capitol have prompted the expansion of hazardous materials preparedness and response capabilities.

Biological Terrorism or Disasters

Preparedness for and response to an attack involving biological agents are complicated by the large number of potential agents (most of which are rarely encountered naturally), their sometimes long incubation periods and consequent delayed onset of disease, and their potential for secondary transmission. Although some authorities suggest biological weapons can be produced with ease, in fact it can be difficult to concentrate cultured organisms and prepare

[28] Federal Emergency Management Agency, Backgrounder: Hazardous Materials,
< http://www.fema.gov/hazards/hazardousmaterials/hazmat.shtm > Site visited April 15, 2004.

them in a form that can be widely disseminated. The consequences of a successful release, however, especially if the infection is easily communicated from infected patients, could far exceed those of a localized chemical or conventional explosive event. Thus, some authorities consider the risk of release of a biological weapon the most dangerous terrorist threat today, although others suggest that the costs and consequences of such an act will deter all but the most extreme groups.[29]

Chemical Terrorism or Disasters

Chemical terrorism could employ any of several military chemical weapons, including nerve agents such as sarin, vesicant ("blister") agents such as sulphur mustard, choking agents such as chlorine or phosgene, and "blood agents" such as hydrogen cyanide. Most of these require significant investments in chemical production capability and resources to produce quantities that could be used in a terrorist attack. According to a 1999 report released by the General Accounting Office, however, "terrorists also could use toxic industrial chemicals that are widely produced, shipped by rail and truck tanks, and stored in both urban and rural manufacturing sites. A terrorist could use a conventional explosive to rupture a transport or storage tank, creating a chemical disaster as the contents contaminated the area." Due to the difficulties in obtaining precursor materials and the technical challenges of producing chemical weapons, however, some experts consider toxic industrial chemicals more likely weapons of terrorism.[30]

The consequences of chemical terrorism will be similar to those of an accidental chemical release from a damaged tank or from an industrial explosion. In fact, it is far more likely that a community will confront the effects of an accidental than an intentional toxic chemical release. According to the Department of Transportation, roughly 300 million hazardous materials shipments occur in the United States each year. From 1993 through 1998, the annual number of serious hazardous materials incidents reported to the US Department of Transportation averaged 418 per year (serious incident defined as involving a fatality or major injury; closure of a major transportation artery or facility or evacuation of 6 or more persons; or a vehicle accident or derailment resulting in release of hazardous materials). These incidents resulted in an average of 11 deaths per year.[31]

Conventional Explosives

Conventional explosives have been the weapons most frequently used by terrorists because they are the easiest to obtain, create, and use. Recent examples include bombings at the World Trade Center, Oklahoma City, the 1998 attacks on US embassies in Kenya and Tanzania, and the recent attack on Spanish civilians on a commuter train in a Madrid suburb. Indeed, intelligence agencies believe that terrorists are more likely to use conventional explosives than chemical or biological weapons.[32]

The medical consequences of terrorism using conventional explosives include death and/or acute injury and destruction of critical infrastructure such as buildings, roads, and utilities. Victims trapped in collapsed buildings will require rapid extrication and care. Health care needs

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[29] World Health Organization, Health Aspects of Chemical and Biological Weapons: Report of a WHO Group of Consultants, (Geneva: WHO, 1970) 97-99.

[30] U.S. General Accounting Office, Combating Terrorism: The Need for Comprehensive Threat and Risk Assessments of Chemical and Biological Attacks (Washington DC: GAO/NSIAD99-163; September, 1999).

[31] U.S. Department of Transportation Hazardous Materials Program Evaluation Team, Department-wide Program Evaluation of the Hazardous Materials Transportation Programs (Washington, D.C.: March, 2000).

[32] U.S. Centers for Disease Control and Prevention, Pandemic Influenza: A Planning Guide for State and Local Officials, (Atlanta, GA: 2000)

include immediate surgical and non-surgical trauma care, follow-up medical care, forensic disposition of bodies and body parts, and mental health care. Physicians and hospitals must be prepared to treat hundreds or thousands of trauma cases, and their response may be complicated by loss of utilities (e.g., electricity, water), difficulty reaching hospitals, or even damage to hospitals in a community. These effects are the same as those of natural disasters such as tornadoes, earthquakes, and industrial or gas main explosions.[33]

Nuclear and Radiological Terrorism

Nuclear and radiological terrorism are very different events. Nuclear terrorism would involve the deliberate detonation of a nuclear weapon; consequences would include fatalities and injuries resulting from the initial explosion and subsequent fires, as well as immediate and long-term effects of radiation exposure. Some assessments suggest that the difficulty of obtaining the materials needed for a nuclear device and the extraordinary technical challenge of building a functioning nuclear weapon make this the least likely form of terrorism.[34]

At its core, terrorism relies upon unpredictable acts of violence to instill fear in a population. As America's experience with homeland security illustrates, a nation cannot predict with any amount of certainty where a terrorist event will occur, or how an attack will be executed. While it is highly unlikely that a terrorist attack will occur in the Town of Poughkeepsie, firefighters from the Fairview Fire District were called upon to respond to New York City in the wake of the 9/11 attacks. Continuing threats to American security- specifically, in New York City- require that the Fairview Fire Department continue to train in terrorism response in the event they should again be called upon in the wake of a terrorist attack.

[33] American Medical Association, Medical Preparedness for Terrorism and Other Disasters (Chicago, IL: May 2001)

[34] Report to the President and Congress of the Advisory Panel to Assess Domestic Response Capabilities for Terrorism Involving Weapons of Mass Destruction, (Washington, DC: RAND; 1999)

COMMUNITY RISK ASSESSMENT COMPONENTS

COMMUNITY RISK ASSESSMENT COMPONENTS[35]

I. GEOSPATIAL CHARACTERISTICS:

✔ **Urban Growth Boundary:** The boundaries of the Fairview Fire District's response jurisdiction are as follows:

TABLE 3:
"JURISDICTIONAL BOUNDARIES OF THE FAIRVIEW FIRE DISTRICT"

Northern Boundary	West Dorsey Lane
Eastern Boundary	Fall Kill Creek
Southern Boundary	Poughkeepsie City Limits
Western Boundary	Hudson River

Mutual and automatic aid contracts with the neighboring jurisdictions require that the Fairview Fire District provide emergency response, including hazardous materials and technical rescue response when necessary, *and when Fairview Fire District personnel and equipment are available to fulfill such obligations.* In the year 2003, the fire department received mutual aid 64 times, and provided mutual aid to neighboring fire districts 153 times. It is important to understand that extra-municipal obligations such as this result in unit unavailability and increased response times for secondary units within the response jurisdiction. These increased response times are exacerbated when volunteer personnel are not available to respond, and by the distance mutual aid companies must travel from their primary response districts in the Fairview Fire District.

✔ **Infrastructure Limits:** Fairview has an extensive water system grid that combines elevated storage tanks, large feeder mains, intermediate mains, and secondary service mains. Multiple pump stations assist in pressure regulation throughout the jurisdiction. However, in that portion of the fire district that includes Hyde Park, there exist no fire hydrants capable of providing a sufficient amount of water to provide adequate fire flows relative to the hazards presented. In addition, the Arbor and Hyde Park Terrace apartment complexes both lack a water supply sufficient for the increased hazards these structures present.

II. TOPOGRAPHY

✔ **Primary topography:** Fairview is located on the banks of the Hudson River, which runs down the west side of the city, from north to south. Significant portions of the city are suburban with light industrial and commercial areas. Shopping areas and warehouses are located throughout the district.

III. WEATHER

✔ **Summer Weather:** Daytime temperatures in Fairview often soar to over 85 degrees. Coupled with the effects of humidity and strenuous work, these conditions can have significant physiological impacts on firefighters delivering the range of emergency services.

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[35] As derived from "Oregon Fire Resource Deployment Standard Process"
< http://www.ofca.org/BestPractice/_process.pdf >

✔ **Winter Weather:** The average temperature in Fairview in January is 25.4 degrees Fahrenheit. The area frequently encounters sub-freezing temperatures. In addition, winter is often accompanied by wind, ice and snow. The following table illustrates typical weather conditions in the Fairview area.

TABLE 4:[36]
"TYPICAL WEATHER CONDITIONS IN DUTCHESS COUNTY"

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average temp. (°F)	25.4	27.6	37.4	48.4	59.2	67.9	72.9	71.2	62.9	51.4	41.3	31.0
High temperature (°F)	34.5	37.4	47.4	59.3	70.5	79.0	83.9	81.9	73.7	62.2	50.4	39.3
Low temperature (°F)	16.3	17.7	27.2	37.5	47.9	56.8	61.8	60.5	52.1	40.5	32.0	22.8
Precipitation (in)	3.6	2.8	3.8	4.0	4.8	4.1	4.5	4.1	4.1	3.8	4.0	3.6
Days with precip.	11	10	11	11	11	10	9	9	8	8	10	11
Wind speed (mph)	12.3	12.5	12.7	11.9	10.6	9.7	9.2	9.1	9.9	10.7	11.6	11.9
Morning humidity (%)	69	68	69	68	73	75	75	78	79	77	74	71
Afternoon humidity (%)	59	56	54	52	55	57	56	58	59	57	59	60
Sunshine (%)	51	55	56	57	60	63	64	63	61	59	49	47
Days clear of clouds	8	8	8	7	7	8	7	9	10	11	8	8
Partly cloudy days	8	8	9	10	11	11	13	12	9	9	9	9
Cloudy days	15	12	13	13	13	11	11	11	11	11	13	14
Snowfall (in)	7.4	8.2	4.9	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7	5.0

✔ **Challenges to typical response:** Fire fighters performing the strenuous activities associated with the range of emergency work are subject to weather conditions, which often exacerbate existing incident conditions. Extreme weather and related conditions affect the response capabilities of fire apparatus responding on emergency alarms, and have considerable physical impact on firefighters and equipment on the fireground. For example, freezing weather and the conditions related to it, such as snow and ice, impede emergency unit response and hamper fireground activities. Similarly, elevated ambient temperatures are strongly correlated with elevated core temperatures in fire fighters, resulting in medical emergencies such as heat exhaustion, overexertion, and dehydration that incapacitate and increase the risk to fire fighters operating at the scene of an emergency.

The activities related to firefighting include extremely strenuous physical work. Analysis of the deaths of 97 firefighters across the United States in 2002 indicates that the largest cause category is stress or overexertion, which was listed as the primary factor in 41.2 percent of all firefighter deaths.

TABLE 5:
"FIREFIGHTER DEATHS BY CAUSE OF INJURY"

CAUSE OF INJURY	DEATHS	PERCENTAGE
Stress	40	41.2%
Struck by/contact with object	36	37.1%
Caught or trapped	15	15.5%
Fell or jumped	4	4.1%
Heat stroke	1	1.0%
Exposure to fumes	1	1.0%
Total	**97**	**100.0%**

[36] Source: CityRating.com website, < http://www.city-data.com/city/Beacon-New-York.html > Site visited July 21, 2004.

Most firefighter deaths attributed to stress result from heart attacks. Of the 40 stress-related fatalities in 2002, 37 firefighters died of heart attacks, 4 died of stroke, and 1 died of heat stroke.[37]

TABLE 6:
"FIREFIGHTER DEATHS BY NATURE OF INJURY"

NATURE OF INJURY	DEATHS	PERCENTAGE
Heart attack	37	38.1%
Internal trauma	31	32.0%
Asphyxiation	13	13.4%
Crushing	7	7.2%
Strokes or aneurysms	4	4.1%
Burns	2	2.1%
Gunshot	1	1.0%
Heat stroke	1	1.0%
Drowning	1	1.0%
Total	**97**	**100.0%**

IV. TRANSPORTATION NETWORKS

✔ **Major Thoroughfares:** U.S. Highway 9 is the major north-south thoroughfare, paralleling the Hudson River on the west side of the jurisdiction. State Highway 9G also runs in north-south fashion, along the east side of the jurisdiction.

✔ **Waterways:** Major water bodies in the jurisdiction include the Hudson River, Inwood Lake, Fallkill Park Lake, and Fallkill Creek. In addition, several lesser ponds are scattered throughout the jurisdiction.

✔ **Rail:** Consolidated Rail Corporation (Conrail) rail lines run throughout the jurisdiction, transporting an unknown quantity and type of chemicals.

✔ **Challenges:** The implications of impedances to response capabilities are significant, especially when fire growth and patient survivability are measured in seconds. Challenges to rapid fire department response include, but are not limited to, bridges over waterways, and inclement weather conditions such as rain, ice, and snow. The amount of train traffic on railways within the jurisdiction also has important implications for the response of fire department units. The Fairview Fire District has a complex rail system that, at times, impedes fire company response. Traffic congestion, however, remains the largest impediment to a swift response in the jurisdiction. According to the *Poughkeepsie Journal*, "The numbers of cars on some local roads has more than tripled over the last couple decades, leading to more congestion and more accidents."[38] This increase in the number of vehicle accidents, of course, translates into a commensurate increase in the number of emergency alarms the fire department is dispatched to.

[37] NFPA's Fire Incident Data Organization (FIDO); updated 06/03.

[38] Michael Valkys, "Dutchess development swells traffic; Residents worry about congestion," Poughkeepsie Journal, October 20, 2002.

V. DEVELOPMENT AND POPULATION GROWTH

✔ Current development and densities

Census 2000 shows that Dutchess County is one of only nine counties in New York State experiencing 8.0% or more population growth. In terms of population size for the country, Dutchess ranks 201st out of 3,141 counties in the United States.[39]

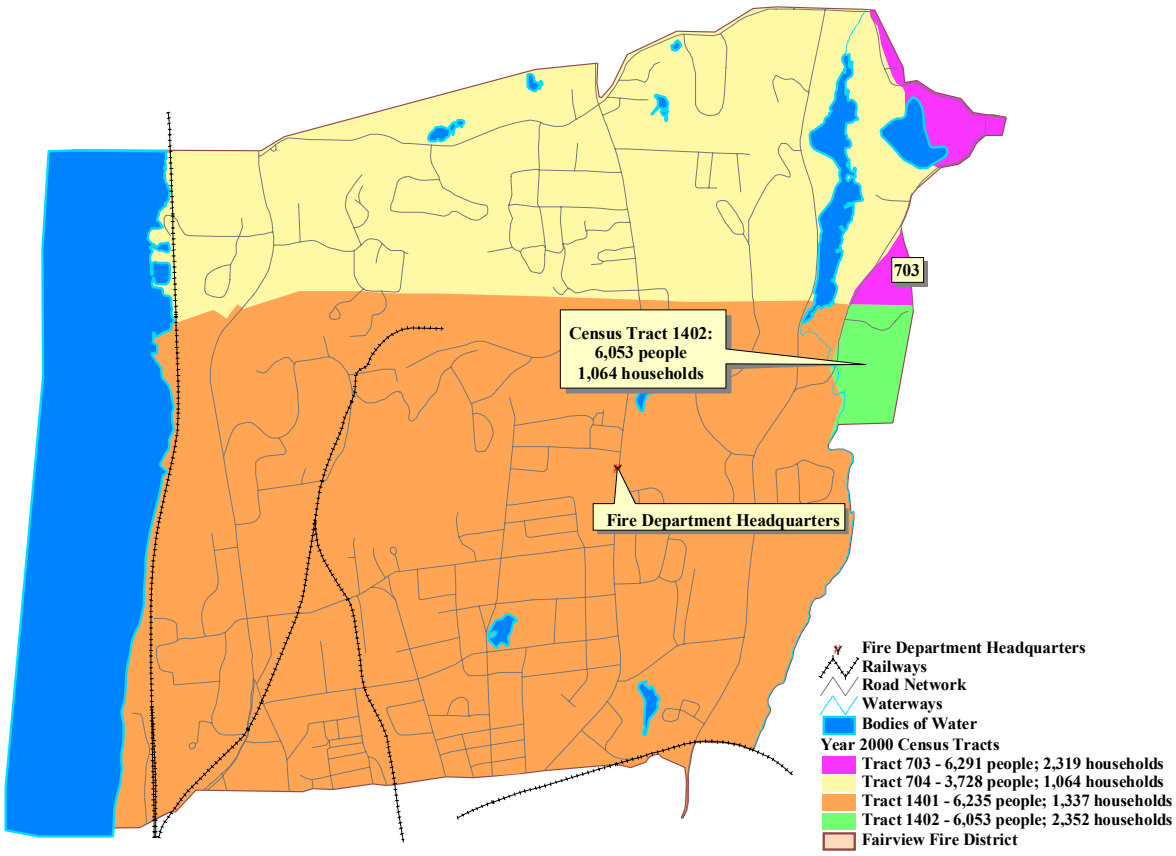
TABLE 7:
"SOUTHERN DUTCHESS COUNTY POPULATION CHANGE"
(1990 – 2000)

	1990	2000	% Change
City of Beacon	13,243	13,808	4.27%
Town of Beekman	10,447	13,659	30.75%
Town of East Fishkill	22,101	25,589	15.78%
Town of Fishkill	15,698	18,523	18.00%
Village of Fishkill	1,957	1,735	-11.34%
Town of LaGrange	13,274	14,928	12.46%
City of Poughkeepsie	28,844	29,871	3.56%
Town of Poughkeepsie	40,143	42,777	6.56%
Town of Union Vale	3,577	4,546	27.09%
Town of Wappinger	26,008	26,274	1.02%
Village of Wappingers Falls	4,605	4,929	7.04%
Total	**175,292**	**191,710**	**9.37%**

According to the Year 2000 U.S. Census, Southern Dutchess County's population grew by 16,418 people since 1990. This demographic shift represents a 9.4% *increase* in population over the past ten years.

[39] Lindsay Carille, "Dutchess County – Ten Years Later," Dutchess County, NY Website; site visited July 21, 2004 < http://www.dutchessny.gov/CountyGov/Departments/Planning/PLCensusTenYrs.htm >.

FIGURE 6:
"FAIRVIEW CENSUS TRACT ANALYSIS" [40]



The Dutchess County, NY, website describes the changing face of Dutchess as follows:

> The 55 and over categories have all increased in number since 1990. As the current population ages, and life expectancy increases (there are almost 1,000 more 85 and older persons in 2000 than in 1990)… officials and planners need to look at availability of senior housing, health care needs, public transportation and public services for seniors.[41]

This demographic shift is summarized in Table 8, on the following page.

[40] It should be noted that the response jurisdiction incorporates only parts of some census tracts. Therefore, the census figures provided are not necessarily representative of the number of individuals residing in the geographical area displayed in this analysis.

[41] Lindsay Carille, "Dutchess County – Ten Years Later," Dutchess County, NY Website; site visited July 21, 2004 < http://www.dutchessny.gov/CountyGov/Departments/Planning/PLCensusTenYrs.htm >.

TABLE 8:
"DUTCHESS COUNTY AGE PROFILE"

AGES	1990	2000	% CHANGE
Under 5	18,451	17,463	-5.4%
5 to 9	17,337	20,410	7.7%
10 to 14	16,413	20,802	26.7%
15 to 19	18,515	20,655	11.6%
20 to 24	20,178	17,404	-13.7%
25 to 34	46,323	35,063	-24.3%
35 to 44	41,793	49,665	18.8%
45 to 54	28,718	39,707	38.3%
55 to 59	11,557	14,321	23.9%
60 to 64	10,494	10,970	4.5%
65 to 84	29,683	33,690	13.5%
85+	3,124	4,083	30.7%
Median Age	33.4	36.7	+3.3
All Ages	**259,462**	**280,150**	**+8.0**

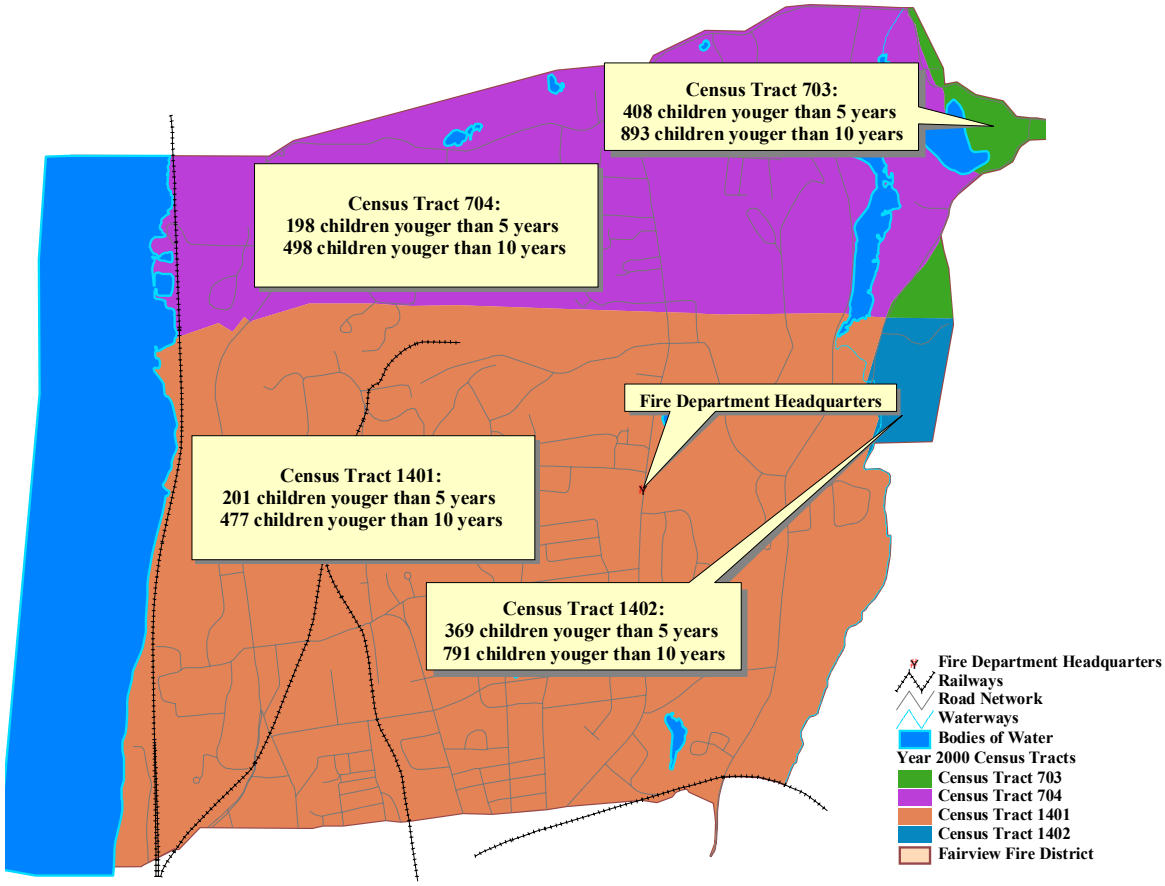
From a public safety perspective, the fire department must evolve to meet the needs of the changing community. Fire losses affect all groups and races, regardless of income, sex, or geographical location. But the severity of the problem is greater for some groups than it is for others. The U.S. Fire Administration summarizes the fire risk posed to specific groups as follows:

> Individuals living in poverty face a greater risk of fire, death, and injury than the general population. African Americans and American Indians have significantly higher fire deaths per capita than the national average. African American victims also comprise a disproportionate share of total fire deaths (27%) although they comprise 13% of the total population. **The risk of death in fire is higher among the very young (under age 15) and older adults (over 64).** African Americans and American Indians in these age groups suffer extremely high loss rates. Older American Indians have a fire risk of over three times that of the general population. African American risk is six times higher.

At least 80 percent of all fire deaths occur in residences. **Those at greatest risk are children under the age of 5 and senior citizens age 65 and older.**[42] **Nationally, children under the age of 10 account for an estimated 22 percent of all fire deaths.**[43] Indicated on the following pages is the distribution these high-risk segments of society in the jurisdiction.

[42] U.S. Fire Administration "Home Fire Safety" Fact Sheet
< http://www.usfa.fema.gov/public/factsheets/facts.shtm > Site visited March 23, 2004.
[43] Ibid.

FIGURE 7:
"POPULATION DENSITIES FOR CHILDREN YOUNGER THAN 5 AND 10 YEARS OLD"



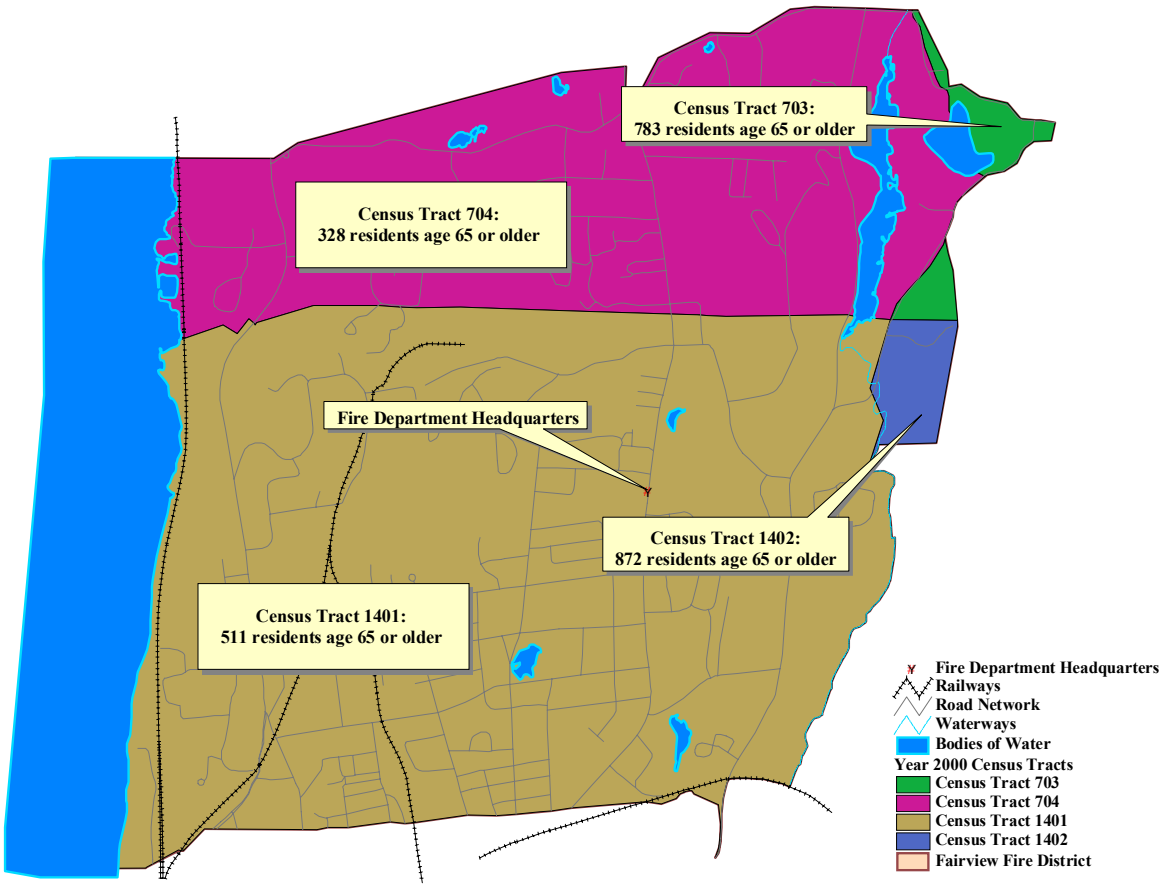
The census tracts displayed in Figure 7 represent those areas of the response jurisdiction that are the most densely populated with children under the age of 5 and 10 years, and that are at an increased risk of injury and death due to fire.[44]

The risk of fire death among seniors over 65 is more than double the average population. That risk triples for seniors over age 75, and is nearly 3½ times the average population for those over age 85.[45] Based on 2000 census data, Figure 8, on the following page, indicates the distribution of the elderly in the fire department's jurisdiction.

[44] It should be noted that the response jurisdiction incorporates only parts of some census tracts. Therefore, the census figures provided are not necessarily representative of the number of individuals residing in the geographical area displayed in this analysis.

[45] U.S. Fire Administration "Home Fire Safety" Fact Sheet
< http://www.usfa.fema.gov/public/factsheets/facts.shtm > Site visited March 23, 2004.

FIGURE 8:
"POPULATION DENSITIES FOR SENIOR CITIZENS 65 AND OLDER" [46]



The importance of the geographical distribution of the area's aging population assumes added significance when this segment of society's historical and expected growth is considered. The "baby boomer" generation is one of the fastest growing segments of American society, and this national trend is reflected locally. In the past 10 years, residents between the age 45 and 54 years old grew by over 38%, while those between the ages of 55 and 59 years grew by 24%.

TABLE 9:
"GROWTH OF DUTCHESS COUNTY 'BABY BOOMER' POPULATION"

AGES	1990	2000	% CHANGE
45 to 54	28,718	39,707	38.3%
55 to 59	11,557	14,321	23.9%

[46] It should be noted that the response jurisdiction incorporates only parts of some census tracts. Therefore, the census figures provided are not necessarily representative of the number of individuals residing in the geographical area displayed in this analysis.

According to the U.S. Census, in Dutchess County, those residents ranging in age from 65 to 84 years increased 13.5% from 1990 to 2000. For those 85 years or older, the population increased by 30.7%.

TABLE 10:
"GROWTH OF DUTCHESS COUNTY ELDERLY POPULATION"

AGES	1990	2000	% CHANGE
65 to 84	29,683	33,690	13.5%
85+	3,124	4,083	30.7%

In addition to the special attention the elderly require in the event of a fire, the county's aging population also places additional demands on the EMS system. The American Geriatrics Society describes the pressure exerted on emergency response systems as follows:

> One out of three times when the bell rings for emergency medical services providers the call involves a person over 60 years of age. It is estimated that some 3.4 million, or 34 percent, of all calls for emergency medical services involve older patients. The rising pressure on our emergency medical system is of growing concern as the nation's 76 million baby boomers near retirement age. In just 30 years, 70 million Americans– one-fifth of the population– will be older than age 65.[47]

The implications of an aging population in Dutchess County for the Fairview Fire District are significant. The fire department should prepare itself to respond to the special needs of these citizens. Furthermore, the response system should be designed to adequately respond to an expected increase in call volume as this segment of society, and the medical conditions they present with and the life safety challenges they pose, continues to increase.

VI. RISK CATEGORIES:

High-Risk Areas

The major factor used to determine a high-risk occupancy is the ability of the occupants of the building to remove themselves from the building in an emergency. Another important, though often overlooked, factor is the construction of the building which, in most cases, is directly related to the age of the building (reference Figure 10, p. 42). A third factor that places buildings in the high-risk category is their lack of fire protection systems, such as no sprinkler system or automatic alarms. There is the potential that many of these buildings that are designated as high risk have common walls and attics, and common openings is cause to classify these structures as high-risk. **High-risk, by definition for occupant safety, includes all hospitals, multi-story extended care facilities, psychiatric care centers, and eldercare facilities as well as low income housing.**

[47] American Geriatrics Society website, < http://www.americangeriatrics.org/policy/GEMS_release2003.shtml >. Site visited August 4, 2004.

High Risk Structures and Multi-Story Buildings

High risk occupancies include low- and high-rise residential, business, light manufacturing, schools, and all high-rise office complexes. The older buildings pose an increased risk of structural failure as well as the risk of fire spread.

In terms of fire safety, a high-rise building could be defined as a building taller than four stories or 75 feet, since fire department aerial ladders rarely reach anything higher than that. Every year there are about 7,000 fires that break out in high rise office buildings causing deaths, injuries and millions of dollars in fire damage.

The threat of high-rise fires is a fact of life in any metropolitan area. In 1986, a fire at the Alexis Nihon Plaza in Montreal, Canada, spread from the 10th floor to the 16th floor while more than 240 fire fighters worked 13 hours to bring the blaze under control.[48] In 1988, it took 383 Los Angeles City fire fighters to control a fire that gutted 4 floors of the 62-story First Interstate Bank Building in 3½ hours.[49] And in 1991, 316 fire fighters participated in the suppression of a fire at One Meridian Plaza in Philadelphia, which destroyed 9 of the building's 38 floors over an 18-hour period before the fire was contained.[50]

In a high-rise building, fire fighters experience extreme difficulties in being able to control fire and smoke spread above the floor of fire origin. In such a structure, fire, smoke and hot gases spread rapidly to the floors above through the vertical elevator shafts, and horizontally through heating, ventilating, and air conditioning (HVAC) return ducts. As extreme fire conditions (e.g., flashover) develop, exterior windows would be expected to break out, allowing more air for combustion into the fire floor and creating a path for vertical, exterior flame spread.[51] In an environment such as this, it is difficult to deliver fire fighters and equipment to the upper floors as the products of combustion restrict fire fighters from advancing beyond the fire floor. In addition, fire fighters encounter myriad related conditions, including falling glass and debris, a lack of water, difficulty in ventilating the structure, and heavy smoke in the stairwells in which fire fighters are attempting to ascend while panicked occupants are attempting to evacuate.

High Risk Medical Facilities

There are three types of care in most modern hospitals: (1) ambulatory, (2) general, and (3) intensive care. Given proper directions, unless smoke and heat is intense, ambulatory patients can make their own way to safety. General care patients may be transported on stretchers or in wheelchairs with some difficulty; horizontal and even some vertical movement is generally possible, although independent evacuation is not. Patients in intensive care are likely to be connected to various life support devices, making movement for even short distances very difficult and evacuation almost impossible without further endangering these patients' lives. A significant percentage of occupants in hospitals and nursing homes are incapable of self-evacuation and are incapable of perceiving a fire threat and choosing a rational response. For these reasons, hospital occupants and residents of health care facilities, including those at the Hudson River Psychiatric Center, are generally presumed to be incapable of self-preservation.

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[48] I. Stronach, "Montreal, $100 Million High-Rise Blaze Thwarts Firefighters," Firehouse, Vol. 12, No. 6 (June 1987)

[49] T.J. Klem, "Three Major High-Rise Fires Reveal Protection Needs," NFPA Journal, Vol. 86, No. 5 (September/October 1992)

[50] Philadelphia Fire Department Incident Report, Philadelphia, PA (February 23, 1991)

[51] R.E. Sanders & D. Madrzykowski, "Fire Service and Fire Science: A Winning Combination," NFPA Journal, Vol. 8, No.2 (March/April 1994)

A health care facility, then, resembles a ship at sea: it is better to keep the fire from the patient than to remove the patient from the fire. Thus, occupants must be defended in place.[52]

High Risk Commercial/Industrial Conditions

The commercial goods and hazardous materials that are transported through the jurisdiction on both the railroads and the highways are also cause for high-risk designation. Certain businesses transport, manufacture, or store chemicals that if spilled or impinged upon with excessive heat can present a serious threat to community safety. In addition, water treatment facilities house a variety of chemicals, including chlorine and hydrogen sulfide for water treatment.

Vacant & Abandoned Buildings

Vacant buildings represent a fire hazard for several reasons. First, they are more likely to experience severe fires than other types of buildings. **Studies have found that abandoned buildings are four times more likely than other structures to suffer the ravages of fire.**[53] Second, the homeless and those seeking shelter from the elements or the public view may illegally access vacant buildings. The occupancy of abandoned or vacant buildings by the homeless during the winter months is especially dangerous because those seeking shelter often start indoor fires to keep warm. To the extent that persons seeking refuge in abandoned buildings are under the influence of alcohol or drugs, there is an added risk that carelessness will result in fire.[54]

Neighborhood Decline

As noted by the U.S. Fire Administration, "building abandonment can become a self-fulfilling prophecy for a neighborhood. The presence of vacant buildings may discourage apartment building owners, who often do not live in the neighborhood, from investing in their buildings. The withdrawal of routine maintenance services soon seriously erodes the quality of the housing units in those buildings, increasing the risk of fire from inadequately maintained heating or electrical systems, for example. In the worst case scenario, an owner may use arson as a means to force tenants out of a building or to fraudulently collect on an insurance policy, thereby 'cashing in' his or her investment from the community. The end result is usually another vacant building in the neighborhood."[55]

Medium Risk

Medium risk would include smaller buildings, mainly one or two stories with adequate separation from adjacent buildings. With the exception of occupancies that cater exclusively to the elderly and invalid, most low-rise apartment complexes and light commercial buildings are designated as medium risk because of the potential for victim rescue.

Low Risk

Due to hidden dangers, unpredictable conditions, and circumstances beyond human control, it is difficult to deem any building as low risk. However, residential construction is the least dangerous from a fire spread perspective. Therefore, low risk areas include residential areas within the response jurisdiction. Nonetheless, it is important to understand that in the census tracts located within the response jurisdiction, the median number of rooms per household

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[52] NFPA Fire Protection Handbook, 18th Ed., © 1997; pp. 9-50 – 9-53

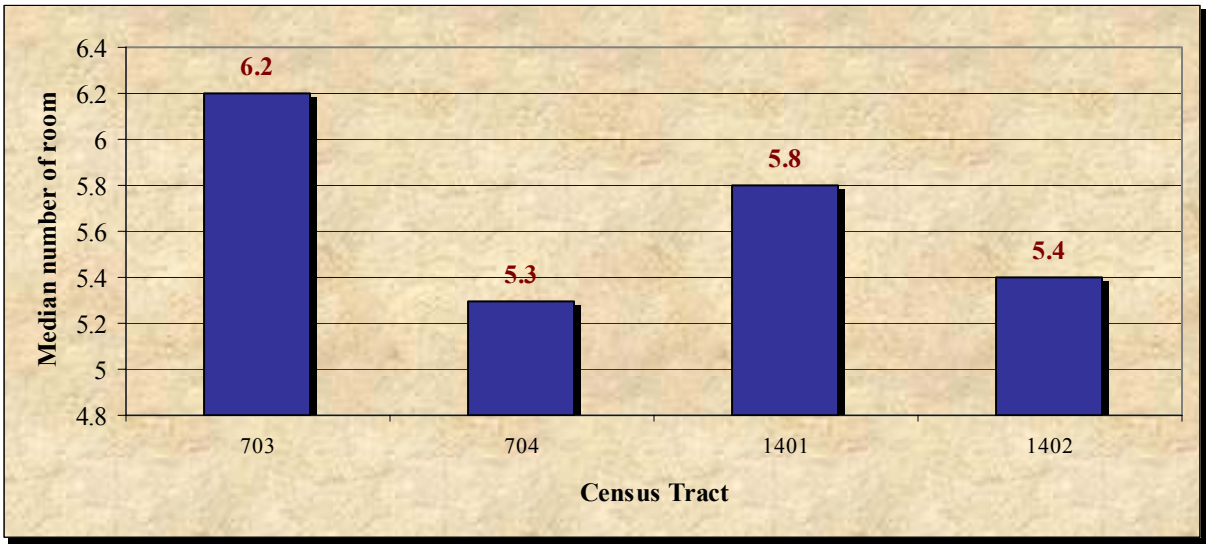
[53] George Sternlieb and Robert Burchell, "Fires in Abandoned Buildings," Fire Journal, vol. 67, no. 2 (1973) 28.

[54] Alison Norton, "Fire Risks of the Homeless." Fire Journal, vol. 83, no. 6, (November/December: 1989), 33.

[55] Socioeconomic Factors and the Incidence of Fire, Federal Emergency Management Agency, (Washington, D.C.: June 1997)

ranges from 5.3 to 6.2. From a fire suppression perspective, the larger the home the larger the potential fuel load. The larger the fuel load, the larger the fire. The larger the fire, the more resources will be required to engage in safe and effective fire suppression operations. In addition, the increased number of rooms per household may be correlated to an increase in the number of occupants.

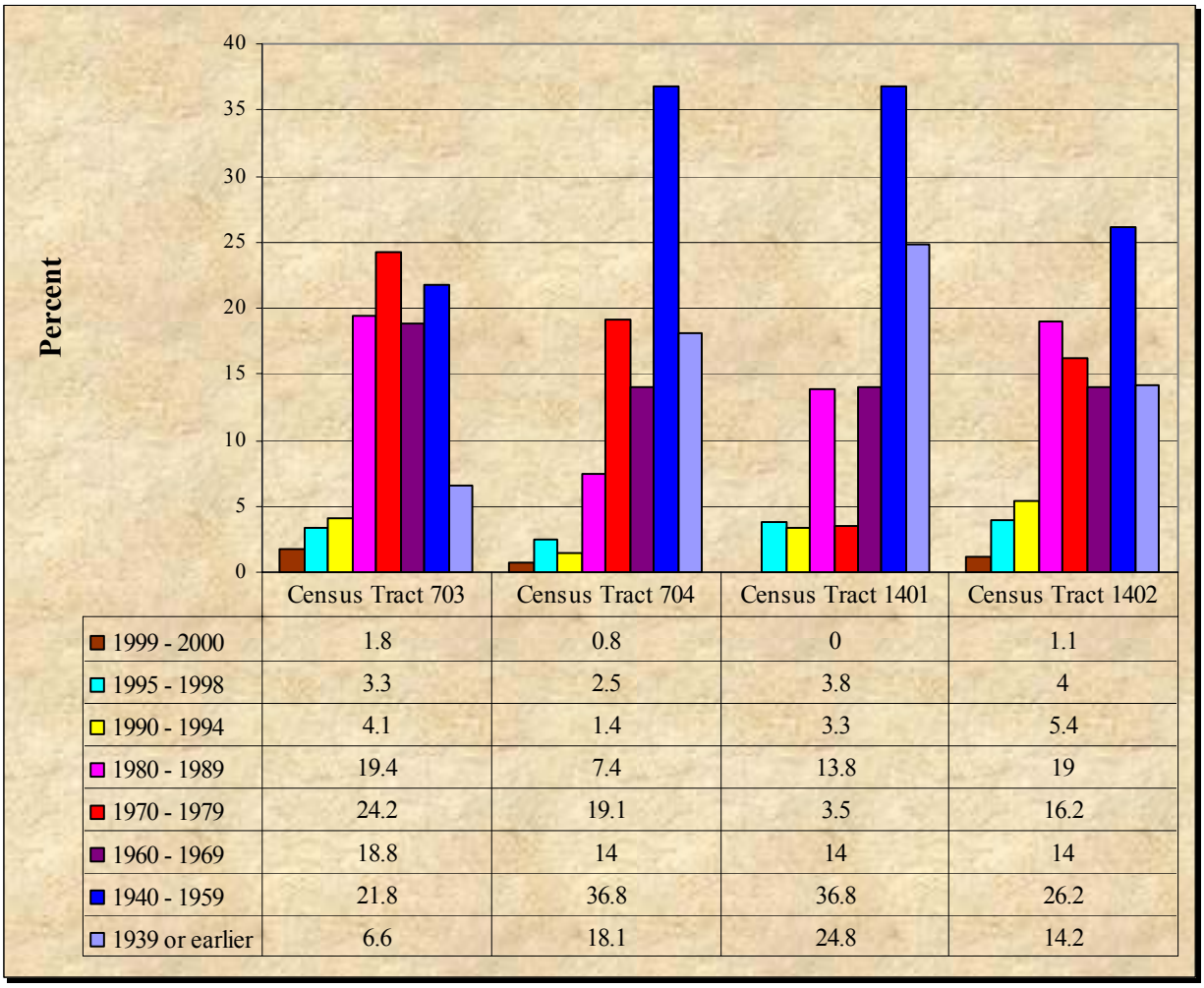
FIGURE 9:
"MEDIAN NUMBER OF ROOMS PER HOUSEHOLD"



Although residential construction presents the lowest risk to firefighters from a fire spread perspective, large homes and the potential for them to be occupied by a number of occupants presents a challenge to emergency personnel. The fire department must be able to assemble an appropriate number of resources at the incident scene within critical time frames, before the fire spreads beyond the point of control, to initiate safe and effective fire suppression and rescue operations. The greater the intensity and size of the fire, the more resources will be required. Similarly, the larger the home, the greater the odds of multiple fire victims in need of rescue by fire department personnel. Therefore, the fire department should be staffed and deploy with resources adequate to mitigate emergencies within its response jurisdiction, relative to the hazards posed.

Furthermore, it would be misguided to suggest that residential structure fires pose a lesser risk to firefighters without considering other factors that may come into play, such as fire load or size of the structure, as revealed above. Another important factor in gauging the level of risk a structure may pose to firefighters during an emergency is the age of the structure. The U.S. Census Bureau collects detailed housing information as part of its decennial national census. Analysis of this information reveals some important characteristics about housing in the Fairview Fire District. Many homes in the jurisdiction are not of modern construction. In census tracts 704 and 1401, for example, 37% of all homes were constructed between 1940 and 1959. Twenty-five percent of all homes in census tract 1401 were built in 1939 or earlier.

FIGURE 10:
"YEAR STRUCTURE BUILT"



	Census Tract 703	Census Tract 704	Census Tract 1401	Census Tract 1402
1999 - 2000	1.8	0.8	0	1.1
1995 - 1998	3.3	2.5	3.8	4
1990 - 1994	4.1	1.4	3.3	5.4
1980 - 1989	19.4	7.4	13.8	19
1970 - 1979	24.2	19.1	3.5	16.2
1960 - 1969	18.8	14	14	14
1940 - 1959	21.8	36.8	36.8	26.2
1939 or earlier	6.6	18.1	24.8	14.2

Buildings constructed prior to 1940 are generally considered to be at an increased risk of fire. Most homes built prior to 1940 are not fitted with automatic sprinklers. In addition, the knob and tube wiring in many of these homes was never designed to handle modern day electrical loads. The rubberized cloth that covers the older wiring becomes brittle over time, increasing the risk of fire or electrical shock. And whereas modern wiring is required to have a ground wire to reduce the chances of electrocution in the event the system short-circuits, knob and tube wiring does not. In fact, because of the increased risk of fire associated with knob and tube wiring, some insurance companies have increased premiums for homes that have it, while still others refuse to insure such homes.

GIS ANALYSIS METHODOLOGY

METHODOLOGY

OVERVIEW

Once the domain of cartographers, computer-assisted drawing technicians, mainframes, and workstations, geographic information systems (GIS) mapping has migrated to the desktop. With ArcView, a user can create intelligent, dynamic maps, using data from virtually any source and across most popular computing platforms to display information that has a geographic aspect. The ArcView GIS software, a product of ESRI, Inc., allows desktop users to work simultaneously with maps, database tables, charts, and graphics, and is an effective tool for conducting computerized system analysis and management.

Geographic information systems are used by government agencies, nonprofit organizations, and businesses to describe and analyze the physical world. Simply put, a GIS combines layers of information about a geographic region to give you a better understanding of that region. Layers of information can be combined depending on the purpose of the study, forming a computer model of a jurisdiction on which many types of analysis can be made. In the public safety sector, and for the purposes of this analysis, GIS software uses geography and computer-generated maps as an interface for integrating and accessing location-based information. For example, the location of fire stations can be layered on a jurisdiction's geography including the road network, water features, building footprints, or any other feature that has been digitized and assigned a location. In this manner, GIS allows public safety personnel to effectively plan for emergency response, determine mitigation priorities, analyze historical events, and predict future events. GIS can also be used to provide critical information to emergency responders upon dispatch or while en route to an incident to assist in tactical planning.

NFPA 1710 AND GIS ANALYSIS

While modern science has been well integrated into many areas of emergency response, it has been glaringly absent in the area of fire-rescue organization and deployment. Fire growth and behavior are scientifically measurable, as are the expected outcomes associated with untreated cardiac arrest, and the specific resource requirements to control fires, reduce fire-related injuries, and prevent deaths. Despite these facts, many communities maintain an *ad hoc* approach fire-rescue organization and deployment.

The NFPA 1710 Standard is important because it applies the documented and proven science of fire behavior and emergency medicine to the basic resource requirements for effective fire and emergency service deployment. Coupled with GIS analysis, this application allows a community to determine if the resources allocated for the different types of fires, emergencies, medical calls and other incidents are sufficient to effectively control the incident and protect lives and property. NFPA 1710 sets forth in concise terms the recommended resource requirements for fires, emergencies and other incidents. The standard requires, and GIS analysis facilitates, the emergency response organization to evaluate its performance and report it to the authority having jurisdiction. The approach embodied by NFPA 1710, and supported by GIS analysis, makes communities and fire fighters safer and responders more effective and enhances efficiency.

ARCVIEW 3.2a AND NETWORK ANALYST GEOGRAPHIC INFORMATION SYSTEMS

ArcView's Network Analyst is an extension, or software tool, that manipulates the network data incorporated into a GIS. Networks are interconnected line features, visually represented as roads, rivers, pipelines, or trails. From this data, it is possible to determine the best route between two spots or amongst several points, calculate travel cost in distance or time, find the closest facility to an address, or model service areas.

Travel speed is based on road type, as assigned by the U.S. Census Bureau. The ArcView 3.2a software Network Analyst extension uses the Geographic Data Technology (GDT)® Dynamap v5.0™ street database, which offers the most accurate and comprehensive U.S. street and address data available today.

ASSIGNED ROAD SPEEDS

A great deal of geographic street data originates from the US Census Bureau TIGER files. One of the attributes extracted from these files is the Census Feature Classification Code (CFCC), which describes street characteristics, among others. The CFCC is a three-character code: the first character is a letter describing the feature class; the second character is a number describing the major category; and the third character is a number describing the minor category. Based on the CFCC codes, a GIS user employing the ArcView Network Analyst extension is able to calculate the driving time for each line segment in a road network (i.e., the roads in a city, county, or other jurisdiction).

Primary Highways *With* Limited Access – 55 mph

Interstate highways and some toll highways are in this category (A1) and are distinguished by the presence of interchanges. These highways are accessed by way of ramps and have multiple lanes of traffic. The opposing traffic lanes are divided by a median strip.

A11 Interstate highway, un-separated
A12 Interstate highway, un-separated, in tunnel
A13 Interstate highway, un-separated, under-passing
A14 Interstate highway, un-separated, with rail line in center
A15 Interstate highway, separated
A16 Interstate highway, separated, in tunnel
A17 Interstate highway, separated, under-passing
A18 Interstate highway, separated, with rail line in center

Primary Roads *Without* Limited Access – 45 mph

This category (A2) includes nationally and regionally important highways that do not have limited access as required by category A1. It consists mainly of US highways, but may include some state highways and county highways that connect cities and larger towns. A road in this category must be hard-surface (concrete or asphalt). It has intersections with other roads, may be divided or undivided, and have multi-lane or single-lane characteristics.

A21 US highways, un-separated
A22 US highways, un-separated, in tunnel
A23 US highways, un-separated, under-passing
A24 US highways, un-separated, with rail line in center
A25 US highways, separated
A26 US highways, separated, in tunnel
A27 US highways, separated, under-passing
A28 US highways, separated, with rail line in center

Secondary and Connecting Roads – 35 mph

This category (A3) includes mostly state highways, but may include some county highways that connect smaller towns, subdivisions, and neighborhoods. The roads in this category generally are smaller than roads in Category A2, must be hard-surface, and are usually undivided with single-lane characteristics. These roads usually have a local name along with a route number and intersect with many other roads and driveways.

A31 State highways, un-separated
A32 State highways, un-separated, in tunnel
A33 State highways, un-separated, under-passing
A34 State highways, un-separated, with rail line in center
A35 State highways, separated
A36 State highways, separated, in tunnel
A37 State and county highways, separated, under-passing
A38 State and county highway, separated, with rail line in center

Local, Neighborhood, and Rural Roads – 25 mph

A road in this category (A4) is used for local traffic and usually has a single lane of traffic in each direction. In an urban area, this is a neighborhood road and street that is not a thoroughfare belonging in categories A2 or A3. In a rural area, this is a short-distance road connecting the smallest towns; the road may or may not have a state or county route number. Scenic park roads, unimproved or unpaved roads, and industrial roads are included in this category. Most roads in the Nation are classified as A4 roads.

A41 Local street, un-separated
A42 Local street, un-separated, in tunnel
A43 Local street, un-separated, under-passing
A44 Local street, un-separated, with rail line in center
A45 Local street, separated
A46 Local street, separated, in tunnel
A47 Local street, separated, under-passing
A48 Local street, separated, with rail line in center

Vehicular Trails – 1 mph

A road in this category (A5) is usable only by four-wheel drive vehicles, is usually a one-lane dirt trail, and is found almost exclusively in very rural areas. Sometimes the road is called a fire road or logging road and may include an abandoned railroad grade where the tracks have been removed. Minor, unpaved roads usable by ordinary cars and trucks belong in category A4, not A5.

A51 Vehicular trail, 4WD only, un-separated
A52 Vehicular trail, 4WD only, un-separated, in tunnel
A53 Vehicular trail, 4WD only, un-separated, under-passing

Road with Special Characteristics – 20 mph (or less)*

This category (A6) includes roads, portions of a road, intersections of a road, or the ends of a road that are parts of the vehicular highway system and have separately identifiable characteristics.

A61 Cul-de-sac
A62 Traffic circle, roundabout
A63 Access ramp
A64* Service drive on highway (5 mph)

Road as Other Thoroughfare – 5 mph (or less)*

A road in this category (A7) is not part of the vehicular highway system. It is used by bicyclists or pedestrians, and is typically inaccessible to mainstream motor traffic except for private-owner and service vehicles. This category includes foot and hiking trails located on park and forestland, as well as stairs or walkways that follow a road right-of-way and have names similar to road names.

A71* Walkway or trail for pedestrians (1 mph)
A72* Stairway for pedestrians (1 mph)
A73 Alley, road for service vehicles
A74 Driveway, service, or access road, usually privately owned

ASSUMPTIONS

Several key assumptions must be addressed prior to drawing any conclusions from this analysis:

- Modeled travel speeds are based on reasonable and prudent road speeds, as defined by the U.S. Census Bureau. **Actual response speeds may be slower, and the associated travel times greater, with any traffic congestion or any other unpredictable impedances including, but not limited to:**

  ✓ ***Traffic Incidents***: collisions and vehicle breakdowns causing lane blockages and driver distractions.

  ✓ ***Work Zones***: construction and maintenance activity that can cause added travel time in locations and times where congestion is not normally present.

  ✓ ***Weather***: reduced visibility, road surface problems and uncertain waiting conditions result in extra travel time and altered trip patterns.

  ✓ ***Demand Changes***: traffic volume varies from hour-to-hour and day-to-day and this causes travel time, crowding and congestion patterns to disappear or to significantly worsen for no apparent reason in some locations.

  ✓ ***Special Events***: an identifiable case of demand changes where the volume and pattern of the change can frequently be predicted or anticipated.

  ✓ ***Traffic Control Devices***: poorly timed or inoperable traffic signals, drawbridges, railroad grade crossing signals or traveler information systems contribute to irregularities in travel time.

  ✓ ***Inadequate Road or Transit Capacity***: the interaction of capacity problems with the aforementioned sources causes travel time to expand much faster than demand.[56]

[56] David Schrank and Tim Lomax, The 2003 Urban Mobility Report, (Texas Transportation Institute, Texas A&M University: September 2003).

✓ In addition, it is reasonable to suggest that because larger emergency vehicles are generally more cumbersome and require greater skill to maneuver, their response may be also be negatively affected by their weight, size, and, in some cases, inability to travel narrow surface streets.

- The scenarios depicted herein assume all apparatus are staffed and available to respond from their assigned stations immediately upon dispatch, as indicated in the following table.

TABLE 11:
"EXISTING STATION LOCATION & DEPLOYMENT CONFIGURATION"

STATION	ADDRESS	APPARATUS	STATION PERSONNEL
Station 1	258 Violet Avenue Poughkeepsie, NY 12601	**Engine 41-11** **Quint 41-45** **Ambulance 41-71** **Engine 41-12** **Ambulance 41-72** *Command Car 41-96* *Command Car 41-97*	**1 Officer and 3 Firefighters** *1st due equipment is contingent upon the nature of emergency; any remaining units would be deployed by volunteer firefighters and/or off-duty, "callback" personnel

Maximum On-duty Staffing: 4

- **If any unit is unavailable for any reason** (e.g., simultaneous emergencies, scheduled training, or as a result of mutual aid obligations) **travel times will be greater as more distant apparatus will be required to respond to an emergency with potential delays.**

- **The time from arrival of the apparatus to the onset of interior fire suppression operations and/or initiation of critical emergency medical interventions by that crew** (access interval) **must be considered when analyzing response system capabilities.** In reality, the access interval is dependent upon factors including, but not limited to, distance from the apparatus to the task location and the elevation of the fire or EMS location (i.e., high rise structures). Locked doors or security bars which must be breached also act as impediments to access. Impediments like these may add to the delay between the discovery of a fire and implementation of an actual fire attack, and to the delay between the discovery of an individual in medical distress and the initiation of emergency medical care.

Input information including station locations, apparatus deployment, incident data, and staffing minimums, were provided by the Dutchess-Fairview Professional Fire Fighters, IAFF Local 2623. The report that follows is a "best estimate" response time model of those roads expected to receive coverage by the Fairview Fire District.

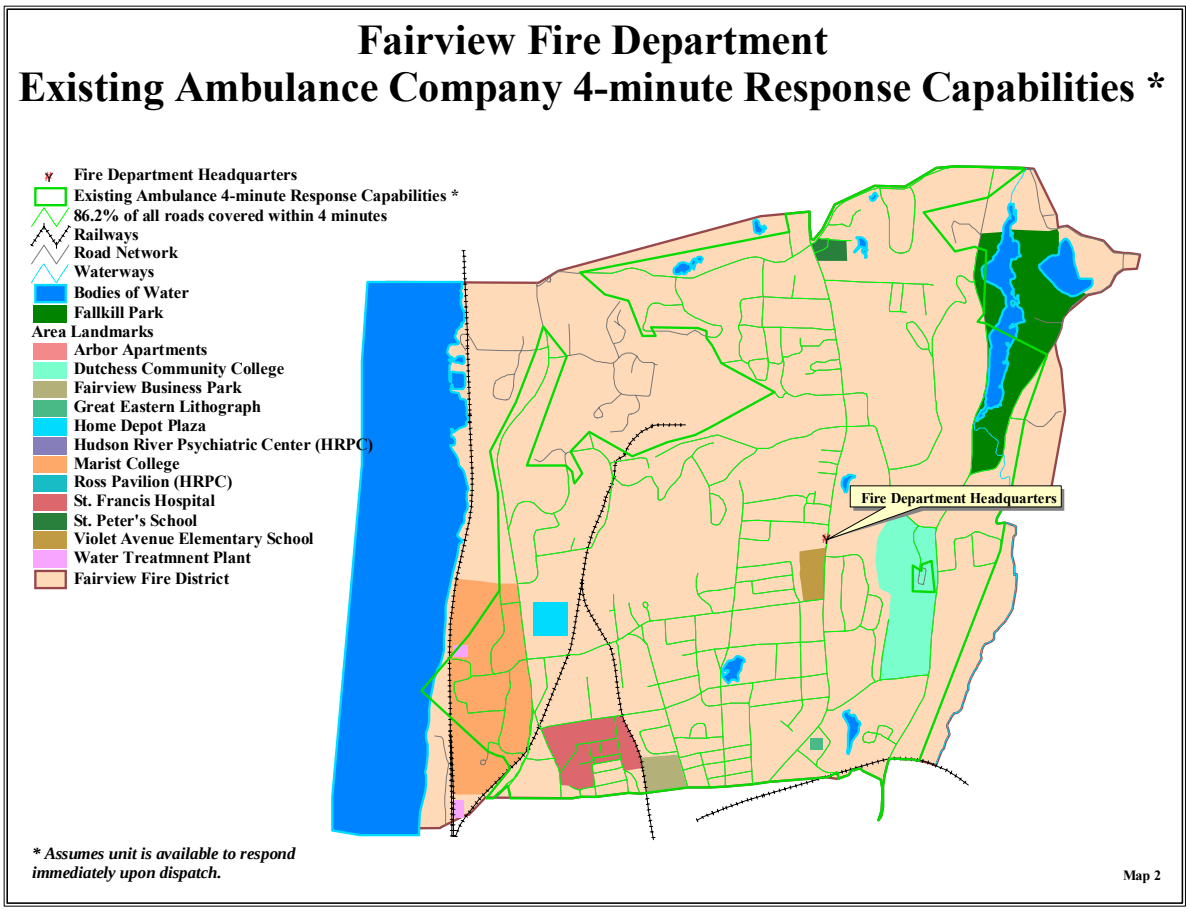
IDENTIFICATION OF EXISTING EMERGENCY RESOURCE RESPONSE CAPABILITIES

SUMMARY

The following series of maps indicate the existing response capabilities of Fairview Fire District emergency apparatus when responding from existing station locations (reference p. 48). The indicated response capabilities for individual units, and the resources designated to respond as part of an alarm assignment, assume that all units and the personnel assigned to staff and respond these units are available to respond immediately upon dispatch.

Dispatch time and turnout time are not considered as part of this analysis, and may add as much as two minutes to overall call-to-arrival time. Actual response speeds may be slower, and the associated travel times greater, with any traffic congestion or any other unpredictable impedances. If any unit is unavailable for any reason, travel times will be greater as more distant apparatus will be required to respond, with potential delays. Impediments to access may add to the delay between the discovery of a fire and implementation of an actual fire attack (resulting in increased fire growth), and to the delay between the discovery of an individual in medical distress and the initiation of emergency medical care (resulting in decreased patient survivability).

MAP 2



Map 2 indicates the existing 4-minute response capabilities of the ambulance when deploying from Fairview Fire Headquarters. Currently, the ambulance that deploys from this station is capable of responding to **86.2% of all roads located within the response jurisdiction in 4 minutes or less,** *assuming the unit is available to respond immediately upon dispatch.*

The Importance of the 4-minute Ambulance Response In the Provision of Emergency Medical Services:

Of the many injuries, traumas, and medical emergencies that require rapid medical attention, sudden cardiac arrest is one of the most frequently occurring. According to the Occupational Safety & Health Administration, there are 300,000 – 400,000 deaths *per year* in the United States from cardiac arrest.[57] Despite being one of the leading causes of death in America, this life threatening condition remains one of the most time-critical medical emergencies that can be treated in the field.

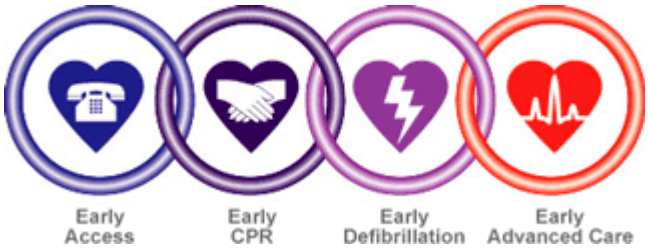
According to the American Heart Association, "Sudden cardiac death occurs on average at about 60 years of age, claims many people during their most productive years, and devastates unprepared families. The most common underlying cause of sudden cardiac arrest is a heart attack that results in ventricular fibrillation (quivering of the heart's lower chambers) or

[57] U.S. Occupational Safety and Health Administration, Technical Information Bulletin: Cardiac Arrest and Automated External Defibrillators (AEDs), < http://www.osha.gov/dts/tib/tib_data/tib20011217.html > Site visited May 17, 2004.

pulseless ventricular tachycardia (extremely rapid but ineffective beating of the heart's lower chambers). This irregular heart rhythm causes the heart to suddenly stop pumping blood."[58]

Most cardiac arrest deaths occur outside the hospital, with survival rates ranging between 1% and 5%. However, if fire fighters responding within 4 minutes of receiving an alarm initiate CPR, the probability of patient survival quadruples, from 4.6% to 18.2%. If those same fire fighters are equipped and trained to provide defibrillation, the expected survival rate is five times greater at 25.8%. Finally, if those fire fighters are trained and equipped as paramedics, the survival rate is increased to 34.3% – nearly a sevenfold increase.[59] A rapid emergency medical response is therefore essential in improving survival rates. Recognizing this, the 1710 Standard requires that a "fire department shall establish the response time objectives of **4 minutes or less for the arrival of a unit with first responder or higher capability at an emergency medical incident.**"[60]

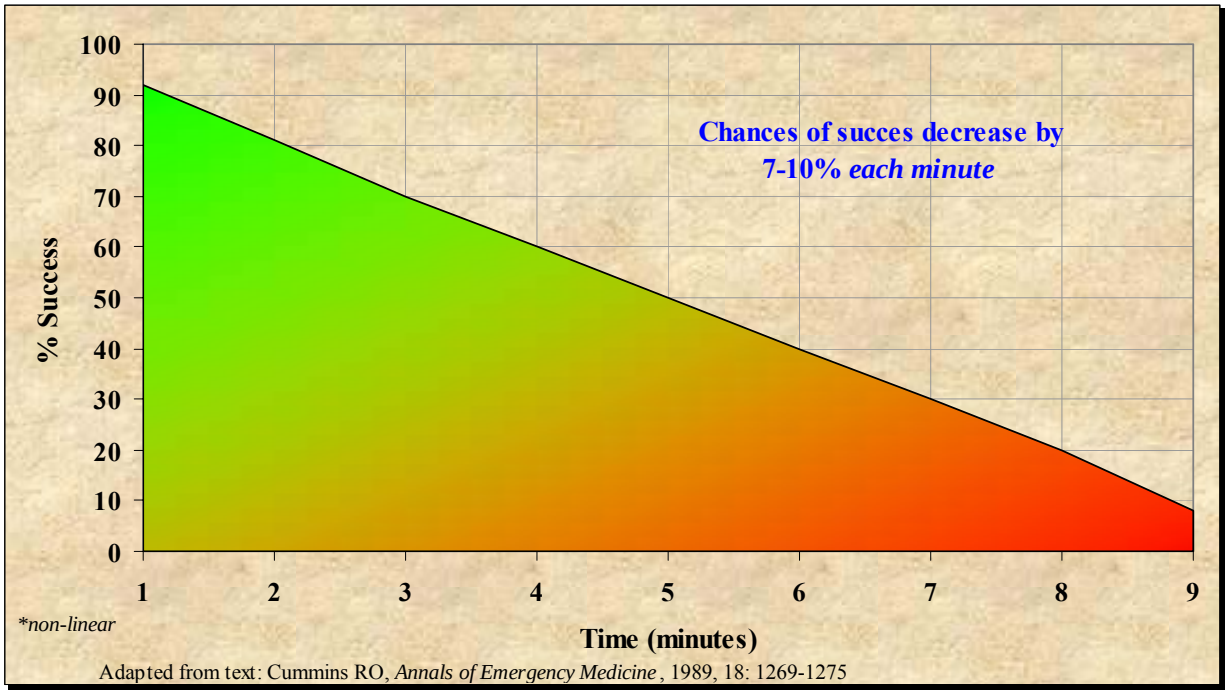
FIGURE 11:[61]
"THE CHAIN OF SURVIVAL"



While patient survivability from cardiac arrest depends upon a series of critical interventions, "rapid defibrillation is the most important single factor in determining survival."[62] Abnormal heart rhythms, with ventricular fibrillation (VF) being the most common, cause cardiac arrest. Defibrillation within 2 minutes can produce cardiac arrest survival rates as high as 90%. However, "if defibrillation is delayed more than 10 minutes, survival rates drop to less than 5%."[63]

[58] American Heart Association, "Sudden Deaths from Cardiac Arrest Statistical Fact Sheet" (2003) < http://www.americanheart.org/downloadable/heart/1046245460533FS23SDCA3.pdf > Site visited August 3, 2004.
[59] M.P. Larsen, M.S. Eisenberg, et al., "Predicting Survival From Out-of-Hospital Cardiac Arrest: A Graphic Model," Annals of Emergency Medicine 22, no. 11 (November 1993): 1652 – 8.
[60] NFPA 1710, § 4.1.3.1.1(2)
[61] "Chain of Survival" diagram courtesy of "ChainofSurvival.com" < http://www.chainofsurvival.com/cos/COSOverview_detail.asp >
[62] Emergency Cardiac Care Committee and Subcommittees of the American Heart Association, "Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care," Journal of the American Medical Association (October 28, 1992): 2289
[63] American Heart Association, "Sudden Deaths from Cardiac Arrest Statistical Fact Sheet" (2003) < http://www.americanheart.org/downloadable/heart/1046245460533FS23SDCA3.pdf > Site visited August 3, 2004.

FIGURE 12:
"CARDIAC ARREST SURVIVAL RATE"



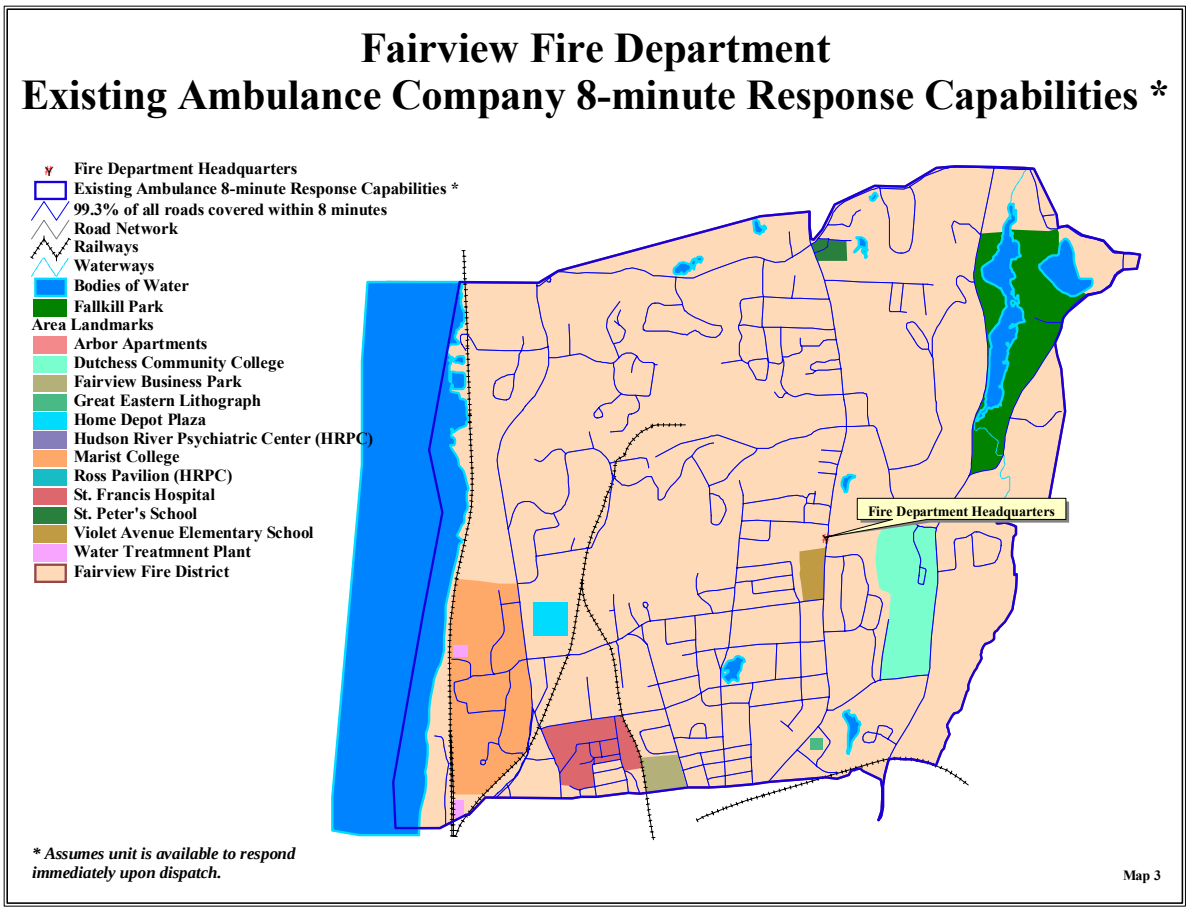
So effective is the use of an AED in increasing survivability of cardiac arrest patients, the International Association of Fire Chiefs has endorsed equipping every fire suppression unit in the United States with an automated external defibrillator. Mirroring this recommendation, NFPA 1710 states, "the fire department… shall ensure [that] emergency medical response capability includes personnel, equipment, and resources to deploy at the first responder level with automatic external defibrillator (AED) or higher treatment level."[64] In accordance with NFPA Standard 1710, Section 4.3.2, the Fairview Fire Department equips all of its apparatus with AED's and ensures all fire fighters are trained in their proper and effective operation.

Analysis of Existing Ambulance Company 4-minute Response Capabilities:

In the event of a medical emergency, the fire department deploys a basic life support (BLS) ambulance to the incident scene. This ambulance is staffed with two firefighters cross-trained in the provision of BLS interventions, such as CPR, basic trauma care, and automated external defibrillation. However, in order to effect a response of the BLS ambulance, two on-duty firefighters must abandon the frontline engine they are assigned to and respond on the ambulance – a staffing condition referred to as "cross-staffing." The result of cross-staffing the ambulance with engine company personnel is that only two on-duty firefighters remain to respond immediately upon dispatch to a simultaneously occurring emergency. Should another emergency occur when only two firefighters are available the station remains completely un-staffed and incapable of response.

[64] NFPA 1710, § 4.3.2

MAP 3



Map 3 indicates the existing 8-minute response capabilities of the ambulance when deploying from Fairview Fire Headquarters. Currently, the ambulance that deploys from this station is capable of responding to **99.3% of all roads located within the response jurisdiction in 8 minutes or less,** *assuming the unit is available to respond immediately upon dispatch*.

The Importance of the 8-minute Ambulance Response In the Provision of Emergency Medical Services:

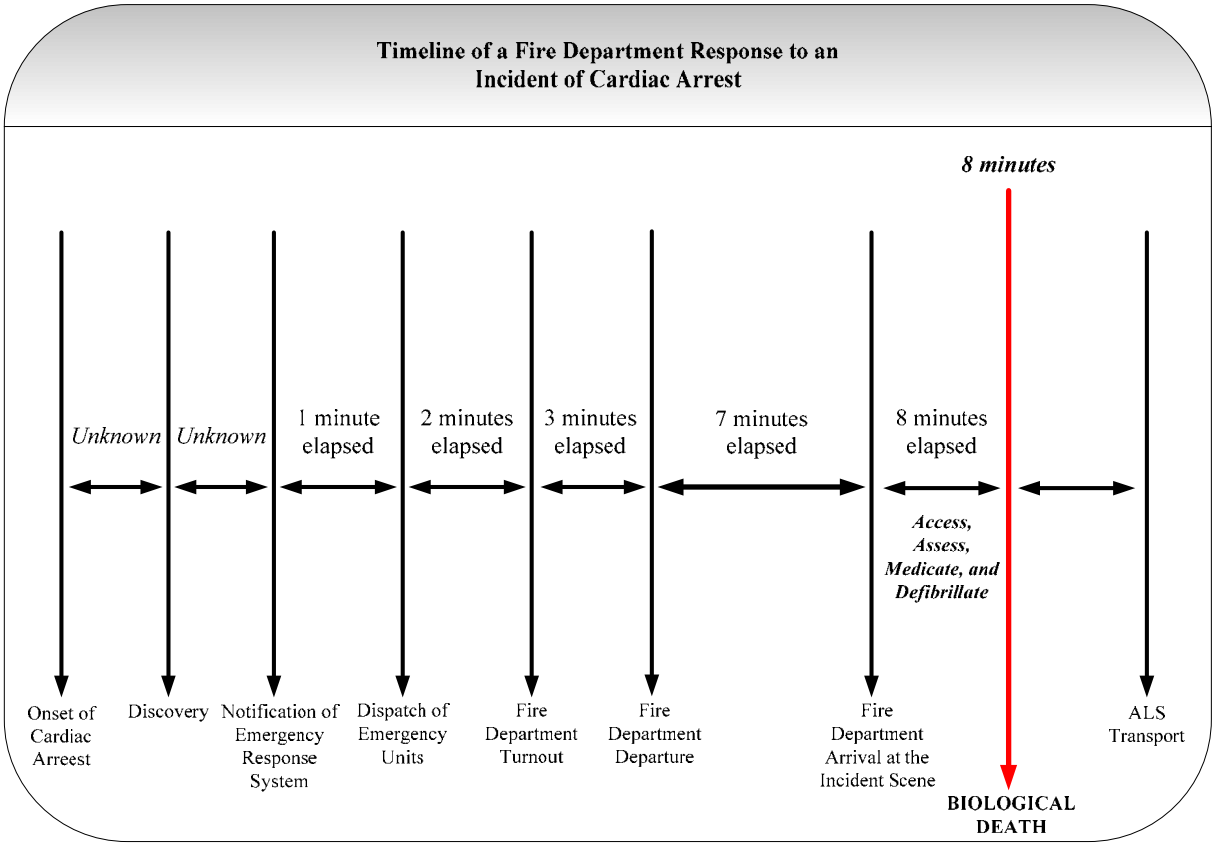
As previously noted, sudden cardiac arrest is one of the most time-critical medical emergencies that can be treated in the field *(reference Map 2)*. The highest hospital discharge rates having been achieved in cardiac arrest patients in whom CPR was initiated within 4 minutes of arrest and advanced cardiac life support (ACLS) within 8 minutes.[65] To this end, firefighters play a critical role in saving lives in the Fairview Fire District. Although the fire department does not provide advanced life support, the basic life support that it does provide ensures patients are stabilized in advance of the arrival of ACLS providers.

The eight-minute benchmark is crucial because a rapid fire department response expedites the delivery of more advanced lifesaving interventions, such as defibrillation and drug therapy. Two-tiered EMS systems such as these have improved survival rates over one-tiered systems,

[65] Emergency Cardiac Care Committee and Subcommittees of the American Heart Association, "Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care," Journal of the American Medical Association (October 28, 1992): 2184.

particularly when the first responder provides automated external defibrillation.[66] According to the Journal of the American Medical Association, "two-tier systems in which the first responders are trained in early defibrillation are most effective in providing rapid Advanced Cardiac Life Support (ACLS)."[67] Cardiac arrest victims have a 33% higher survival rate when paramedics arrive within eight minutes, according to the American Heart Association. After eight minutes, the prospects of recovery decreases rapidly.[68]

FIGURE 13:
"TIMELINE FOR DISCOVERY AND RESPONSE TO A CARDIAC ARREST"



The Eisenberg Model

A 1993 University of Washington study of 1,667 cardiac arrests linked survival of cardiac arrest to the time that elapsed before the initiation of three critical interventions: CPR, defibrillation and advanced cardiac life support. From this study, researchers produced a model for predicting cardiac arrest survival rates, known as the Eisenberg Model.[69] Because it clearly links response time to the probability of survival, the Eisenberg model has become the standard of performance for measuring effectiveness in the delivery of pre-hospital emergency medical services.

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[66] Analysis of some systems with high survival rates for out-of-hospital cardiac arrest reveals common practices of (1) multi-tiered systems deployed by a 911 priority dispatch system, (2) aggressive use of fire department apparatus for first response and automated defibrillation, (3) intensive medical supervision, and (4) widespread citizen awareness and CPR training.

[67] Emergency Cardiac Care Committee and Subcommittees of the American Heart Association, "Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care," Journal of the American Medical Association (October 28, 1992): 2290.

[68] Matthew Cella, "Response Rate of EMS Declines," The Washington Times, 1 April 2003

[69] M.P. Larsen, M.S. Eisenberg, et al., "Predicting Survival from Out-of-Hospital Cardiac Arrest: A Graphic Model," Annals of Emergency Medicine 22, no. 11 (November 1993): 1652 – 8.

Table 12 indicates predicted survivability rates for cardiac arrest patients, based upon the Eisenberg formula for predicting cardiac arrest survival rates, following the initiation of CPR, defibrillation, and advanced cardiac life support (ACLS) in 5, 6, and 7 minutes, respectively.

TABLE 12:
"EFFECT OF EMERGENCY CARE RESPONSE TIMES ON CARDIAC PATIENT SURVIVAL RATES"[70]

Fire Dep't. Response Time	Initiation of CPR ♥	Time to Defibrillation ⚡	Time to Advanced Cardiac Life Support (ACLS) 🚑	Predicted Survival Rate/ All Cardiac Arrest *(percentages)*
9 minutes	10 minutes	11 minutes	13 minutes	4.6%
4 minutes	F.D. EMT: 5 minutes	11 minutes	12 minutes	18.2%
4 minutes	F.D. EMT: 5 minutes	F.D. EMT-D: 6 minutes	11 minutes	25.8%
4 minutes	**F.D. EMT: 5 minutes**	**F.D. EMT-D: 6 minutes**	**F.D. Paramedic: 7 minutes**	**34.3%**

This scenario requires two fire fighters to provide CPR, one to prepare the AED and analyze the results of an electrocardiogram (ECG) report, and one to prepare for and initiate advanced cardiac life support measures, such as advanced airway management, I.V. therapy, and pharmacological interventions. This breakdown of the expected capabilities of a medical alarm assignment requires a minimum contingent of four EMS personnel to arrive at the scene of a cardiac arrest within 5 minutes of receiving an alarm. Most experts agree that four responders (at least two trained in ACLS and two trained in BLS) are the minimum required to provide ACLS to cardiac arrest victims.[71]

As the table indicates, a 9-minute response time means that CPR is not initiated until at least 10 minutes have elapsed from the time of cardiac arrest; 11 minutes have elapsed before defibrillation; and 13 minutes have elapsed before ACLS care is initiated, resulting in an expected patient survival rate of only 4.6 percent. Conversely, a 4-minute fire department response – with CPR initiated in 5 minutes, defibrillation in 6 minutes, and ACLS in 7 minutes – results in patient survivability rates of over 34%.

The quick arrival of an appropriate number of adequately trained personnel deploying with lifesaving medical resources is critical to increasing survivability from cardiac arrest and traumatic injury. For these reasons, **this analysis recommends that the ambulance be staffed with two full-time fire fighters, both of which are trained, *at a minimum*, to the level of EMT-B. Inasmuch as an increase in survivability correlates with the degree to which fire fighters are trained in emergency medicine, the fire department should consider staffing all engine companies with two fire fighters certified as EMT-Paramedics.**

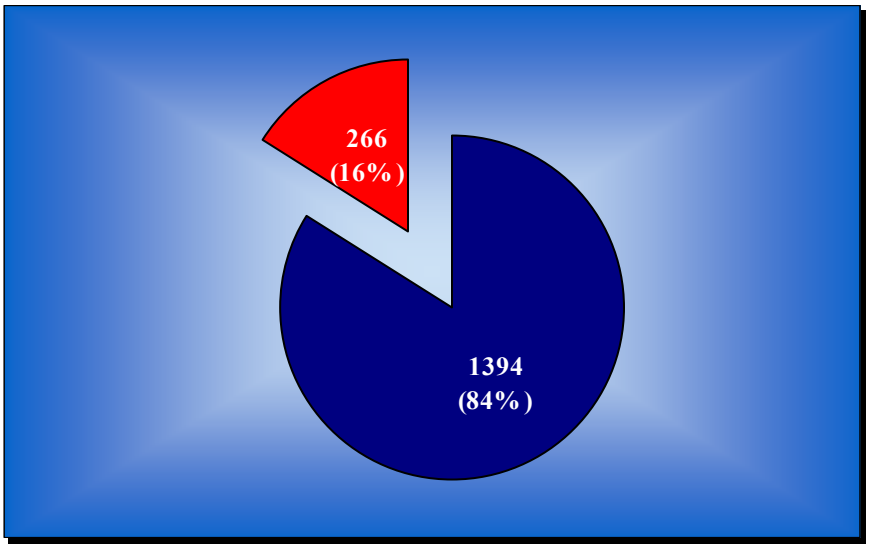
[70] M.P. Larsen, M.S. Eisenberg, et al., "Predicting Survival from Out-of-Hospital Cardiac Arrest: A Graphic Model," Annals of Emergency Medicine 22, no. 11 (November 1993): 1652 – 8.
[71] The Journal of the American Medical Association, October 28, 1992; p. 2291

Analysis of Ambulance Deployment and its Effects on Available Staffing:

In the event of an emergency medical incident, the fire department deploys a basic life support (BLS) ambulance to the incident scene. This ambulance is staffed with two firefighters cross-trained in the provision of BLS interventions, such as CPR, basic trauma care, and automated external defibrillation. However, in order to effect a response of the BLS ambulance, two on-duty firefighters must abandon the frontline engine they are assigned to and respond on the ambulance – a staffing condition referred to as "cross-staffing."[72] Cross-staffing the ambulance with engine company personnel results in only two on-duty firefighters remaining to respond immediately upon dispatch to a simultaneously occurring emergency.

In the year 2003, 16% of the fire department's 1,664 responses involved simultaneously occurring emergencies. During these 266 instances – a figure approaching nearly once per day – the fire department was forced to rely upon the remaining two firefighters to provide to the citizens of the response jurisdiction the range of emergency services.

FIGURE 14:
"NUMBER AND PERCENT OF EMERGENCY ALARMS RESPONDED TO BY TWO (OR FEWER) FIREFIGHTERS"

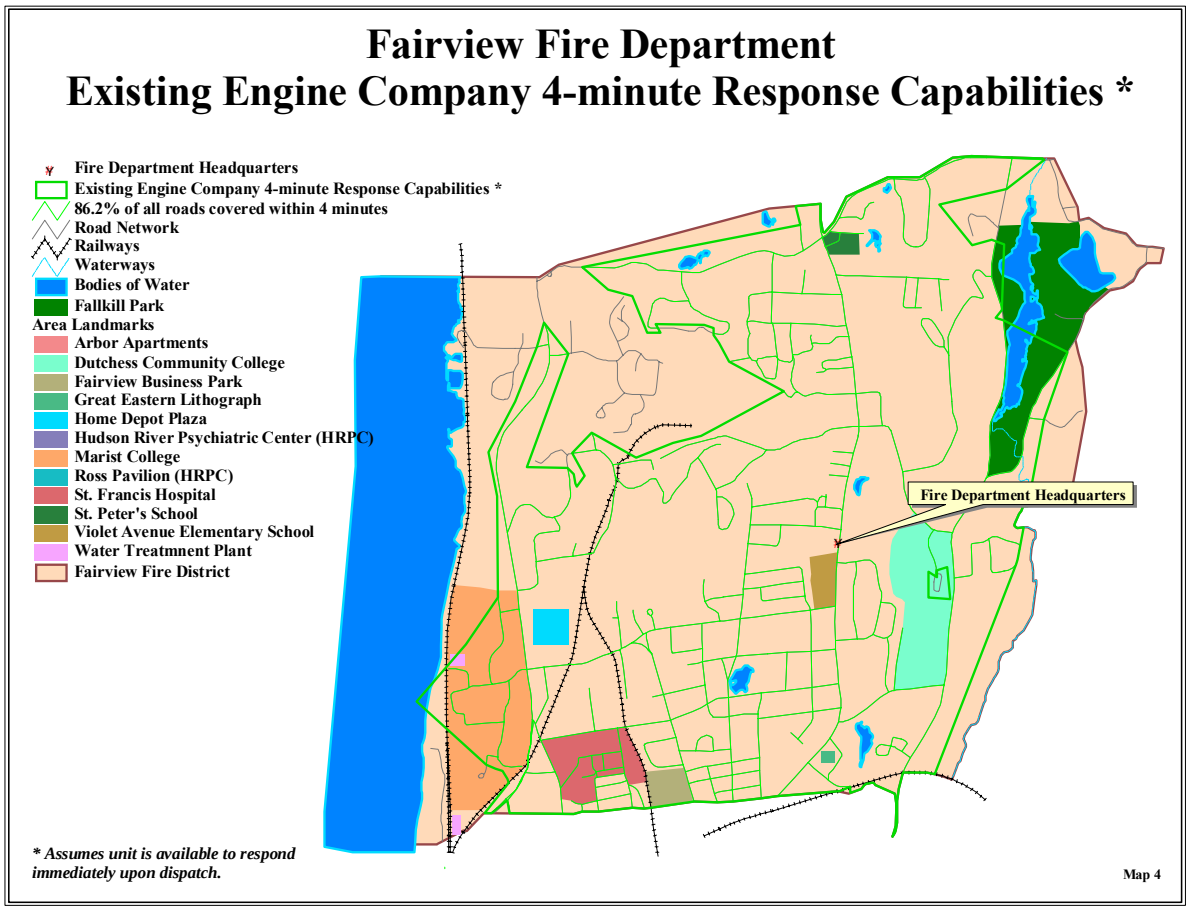


The deployment of only two firefighters into the community has serious negative implications for the delivery of emergency services. Most significantly, these two firefighters are relied upon to respond to any simultaneously occurring emergency, from a medical emergency to a hazardous materials spill to a structure fire. In the event that another emergency should occur while half of the on-duty staff is engaged on an overlapping medical incident and unavailable to respond, the remaining two firefighters will staff and deploy the remaining apparatus. For a medical emergency, both firefighters will staff and respond the second ambulance. For a fire (structure, vehicle, or otherwise), one firefighter will be required to staff and respond the second engine, and the other firefighter will staff and respond the ladder truck. In either case, the fire

[72] Cross-staffing is a practice whereby emergency responders staff several types of emergency response vehicles simultaneously in a work period. The type and scope of an emergency (i.e., structure fire, medical emergency) dictate which type of emergency response vehicle (i.e., engine, ambulance) the emergency responder's staff for an incident.

department will completely exhaust its pool of available personnel. No personnel remain at the station to respond to other emergencies in the district.

MAP 4



Map 4 indicates the existing 4-minute response capabilities of the engine company when deploying from Fairview Fire Department Headquarters. Currently, the engine that deploys from this station is capable of responding to **86.2% of all roads located within the response jurisdiction in 4 minutes or less,** *assuming the unit is available to respond immediately upon dispatch.*

The Importance of the 4-minute Engine Company Response In Structural Fire Fighting Operations:

As rule, a fire doubles in size for every minute that passes without the application of aggressive fire suppression measures. In less than 30 seconds a small flame can rage completely out of control and turn into a major fire. During fire growth, the temperature of a fire rises to 1,000° to 1,200° F. Flashover (the very rapid spreading of the fire due to super heating of room contents and other combustibles) at 1,100° to 1,200° F. may occur in a burning room in as little as 4 minutes, depending upon its contents.[73] At flashover, the odds of survival for individuals inside the structure- both victim and rescuer- are virtually non-existent.

NFPA Standard 1710 states that a fire department shall establish the response time objective of "**4 minutes or less** for the arrival of the first arriving engine company at a fire suppression

[73] In general, however, flashover is most likely to occur within 10 minutes of fire ignition within a confined space, and with typical contents.

incident."[74] As stated in NFPA 1710, Section 5.2.1.1, "on-duty fire suppression personnel shall be comprised of the numbers necessary for fire-fighting performance relative to the expected fire-fighting conditions. These numbers shall be determined through task analyses that take the following factors into consideration:

(1) Life hazard to the populace protected
(2) Provisions of *safe* and *effective* fire-fighting performance conditions for the fire fighters
(3) Potential property loss
(4) Nature, configuration, hazards, and internal protection of the properties involved
(5) Types of fire ground tactics and evolutions employed as standard procedure, type of apparatus used, and results expected to be attained at the fire scene."

The Importance of the 4-minute Engine Company Response In the Provision of Emergency Medical Services:

Fire fighters respond to all emergencies in the response jurisdiction necessitating the skills, capabilities, and resources of the fire department. Motor vehicle accidents, for example, often times require the fire department to stabilize the incident scene and gain access to the patient before emergency medical care can be rendered. While the extrication is being performed, the fire department must provide patient stabilization and scene safety. On-scene operations such as these require two firefighters to stabilize the patient and two to extricate. Assuming all four on-duty personnel are engaged at the incident scene, this leaves no personnel to ensure scene safety. In addition, no personnel remain immediately available to respond to simultaneously occurring alarms.

Likewise, Fairview fire fighters oversee the medical care of patients beyond the reach of those who provide more advanced levels of EMS. For example, those individuals requiring the technical rescue services that are provided exclusively by the fire service will also receive initial medical attention by Fairview fire fighters. To this extent, the fire department plays a critical role in the provision of EMS to the citizens of Dutchess County.

Analysis of Engine Deployment and its Effects on Available Staffing:

Currently, Fairview Fire Headquarters is staffed with four personnel, which consists of one company officer and three firefighters. These four firefighters are responsible for the deployment of numerous apparatus, depending upon the type of emergency. For each alarm- fire, medical, or otherwise- the department responds with two career firefighters per apparatus. For example, a dispatch for a structure fire, which consists of one engine and one truck, will have two career staff on the engine and two career staff on the truck. Similarly, two career firefighters staff and respond an ambulance to a medical emergency, resulting in only two personnel remaining at the station to respond to simultaneously occurring alarms. In the event that a fire should occur at the same time as the medical emergency- a circumstance which is not altogether unlikely, as 16% of all fire department responses involve simultaneously occurring emergencies- then the two fire fighters remaining at the fire station are required to respond both the second engine and the ladder truck (reference Figure 19, p. 69).

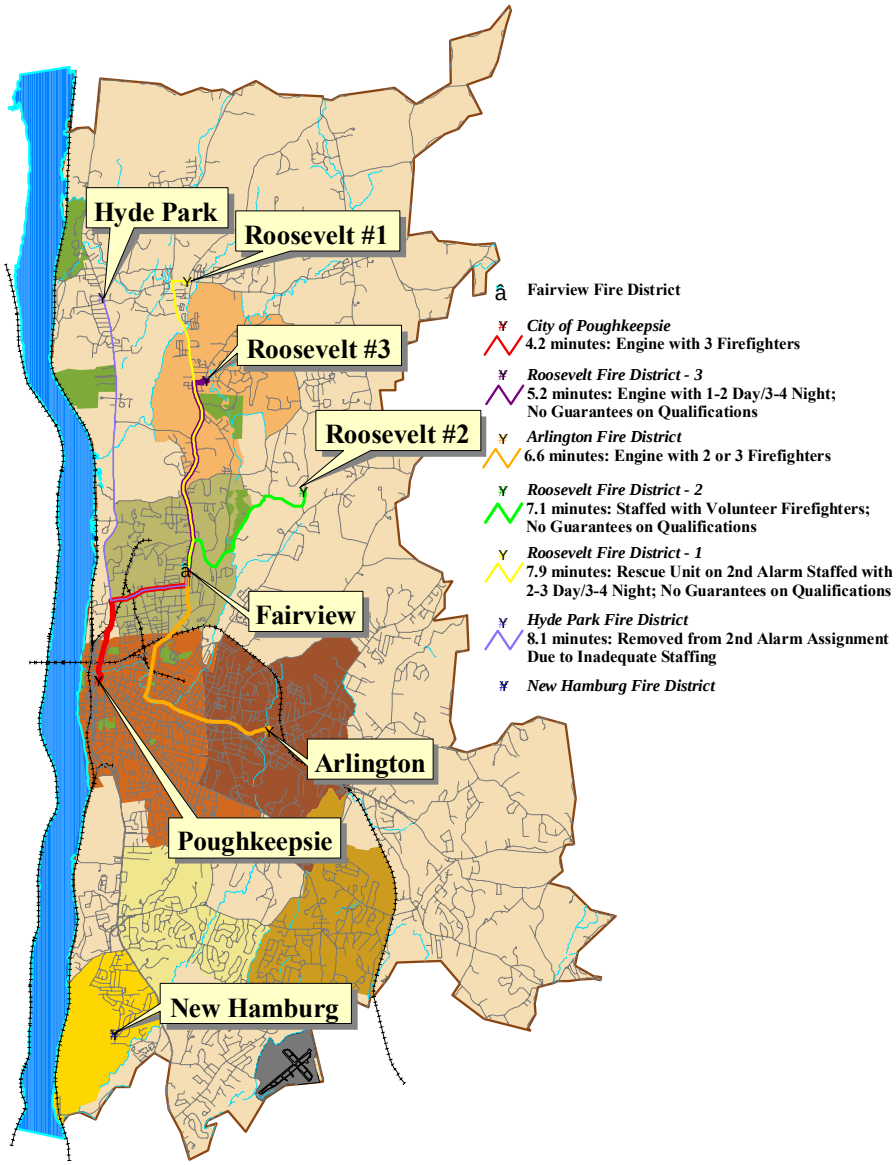
When these personnel are available to respond the engine immediately upon dispatch, over 86% of all roads will receive a fire department response within 4 minutes. But when the engine is

[74] NFPA 1710, § 4.1.3.1.1 (1)

unavailable to respond due to call-related activity- or any activity that renders the unit unavailable to respond immediately upon dispatch, such as in-service training or back-to-back EMS calls[75]- the fire district is rendered completely incapable of effecting an emergency response.

The unavailability of the engine to respond to emergencies within the response district creates a gap in services to the community, and a delay in fire department response on several different levels. A delay occurs as volunteers respond from their location within (or beyond) the response jurisdiction to the firehouse, don their protective gear and wait for additional personnel before actually responding secondary apparatus. There also exists the potential for delay as mutual aid resources respond from their primary response districts into the Fairview Fire District.

FIGURE 15:
"EXISTING MUTUAL AID RESOURCES EXPECTED RESPONSE TIMES"

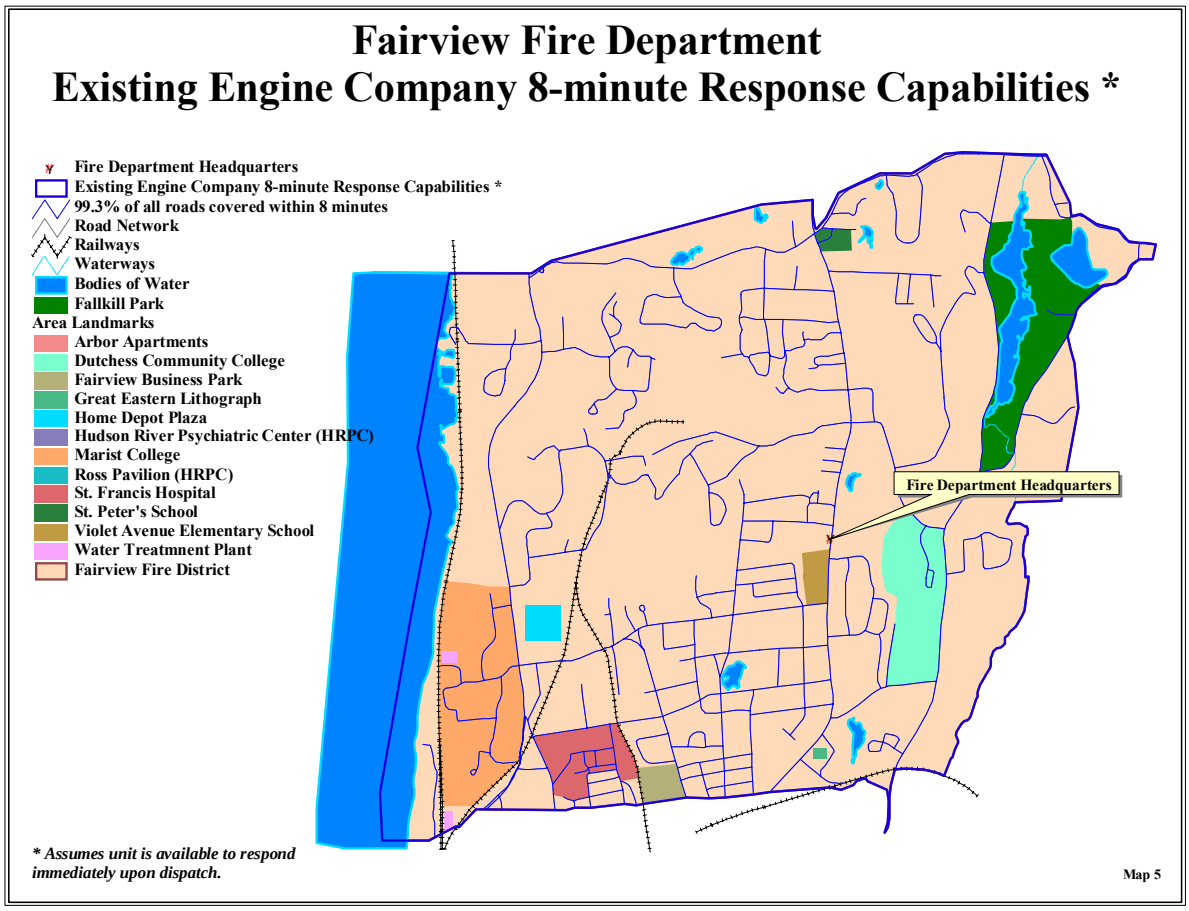


[75] Recall that simultaneously occurring emergencies constitute 16% of the fire department's total call volume.

As is indicated in Figure 15, the City of Poughkeepsie can respond three firefighters on mutual aid in about 4 minutes, assuming Poughkeepsie Fire Department units are available to respond. The Roosevelt Fire District can respond an engine staffed with between 1 to 2 firefighters during the day, and three to four in the evening, from Station #3. There are, however, no guarantees on the degree to which these volunteer firefighters may be trained. As such, resources deploying from RFD #3 should not be considered a reliable source of mutual aid. The Arlington Fire District can respond two or three more firefighters in about 7 minutes, and Roosevelt Fire District Station #1 is able to respond a rescue company on a 2nd alarm, staffed with between two and four firefighters, depending upon time of day, in approximately 8 minutes. Additional mutual aid resources, deploying from the Roosevelt and Hyde Park Fire Districts, are either volunteer companies or suffer from staffing deficiencies. As such, the consideration of these resources as providing reliable mutual aid should be, and has been, discontinued.

The travel times indicated herein are based on the assumption that these resources are available to respond immediately upon dispatch, and do not encounter response impediments such as traffic congestion, snow, construction, or any other impediment (reference pp. 47-48). Whether a delay occurs due to the unavailability of Fairview Fire Department mobile resources and personnel, the reliance upon volunteer firefighters who are not immediately available to respond, or mutual aid resources responding from distant locations, any delay in response translates directly into a proportional *increase* in the expected loss of life and property as a fire continues to propagate and a medical condition continues to worsen.

MAP 5

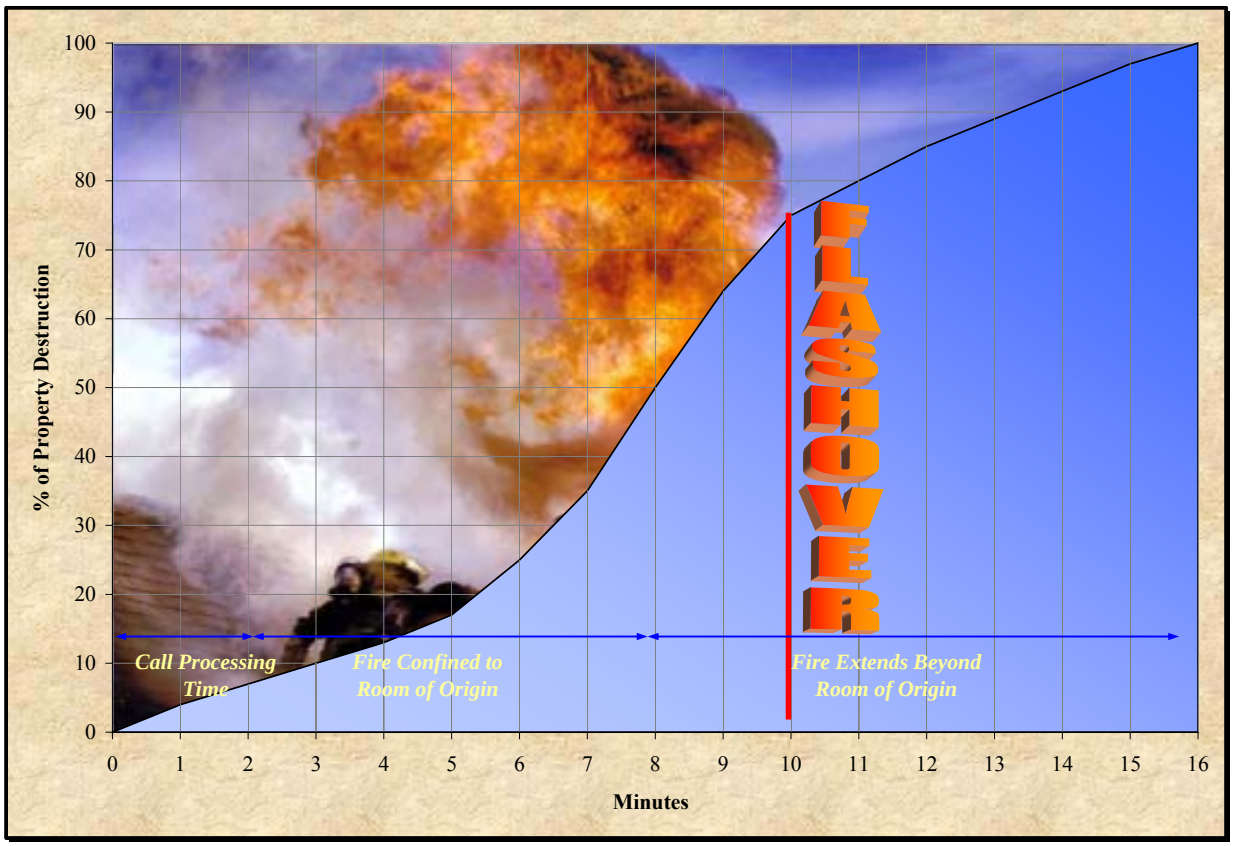


Map 5 indicates the existing 8-minute response areas for engine companies responding from all existing fire stations. Currently, the engine company, when that deploy from the central station, is capable of responding to **99.3% of all city roads in 8 minutes or less,** *assuming the unit is available to respond immediately upon dispatch.*

The Importance of the 8-minute Engine Company Response In Structural Fire Fighting Operations:

The 8-minute goal for arriving companies is critical because the progression of a structural fire to the point of "flashover" (the very rapid spreading of the fire due to super heating of room contents and other combustibles) generally occurs in less than 10 minutes. As there is a potential delay between fire ignition, discovery, and the transmission of an alarm it may be said that flashover is likely to occur within 8 minutes of firefighters receiving the alarm.

FIGURE 16:
"THE FIRE PROPAGATION CURVE"



Minimally, a crew of four is required to make a safe initial attack on a fire, with a crew of two working inside the burning structure and a backup crew of two standing by to assist as necessary. This is known as the "2 In/2 Out" regulation, and is codified as OSHA CFR 1910.134. Currently, the Fairview Fire District staffs its frontline engine company with only two fire fighters, out of compliance with NFPA 1710 company staffing objectives. On the scene of a fire the driver/operator of an engine must remain with the apparatus to operate the pump. Assuming a crew of two, this leaves only a single fire fighter from the engine company immediately available to initiate the attack or complete search and rescue activities. Therefore, a fire attack initiated by a single fire company staffed with only two firefighters would not be capable of initiating a safe and effective fire suppression and/or rescue operation in compliance with the "2 In/2 Out" regulation until two more fire department personnel- such as the fire chief and a second company staffed with one firefighter, or a second-in company staffed with two firefighters- arrives to support fire and rescue operations, and to assist the first company in the event of an unexpected emergency.[76, 77]

[76] As stated in NFPA 1500, "a rapid intervention team shall consist of at least two members and shall be available for rescue of a member or a team if the need arises. Once a second team is assigned or operating in the hazardous area, the incident shall no longer be considered in the 'initial stage,' and at least one rapid intervention crew shall be required."

[77] An unexpected emergency may include, but is not limited to, extreme fire conditions such as flashover; localized, partial, or complete structural collapse; failure to implement the incident command system, resulting in "freelancing" and a breakdown in fire fighter accountability; flawed tactical strategies; fire fighter disorientation or entrapment; or an injury that incapacitates a fire fighter, from a strained muscle to severe trauma.

Currently, the fire chief is only on duty Mondays through Fridays, from 6:30 a.m. until 2:30 p.m., and responds to an alarm at his availability and discretion. As previously indicated (reference Figure 15, p. 61), mutual aid resources respond from distant locations only if available, and do so with increased response times. Compounding the limitations of this deployment arrangement are volunteer companies that are not immediately available, and may not possess the level of training necessary to safely and effectively perform critical fireground operations. Hence, **the mutual aid resources relied upon by the Fairview Fire Department to augment its primary fire suppression and rescue operations present with questions regarding availability, reliability, and competence.**

Analysis of Engine Deployment and its Effects on Available Staffing:

The rapid response of an adequate number of appropriately-trained firefighters is essential to the initiation of fire suppression and rescue operations. Independent studies performed by private consultants, industry trade groups, emergency service associations and individual fire departments across the United States and Canada all validate similar findings: adequately staffed fire suppression companies responding in a timely fashion are able to initiate and perform emergency scene operations more safely, more effectively, and with greater success than under-staffed companies. Examples of some of the more significant findings are as follows:

The Dallas Study [78]

The Dallas Study is the benchmark study of the link between crew size and fire suppression effectiveness. This study was performed as a series of controlled evolutions on a specified set of fire situations using different components in the range of four to six people. Significantly, the study found that "fatigue was a serious problem for smaller groups." Indeed, the author of a 1993 memorandum concluded that this finding was relevant because it highlights the link between staffing and fire fighter deaths and injuries. Task analyses performed by the Dallas, Texas and Westerville, Ohio Fire Departments confirm the increased efficacy of adequately staffed fire department units at the scene of a structure fire. This joint study concluded that **four fire fighters are capable of performing the rescue of potential victims 80% faster than a crew of three fire fighters.**

The Austin Study [79]

In 1993, the Austin Fire Department conducted a study to determine whether companies staffed with four fire fighters were safer and more effective than the three-person companies the department was currently deploying. In order to compare the effectiveness of fire companies, and the physiological impact on fire fighters and Austin Fire Department injury rates at various staffing levels, the fire department conducted drills consisting of a series of common fireground tasks divided into three scenarios: a simulated two-story residential fire; a simulated aerial ladder evolution; and a simulated engine company high-rise fire.

These simulations revealed that regardless of the experience, the preparation, or the training of the fire fighters, loss of life and property increases when a sufficient number of personnel are

[78] McManis Associates and John T. O'Hagan & Associates, "Dallas Fire Department Staffing Level Study," (June 1984); pp. 1-2 and II-1 through II-7; Richard C. Morrison, "Manning Levels for Engine and Ladder Companies in Small Fire Departments," (1990).
[79] Chief Bill Roberts, "The Austin Fire Department Staffing Study," (March 1993).

not available to conduct the tasks required in an efficient manner. The severity and the degree of hazard increases until controlled or the fire passes the critical point. Consequently, the Austin Fire Department concluded that the effectiveness significantly improves when a company is increased from three to four personnel. In the two-story residential fire, the efficiency or time improvement between the three-person and four-person crew was 73%. In the aerial ladder evolution, the efficiency improvement between three-person and four-person crews was 66%. In the high-rise fire, the efficiency improvement between the three-person and four-person engine company crew was 35%.

In addition, to the fireground simulation, the Austin Fire Department also reviewed injury reports involving 136 emergency incidents to which 1,938 fire fighters responded from 1989 to 1992. The analysis revealed that the injury rate for four or five-person crews was 5.3 per 100 fire fighters while the three-person companies experienced an injury rate of 7.77 injuries per 100 fire fighters. The injury rate for three-person companies was 46% higher than the rate for larger crews.

The IAFF Study [80]

This study was a comprehensive analysis of fire fighter injuries and minimum staffing levels in a number of cities. The study found that 69% of jurisdictions that maintained crew sizes of less than four fire fighters had fire fighter injury rates of 10 or more per 100 fire fighters, while only 38.3% of jurisdictions maintaining crew sizes of four or more fire fighters had comparable injury rates. In other words, jurisdictions having crew sizes of less than four fire fighters suffered a benchmark injury rate at nearly twice the percentage rate of jurisdictions that maintained crew sizes of four or more fire fighters.

The National Fire Academy Study [81]

This report summarizes a 1977 test conducted by the Dallas Fire Department, which consisted of a simulated fire involving several rooms at the rear of the third floor of an old school. This simulated fire was conducted to determine how long it took a three, four, or five person team to advance its line to this area and get water on the fire. Immediately following those tasks, each individual's physical condition was assessed. Timing began as each engine company entered the schoolyard.

The average time for the engine companies to complete the tasks is revealing. The three-person team average was 18.8 minutes. All personnel were exhausted, rubber legged, had difficulty standing up and all three were unfit for further fire fighting. The four-person team, conducting the very same test, averaged 10.29 minutes and upon completing they were nearing exhaustion. The five-person team averaged 6.15 minutes, and showed little evidence of fatigue at the end of the exercise.

The NFPA 1710 Standard

Prior to the studies cited above (and others), the NFPA had never issued a standard that set forth comprehensive minimum criteria to ensure safe and effective fire and emergency medical response by career fire departments. Recognizing the correlation between adequate staffing and rapid response with the safe and effective delivery of fire and rescue operations, the NFPA 1710

[80] International Association of Fire Fighters, "Analysis of Fire Fighter Injuries and Minimum Staffing per Piece of Apparatus in Cities with Populations of 150,000 or More," (December, 1991).

[81] National Fire Academy, Executive Development Program III, "Fire Engines are Becoming Expensive Taxi Cabs: Inadequate Manning," (February 1981), 2 – 4.

Standard was created. The standard represents the culmination of more than a decade of work by the NFPA Standards Council, its Technical Committees, and its membership. The result is a comprehensive, uniform and practical standard governing fire and rescue service deployment by career fire departments throughout North America. The NFPA 1710 Standard is important because it applies the documented and proven science of fire behavior and emergency medicine to the basic resource requirements for effective fire and emergency service deployment.

The 1710 Standard defines companies as either engine or truck (ladder) companies or specialized apparatus such as rescue or squad companies, depending on the type of apparatus and the fire suppression functions that are performed. Regardless of the type of company, each must consist of a group of trained and equipped fire fighters, operating under the supervision of a company officer, who respond on and deploy from that apparatus at the emergency scene. NFPA Standard 1710 recommends "fire companies whose primary functions are to pump and deliver water and perform basic fire fighting at fires, including search and rescue… shall be staffed with **a minimum of four on-duty personnel**.[82] Fire companies whose primary functions are to perform the variety of services associated with truck work, such as forcible entry, ventilation, search and rescue, aerial operations for water delivery and rescue, utility control, illumination, overhaul and salvage work… shall [also] be staffed with **a minimum of four on-duty personnel**."[83] In those instances where the deployment of four firefighters is not possible from a common piece of apparatus, the NFPA makes an exception in the form of an equivalency clause.

Equivalency

NFPA 1710's equivalency statement allows jurisdictions to use other "systems, methods or approaches" to meet requirements of the standard if they can validate and document in writing that such avenues are equal or superior to the requirements contained in the standard.[84] Nothing in the standard "is intended to prohibit the use of systems, methods, or approaches of equivalent or superior performance to those prescribed" in NFPA 1710.[85] The NFPA allows for an exception in those instances when multiple apparatus are used to make up a company. The standard recognizes and clarifies the limited use of such multi-piece companies, to include the following:

- The use of a fire department personnel vehicle if the apparatus does not have adequate seated positions.

- An engine and a water tanker, such as those used in some suburban and rural response where a water supply (hydrant or natural water bodies) is not available.

- An engine and an EMS unit (ambulance or rescue).[86]

[82] NFPA 1710, § 5.2.2.1 and § 5.2.2.1.1
[83] NFPA 1710, § 5.2.2.2 and § 5.2.2.2.1
[84] Equivalency statements are common features in NFPA standards and the equivalency statement added by the Standards Council is not unique to the NFPA 1710 Standard. Customarily, the equivalency statement does little more than clarify the written standard as the minimum to which users must comply. It is not intended to allow for any jurisdiction or fire department to reduce the requirements in the standard and still claim compliance.
[85] NFPA 1710, § 1.3
[86] It should be noted that the usefulness of such an assignment, though allowed by the standard, is questionable, especially if patient transport is provided, since the engine would always have to remain with the EMS unit to keep the company intact.

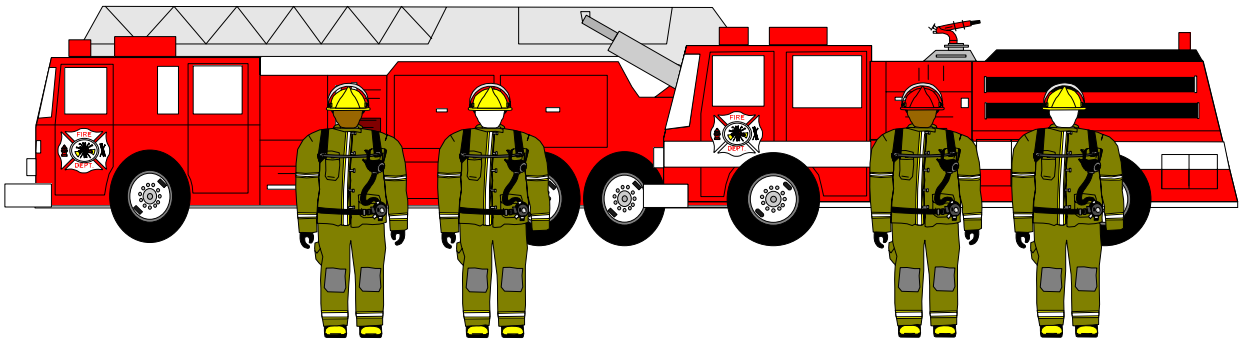
It is important to note that such exceptions require that these multi-piece companies are always:

1. **dispatched and arrive together,**
2. **are continuously operated together, and**
3. **consist of *at least* three firefighters operating under the supervision of a company officer, for a total of four fire department personnel.**

When at least four firefighters deploy simultaneously into the community from a single engine, it may be said that the fire department is operating in compliance with NFPA 1710. When two or more apparatus deploy simultaneously, operate under the supervision of a company officer, and the total firefighter compliment equals four, the fire department remains in compliance with NFPA 1710 by way of the equivalency clause. For example, when a fire engine and ladder truck, each staffed with two firefighters, deploy *in tandem* into the community, in response to a structure fire, it may be said that they are operating in compliance with NFPA 1710's equivalency provision. Although neither unit is staffed with four firefighters, in compliance with company staffing objectives, compliance with NFPA 1710 is nonetheless accomplished because both units are responding simultaneously from a common location, and the total firefighter compliment amounts to three firefighters under the command of a company officer, for a total of four fire personnel. The following graphic illustrates NFPA 1710 equivalency.

FIGURE 18:

NFPA 1710, Section 1.3 - Equivalency:
"Nothing in this standard is intended to prohibit the use of systems, methods, or approaches of equivalent or superior performance to those prescribed in this standard."



2 firefighters deploying from ladder truck

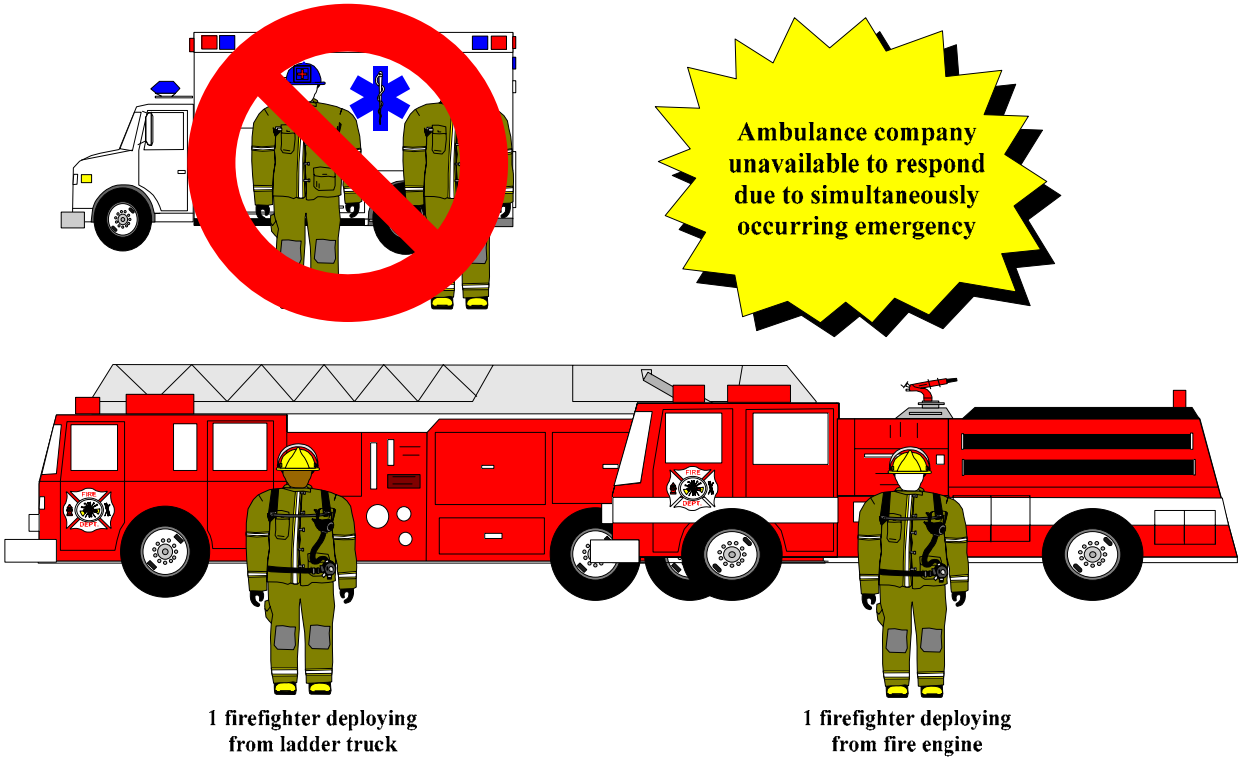
1 company officer and 1 firefighter deploying from fire engine

The Fairview Fire Department becomes non-compliant with NFPA 1710 company staffing objectives,[87] however, in the event of a medical emergency, which requires two engine company firefighters to staff and deploy the ambulance. This staffing and deployment arrangement leaves only two firefighters at fire headquarters available to respond to a simultaneously occurring emergency.

[87] Compliance with company staffing objectives requires four fighters, including a company officer, deploying from a common apparatus.

In the event the simultaneously occurring emergency is a structure fire, and firefighters on the ambulance are unavailable to respond, the two personnel remaining at fire headquarters will be forced to respond with only a single firefighter on the engine and a single firefighter on the ladder truck. This condition, which is not compliant with the staffing objectives outlined in NFPA 1710, and which violates the standard's equivalency clause, is graphically depicted in Figure 19.

FIGURE 19:

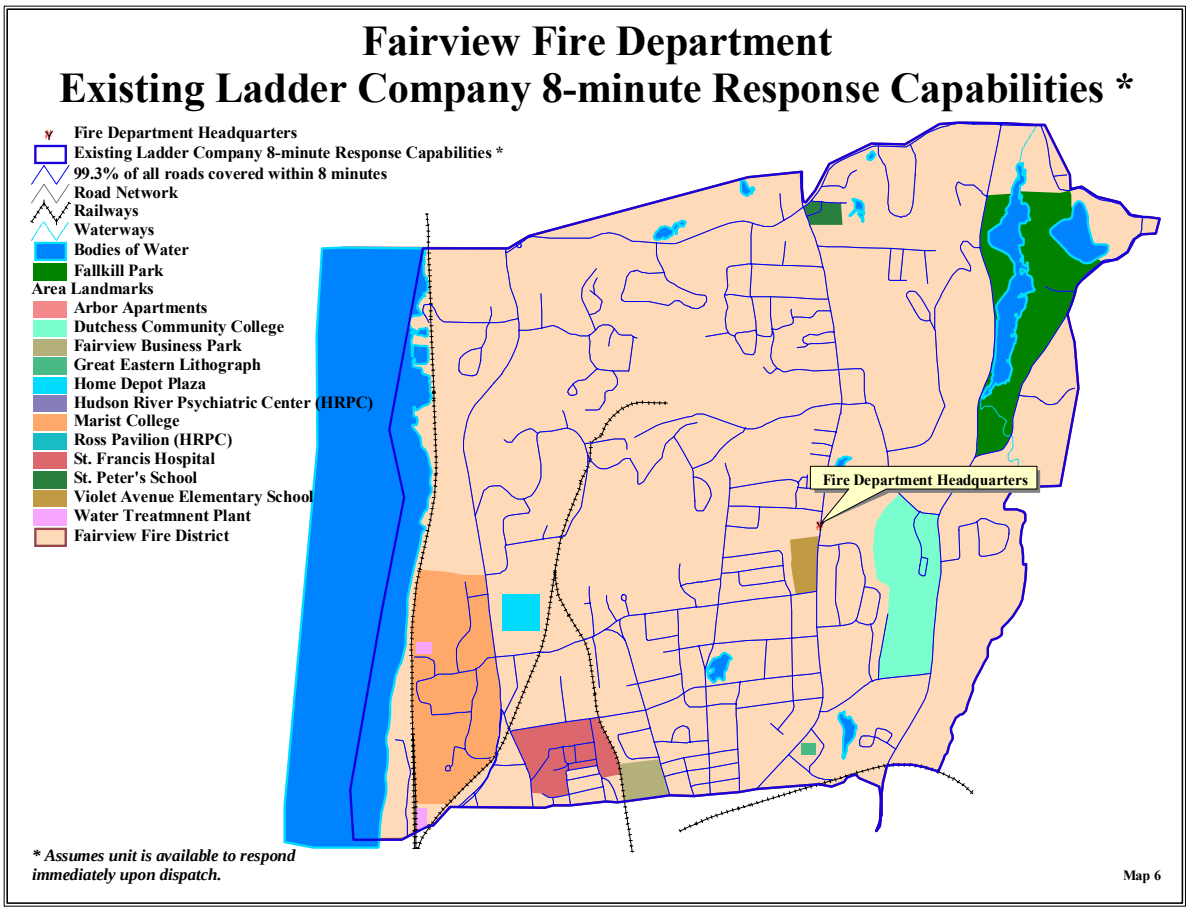


As previously indicated, **compliance with the equivalency clause requires multiple units to be dispatched together and operate continuously together at all times.** As the example of a fire department response to a medical emergency indicates, multiple units are not deployed into the community, and as a result the Fairview Fire Department operates out of compliance with NFPA 1710. It is worth reiterating here that requests for emergency medical assistance are received by the fire department more than any other type of alarm. The result is an increase in the amount of time only two firefighters are available to respond to simultaneously occurring emergencies, and an increase in the amount of time the department operates out of compliance with NFPA 1710. Moreover, as the population of Dutchess County continues to grow- especially the older segment of society- it is expected that the fire department will be required to respond to an increasing number of requests for emergency medical assistance. Assuming staffing remains at existing levels, below that recommended by professional standards, any increase in alarm activity will result in an even greater increase in the amount of time the fire department operates out of compliance with NFPA 1710.

Responding with anything less than four firefighters, out of compliance with NFPA 1710, decreases the effectiveness and efficiency of emergency operations and increases the risk posed to firefighters and citizens, alike. For these reasons, **it is the recommendation of this study that the Fairview Fire District make efforts to enhance existing response capabilities by**

staffing all fire suppression apparatus with four multi-role fire fighters cross-trained as certified emergency medical responders.

MAP 6



Map 6 indicates existing ladder company 8-minute response capabilities. Currently, the ladder truck, when deploying from the central fire station, is capable of responding to **99.3% of all roads located within the response jurisdiction in 8 minutes or less,** *assuming personnel are available to respond the apparatus immediately upon dispatch.*

The Importance of the 8-minute Ladder Company Response In Structural Fire Fighting Operations:

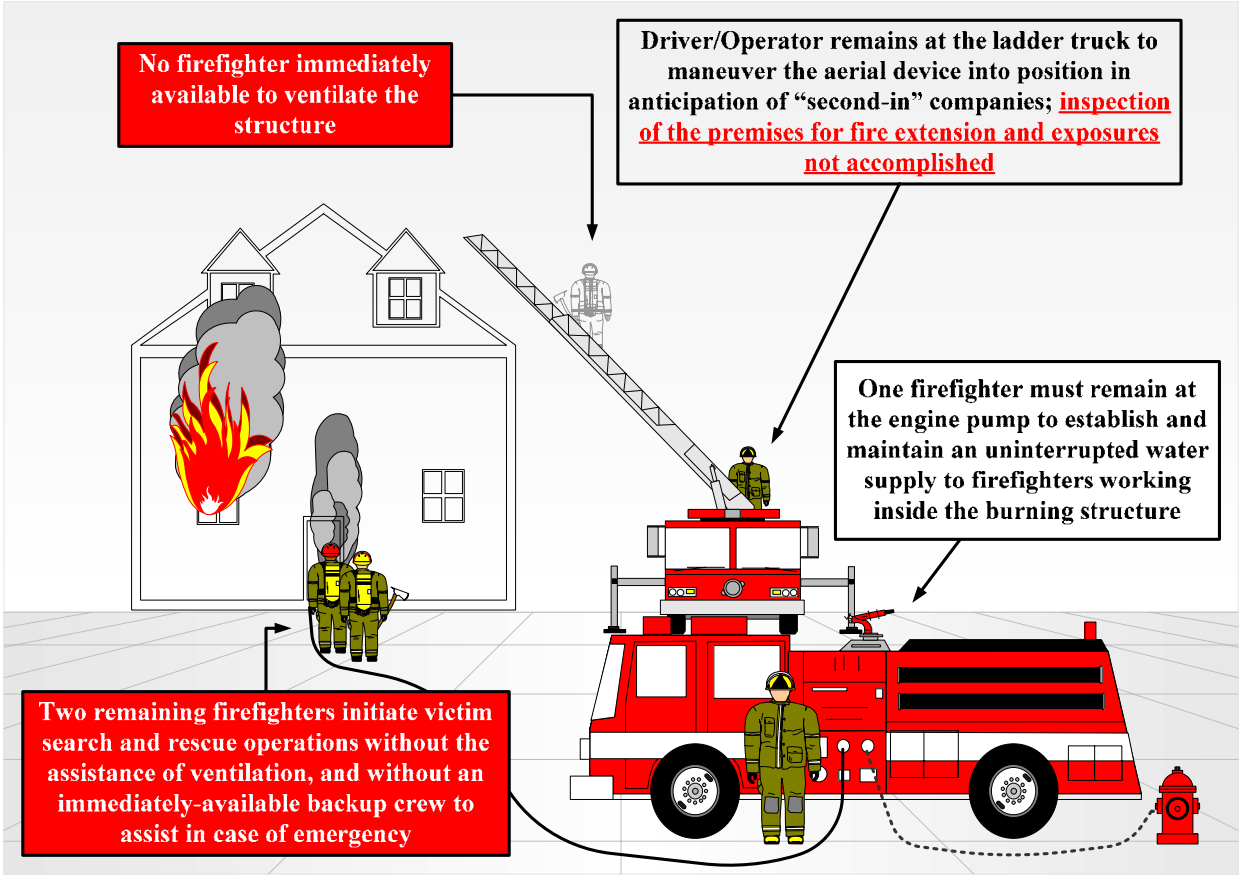
Ladder companies play a vital role on the scene of a structure fire securing building access and overseeing the ventilation of dangerous, superheated products of combustion from the building. The importance of being able to ventilate a building efficiently, effectively, and *in coordination* with interior attack operations is key to supporting search and rescue operations. Once the superheated gases and smoke from the building have been ventilated, fire fighters conducting interior fire suppression and rescue operations are able to more clearly locate the seat of the fire and more effectively perform victim search and rescue. The rapid extrication of victims from inside a burning structure is critical to saving lives: the quicker fire victims are removed from the structure, the quicker they can be treated by fire department and medical personnel for smoke inhalation, burns, and other injuries related to fire. Thus, the response of the ladder truck *in concert with* other fire suppression companies assigned to respond to a structure fire is critical to initiating *safe* and *effective* fire suppression and rescue operations. Any delay in response translates directly into a proportional *increase* in the expected loss of life and property.

Analysis of Ladder Truck Deployment and its Effects on Available Staffing:

NFPA 1710 states that "Fire companies whose primary functions are to perform the variety of services associated with truck work, such as forcible entry, ventilation, search and rescue, aerial operations for water delivery and rescue, utility control, illumination, overhaul and salvage work… shall [also] be staffed with a **minimum of four on-duty personnel.**"[88] The "2 In/2 Out" regulation requires a crew of four to make a safe initial attack on a fire, with a crew of two working inside the burning structure and a backup crew of two standing by to assist as necessary. Currently, the Fairview Fire District cross-staffs the ladder with two fire fighters, at most. In some instances, the ladder truck deploys with only a single firefighter on board (reference Figure 19, p. 69). In either event, it may be said that the ladder truck is not staffed in compliance with NFPA 1710 company staffing objectives.

On the scene of a fire the driver/operator of the ladder truck must remain with the apparatus to safely operate the aerial device. Assuming the maximum compliment of two firefighters are deploying from the ladder truck, this leaves only a single firefighter to support the attack or complete search and rescue activities.

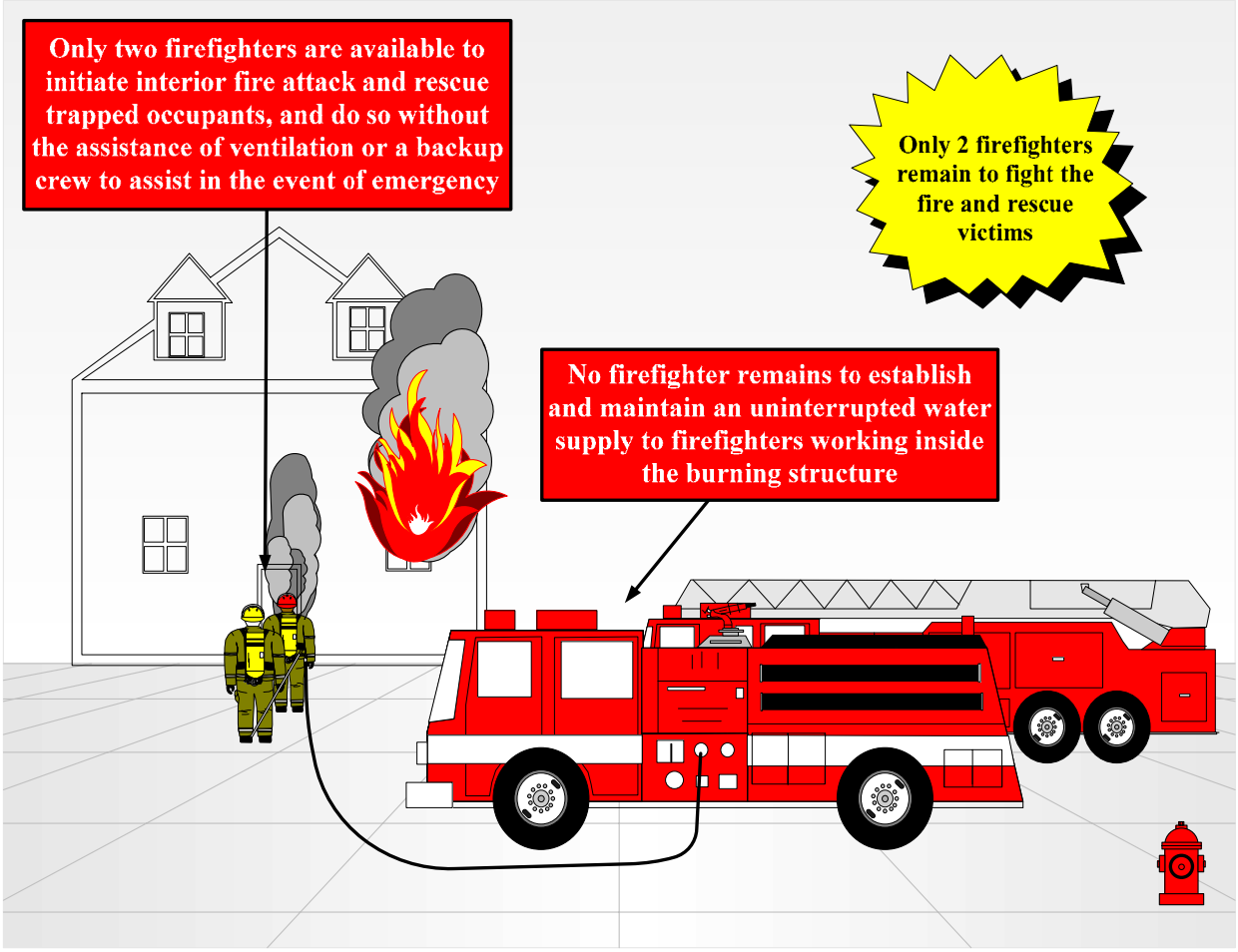
FIGURE 20:
"EXISTING ALLOCATION OF F.F.D. PERSONNEL AT A RESIDENTIAL STRUCTURE FIRE"
(assuming all units in this scenario are available to respond)



[88] NFPA 1710, Section 5.2.2.2 and 5.2.2.2.1

In the event only a single firefighter is deploying from the ladder truck- as would be the case in a simultaneously occurring alarm, when two firefighters have deployed the ambulance, leaving only two on-duty firefighters to staff remaining engine and ladder truck- no personnel remain to operate the aerial device, as the lone truck company firefighter will engage in defensive fire suppression and/or rescue activities with the lone engine company firefighter. In the event an immediate threat to life exists, the two firefighters staffing the engine and the ladder truck will abandon their assigned apparatus and initiate emergency rescue operations.

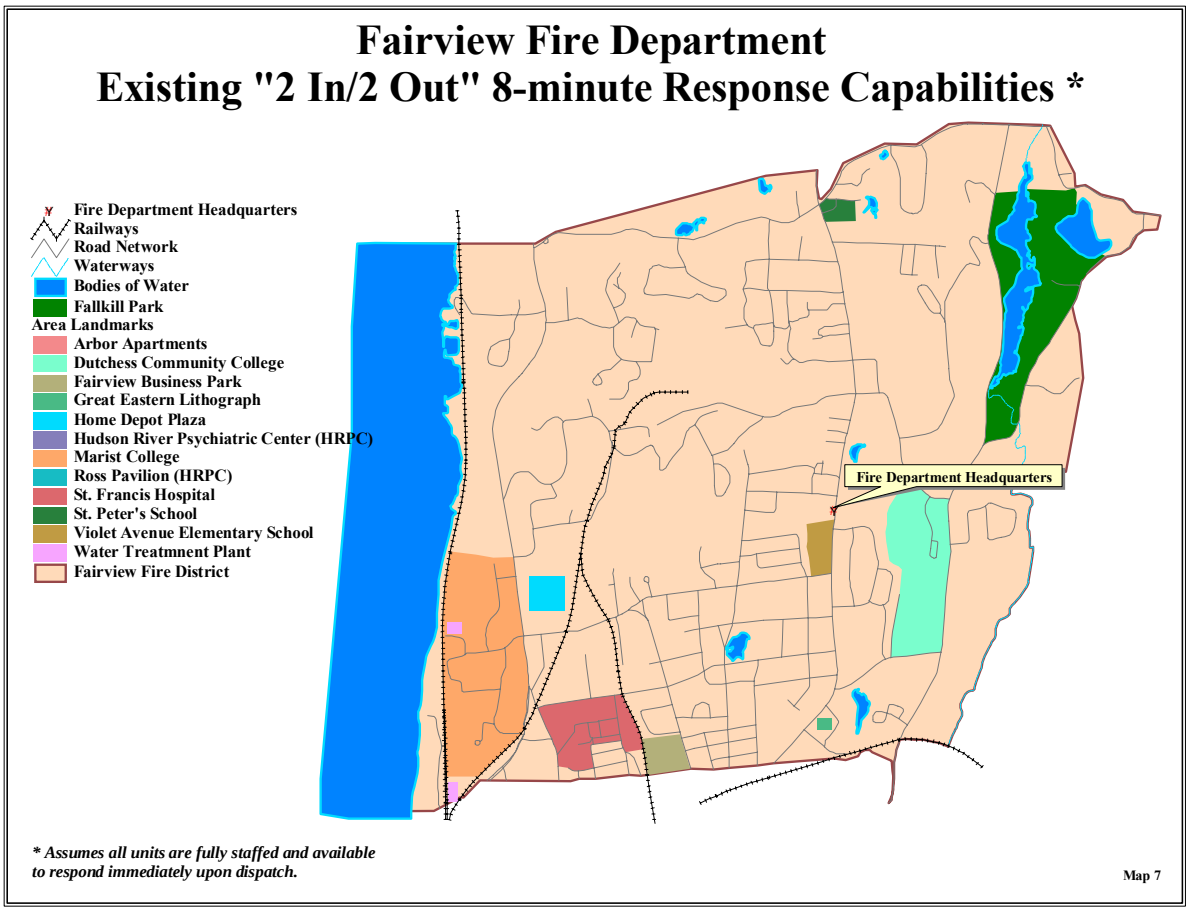
FIGURE 21:
"ALLOCATION OF PERSONNEL AT A RESIDENTIAL STRUCTURE FIRE WHEN ONLY TWO FIREFIGHTERS REMAIN TO RESPOND TO SIMULTANEOUSLY OCCURRING EMERGENCIES"



By engaging in emergency rescue operations when only two personnel are available (one from the engine, one from the ladder truck), firefighters greatly increase their risk of personal injury and death. And yet, these measures are a frequent occurrence in the Fairview Fire District as a result of staffing deficiencies. For these reasons, **it is the recommendation of this study that the Fairview Fire District make efforts to ensure the safe and effective delivery of fire department services by staffing all fire suppression apparatus with *at least* four multi-role fire fighters cross-trained to the level of EMT-B.**[89]

[89] NFPA 1710, §5.2.2.1.2 and §5.2.2.2.2 - "In jurisdictions with tactical hazards, high hazard occupancies, high incident frequencies, geographical restrictions, or other pertinent factors as identified by the authority having jurisdiction, these companies shall be staffed with a minimum of five or six on-duty members."

MAP 7



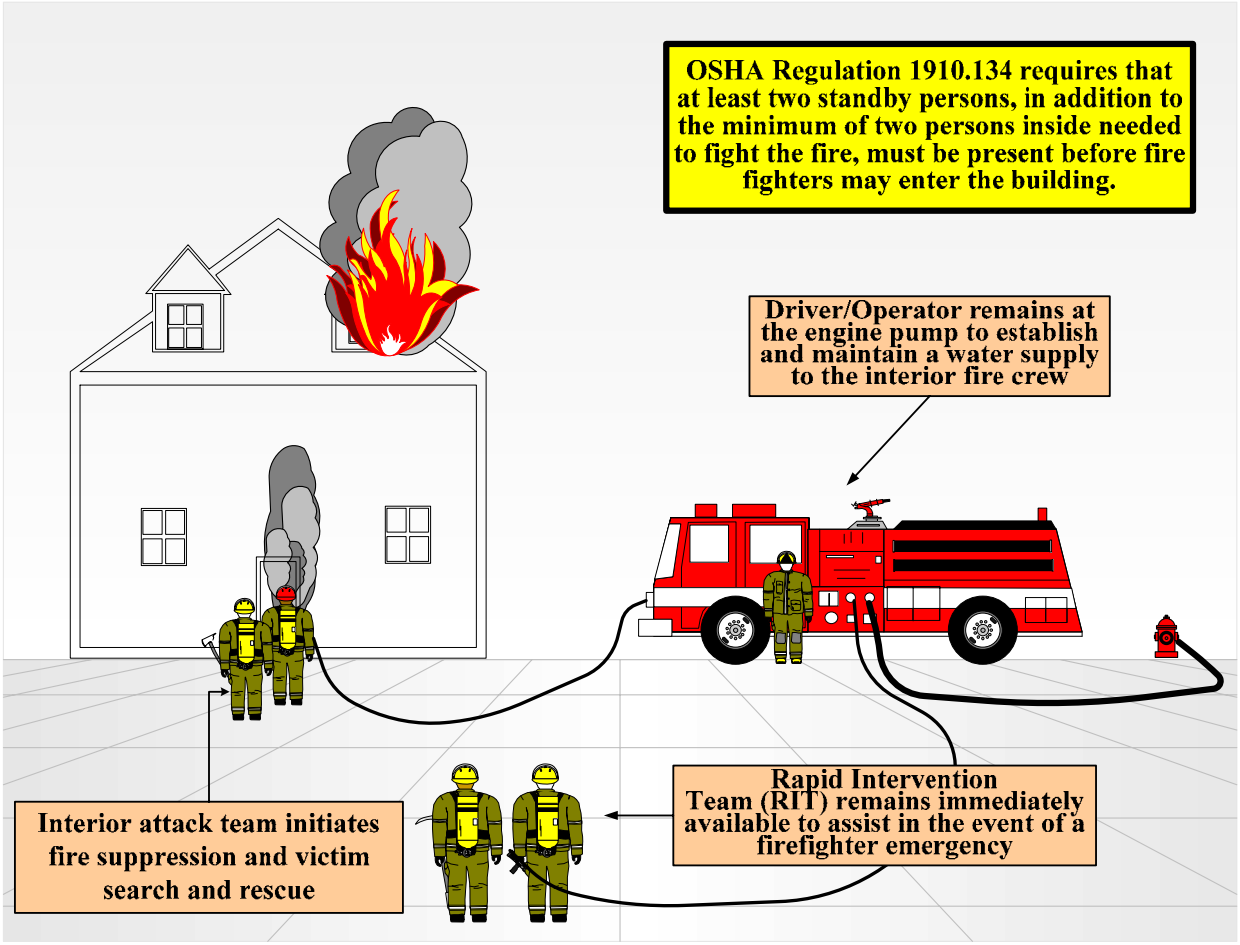
Map 7 indicates those areas where the Fairview Fire Department is currently capable of initiating *safe* and *effective* fire suppression and rescue operations, within 8 minutes, in accordance with the "2 In/2 Out" regulation. Under existing conditions, it is predicted that **the Fairview Fire Department is completely incapable of initiating fire suppression and rescue operations in accordance with the "2 In/2 Out" regulation. Only when mutual aid resources responding from distant locations arrive at the incident scene is the Fairview Fire Department capable of initiating *safe* and *effective* fire suppression and rescue operations** (reference Figure 15, p. 61).

OSHA's "2 In/2 Out" Regulation:

The "2 In/2 Out" policy is part of paragraph (g)(4) of OSHA's revised respiratory protection standard, 29 CFR 1910.134. The safety of fire fighters engaged in interior structural firefighting is the major focus of paragraph (g)(4) of the OSHA Respiratory Protection standard. OSHA's interpretation on requirements for the number of workers required being present when conducting operations in atmospheres that are immediately dangerous to life and health (IDLH) covers the number of persons who must be on the scene before firefighting personnel may initiate an interior attack on a structural fire. An interior structural fire (an advanced fire that has spread inside of the building where high temperatures, "heat" and dense smoke are normally occurring) would present an IDLH atmosphere and, therefore, require the use of respirators. In those cases, at least two standby persons, in addition to the minimum of two persons inside

needed to fight the fire, must be present before fire fighters may enter the building.[90, 91] This requirement is mirrored in NFPA 1500, which states that "a rapid intervention team shall consist of at least two members and shall be available for rescue of a member or a team if the need arises. Once a second team is assigned or operating in the hazardous area, the incident shall no longer be considered in the 'initial stage,' and at least one rapid intervention crew shall be required."

FIGURE 22:
"OSHA '2 IN/2 OUT' ILLUSTRATED"



Two of the most important elements in limiting fire spread are the quick arrival of sufficient numbers of personnel and equipment to attack and extinguish the fire as close to the point of origin as possible, as well as rescue any trapped occupants and care for the injured. Several existing National Fire Protection Association standards address this time-critical issue. NFPA 1500 states, "while members can be assigned and arrive at the scene of an incident in many different ways, it is strongly recommended that interior fire fighting operations not be conducted without an adequate number of qualified firefighters operating in companies under the supervision of company officers. **It is recommended that a minimum acceptable fire company staffing level should be four members responding on or arriving with each**

[90] Under the NFPA standards relating to fire fighter safety and health, the incident commander may make exceptions to these rules if necessary to save lives. The Standard does not prohibit fire fighters from entering a burning structure to perform rescue operations when there is a "reasonable" belief that victims may be inside.
[91] Paula O. White, letter to Thomas N. Cooper, 1 November 1995 (OSHA)

engine and each ladder company responding to any type of fire." NFPA Standard 1710 also recommends that all fire suppression companies, including engine and ladder trucks, should be staffed with *at least* four firefighters each.[92, 93] For either fire suppression company, including quint apparatus, NFPA Standard 1710 further states that "in jurisdictions with tactical hazards, high hazard occupancies, high incident frequencies, geographical restrictions, or other pertinent factors as identified by the authority having jurisdiction, these companies shall be staffed with a minimum of five or six on-duty members."[94]

A number of incidents in which the failure to follow "2 In/2 Out" procedures have contributed to fire fighter casualties. For example, in Lexington, Kentucky, one fire fighter died and a second was severely injured following a fire where Kentucky OSHA later cited the fire fighters' employer for failing to utilize "2 In/2 Out" procedures. In a second case, two fire fighters died from smoke inhalation after being overcome by toxic fumes while fighting an accidental fire in Philadelphia, PA. Although two additional fire fighters were outside the home, both were engaged in support activities (hydrant hook-up and pump operation), and neither was fully accountable for monitoring the interior personnel.

There also exist a number of success stories following the adoption of "2 In/2 Out" procedures. In Pittsburgh, PA, the fire department implemented an accountability and rescue system following a fatal fire. In one instance, four fire fighters who were performing an interior attack on an apartment building fire became disoriented and were trapped in the building. The standby personnel were able to initiate rescue operations promptly and, although the four interior fire fighters and two of the rescuers were injured, all survived.[95]

"2 In/2 Out," Flashover, & Fire Department Operations:

As the progression of a fire to the point of flashover generally occurs within 10 minutes, and sufficient staffing is not maintained in the fire district to initiate a safe, effective, and aggressive fire attack, it is expected that structure fires in the response jurisdiction will continue to burn up to and beyond the point of flashover. Flashover is a critical stage of fire growth for two reasons. First, no unprotected living thing in a room where flashover occurs will survive and the chance of saving lives drops dramatically. Second, flashover creates a huge jump in the rate of combustion, and a significantly greater amount of water is needed to reduce the burning material below its ignition temperature. A post-flashover fire burns hotter and moves faster, requires more resources for fire attack, and compounds the problems of search and rescue, exposure protection, and containment.[96]

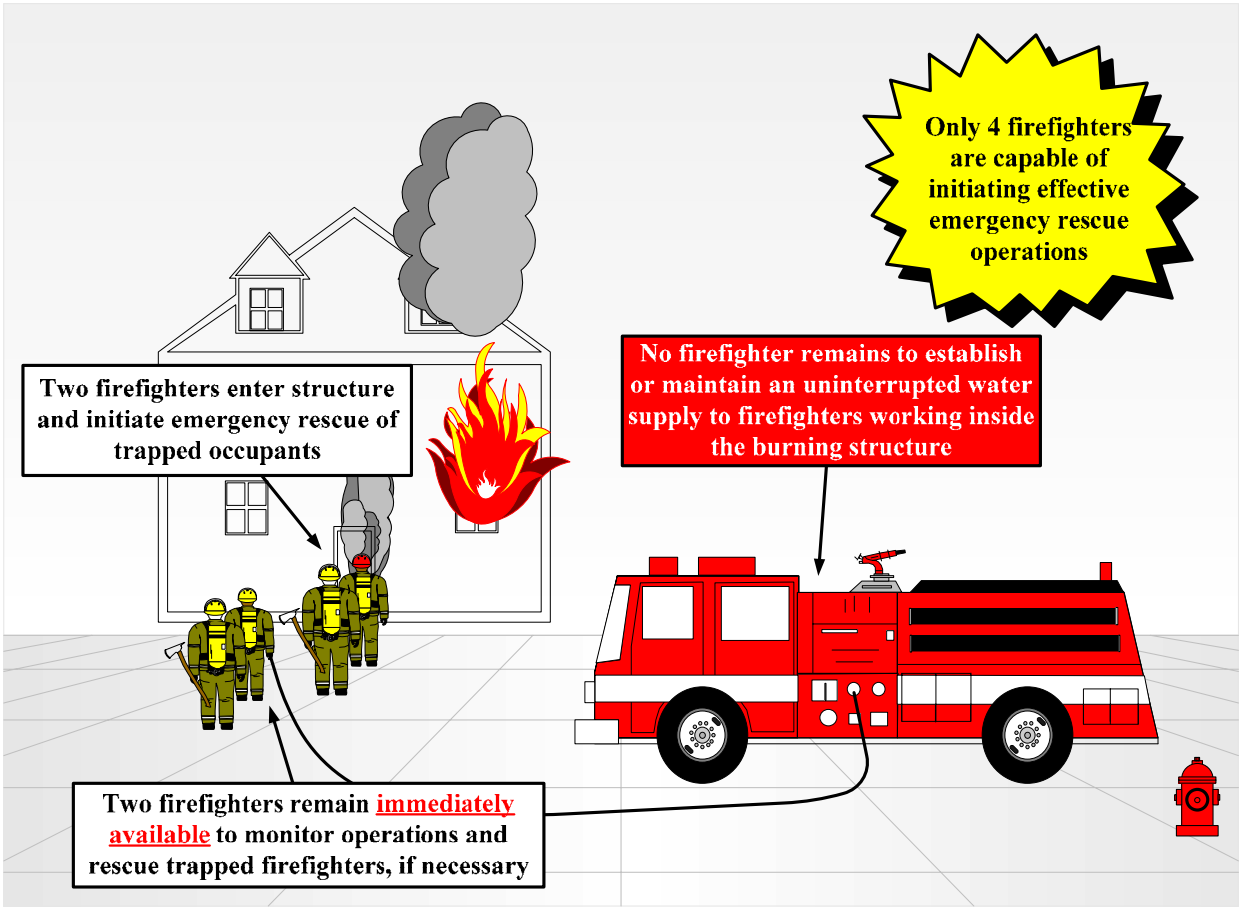
Due to staffing deficiencies at the Fairview Fire Department, a sufficient number of on-duty personnel exist to implement "2 In/2 Out" fireground operations only when all four on-duty firefighters and the fire chief are available to respond. Recall, however, that on-duty staffing is frequently depleted as a result of cross-staffing practices, and that the fire chief is available for response on weekdays only, from 6:30 a.m. to 2:30 p.m. Secondary units arriving from mutual aid companies in neighboring jurisdictions experience response delays due to extended travel distances and their availability (reference Figure 15, p. 61). That many of these resources are

[92] NFPA 1710, § 5.2.2.1 and § 5.2.2.1.1
[93] NFPA 1710, § 5.2.2.2 and § 5.2.2.2.1
[94] NFPA 1710, § 5.2.2.1.2 and § 5.2.2.2.2
[95] John B. Miles, Jr., letter to J. Curtis Varone, Esq., 29 April 1998 (OSHA)
[96] The University of California at Davis Fire Department website; site visited April 2, 2004.
< http://fire.ucdavis.edu/ucdfire/UCDFDfiresuppression.htm >

volunteer firefighters who may not be immediately available to respond, or have limited training and are prohibited from engaging in advanced fireground operations, raises the question of whether or not the mutual aid contracts the Fairview Fire District maintains with its neighbors is a reliable source of support.

When confronted with occupants trapped in a burning structure and a single fire company is on scene, only a company staffed with four firefighters is able to initiate emergency search and rescue operations in compliance with the "2 In/2 Out" regulation. However, to do so requires the complete engagement of every on-duty firefighter to participate in the effort, and means that the driver-operator of the apparatus will not be able to tend to the pump to ensure the delivery of water to the fire fighters performing the initial attack and search and rescue operations.

FIGURE 23:
"'2 IN/2 OUT' OPERATIONS WITH A CREW OF FOUR FIREFIGHTERS WHEN THERE EXISTS AN IMMEDIATE THREAT TO LIFE"

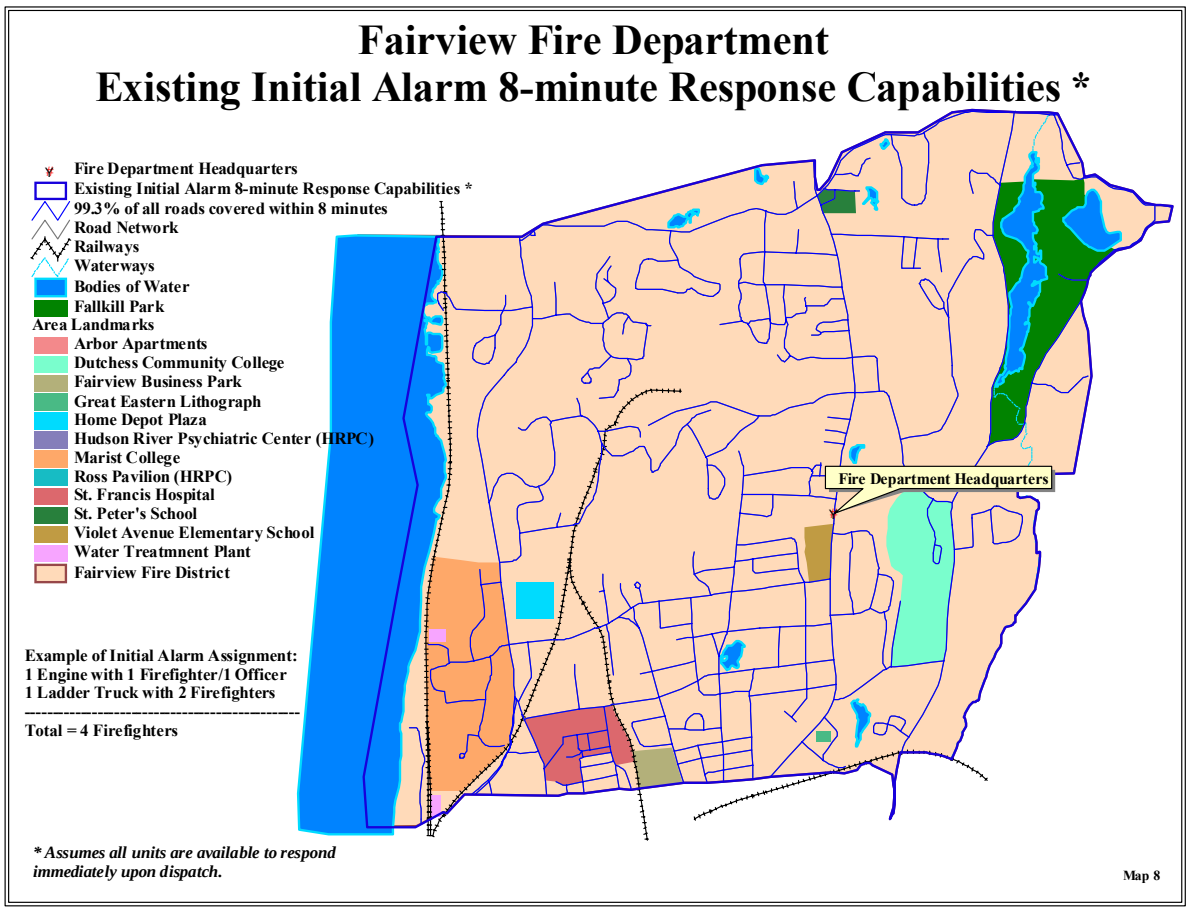


When there exists an immediate threat to life, only a company of four fire fighters can initiate fire suppression and rescue operations in compliance with the "2 In/2 Out" regulation, and in a manner that minimizes the threat of personal injury. In all other instances with a four-person fire company (i.e., when there is not an immediate threat to life), the first-in company must wait until the arrival of the fire chief or second-in units (including those responding on mutual aid request; reference Figure 15, p. 61 for anticipated travel times) to initiate safe and effective fire suppression and rescue operations. This condition underlines the importance and desirability of

fire companies to be staffed with *at least* four firefighters.[97] Furthermore, it stresses the benefit of four-person companies and their ability to save lives independent of unreliable volunteer firefighters and mutual aid resources which may or may not be available to respond.

[97] At least five firefighters are required to assemble at the incident scene before "2 In/2 Out" operations can commence, with 2 firefighters initiating interior fire attack, 2 firefighters standing by in the event of an emergency, and 1 firefighter to establish and maintain a water supply.

MAP 8



Map 8 indicates the existing 8-minute response capabilities of the engine and ladder companies assigned to deploy as part of an Initial Alarm assignment for a fire in a residential structure. Currently, the units assigned to this alarm type are capable of assembling on **99.3% of all roads within 8 minutes,** *assuming all personnel are available to deploy these units immediately upon dispatch.* However, it is important to note that, due to staffing deficiencies, the fire department is capable of deploying a maximum of four firefighters on this alarm type, under optimal conditions. In the event of a simultaneously occurring alarm, when two of the four on-duty firefighters are unavailable to respond, only two firefighters remain to respond to this emergency (reference Figure 19, p. 69).

Fire Growth, Flashover, and the Importance of a Rapid Response to a Fire in a Residential Structure:

The Smoldering Phase

The first stage of any fire is the smoldering stage. When heat is applied to a combustible material, the heat oxidizes the material's surface into combustible gases. The oxidation process is exothermic, meaning that the oxidation process itself produces heat. The heat from oxidation raises the temperature of surrounding materials, which increases the rate of oxidation and begins a chemical chain reaction of heat release and burning. A fire can progress from the smoldering phase immediately or slowly, depending upon the fuel, nearby combustibles, and the availability of oxygen in the surrounding air.

The Free Burning Phase

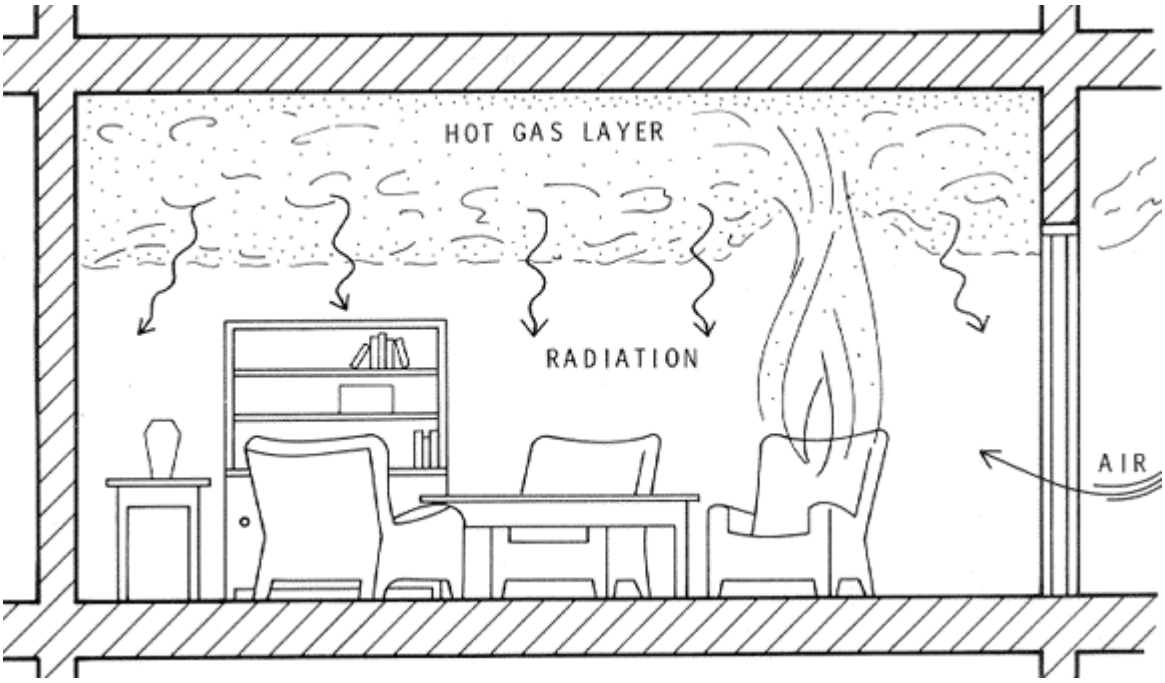
The second stage of fire growth is the "free" or "open burning" stage. When the temperature of a fire gets high enough, visible flames can be seen. The visible burning at this stage is still limited to the immediate area of origin. The combustible process continues to release more heat, which heats nearby objects to their ignition temperature, and they begin burning. In a wildland fire the surrounding growth will ignite and the flames will spread, quickly if wind and dry growth are present. A structure fire is different, because the gaseous products of combustion, most of which are flammable and lighter than air, rise and are contained in the upper levels of the structure. When this occurs, the structure fire is at a critical point: either the fire has insufficient oxygen available to burn and it progresses back to the smoldering stage, or it has sufficient oxygen available to move on to the next stage.

When an object in a room starts to burn, such as the armchair in Figure 24 on the following page, for some time after ignition it burns in much the same way as it would in the open. After a short period of time, however, confinement begins to influence fire development. The smoke produced by the burning object rises to form a hot gas layer below the ceiling; this layer heats the ceiling and upper walls of the room. Thermal radiation from the hot layer, ceiling, and upper walls begins to heat all objects in the lower part of the room and may augment both the rate of burning of the original object and the rate of flame spread over its surface.

At this point, the fire may go out if, for example, the first object burns completely before others start, or if sufficient oxygen cannot get into the room to keep the object burning. Sometimes, however, the heating of the other combustibles in the room continues to the point where they reach their ignition temperatures more or less simultaneously. If this occurs, flames suddenly sweep across the room, involving most combustibles in the fire. This transition from the burning of one or two objects to full room involvement is referred to as "flashover." [98]

[98] J.R. Mehaffey, Ph.D., Flammability of Building Materials and Fire Growth, Institute for Research in Construction (1987)

FIGURE 24:
"FIRE GROWTH IN A CONFINED SPACE"[99]



Flashover

The third stage of fire growth is called *flashover*. It is the most significant moment of any structure fire. As combustible gases are produced by the two previous stages they are not wholly consumed. They rise and form a superheated gas layer at the ceiling. As the volume of this gas layer increases, it begins to bank down to the floor, heating all combustible objects regardless of their proximity to the burning object. In a typical structure fire, the gas layer at the ceiling can quickly reach temperatures of 1500 degrees Fahrenheit. If there is enough existing oxygen, usually near floor level, flashover occurs and everything in the room breaks out into open flame at once. The instantaneous eruption into flame generates a tremendous amount of heat, smoke, and pressure with enough force to push beyond the room of origin through doors and windows. Usually at the time of flashover, windows in the room will break, allowing for the entry of fresh air. The introduction of fresh air serves to further fuel the growth of the fire, increase the temperature of the fire, and aid in the spread of the fire beyond the room of origin. The combustion process then speeds up because it has an even greater amount of heat to move to unburned objects.

The ability of adequate fire suppression forces to greatly influence the outcome of a structural fire is undeniable and predictable. Data generated by the National Fire Protection Association provides empirical proof that rapid and aggressive interior attack can substantially reduce the human and property loss associated with structural fires. At each stage of a fire's extension beyond the room of origin, the rate of civilian deaths, injuries, and property damage grows exponentially.

[99] Image courtesy of University of California at Davis Fire Department

TABLE 13:[100]
"THE RELATIONSHIP BETWEEN FIRE EXTENSION AND FIRE LOSS"

RATE PER 1,000 FIRES			
Fire Extension in Residential Structures:	Civilian Deaths	Civilian Injuries	Average Property Damage
Confined to Room of Origin	2.07	24.30	$1,505.00
Confined to Floor of Origin	18.60	80.44	$12,134.00
Beyond Floor of Origin	27.23	55.37	$21,343.00

The Importance of Adequate Staffing to Conduct Safe and Effective Fire Suppression and Rescue Operations:

A prime objective of fire service agencies is to maintain enough strategically located personnel and equipment so that the minimum acceptable response force can reach a reasonable number of fire scenes before flashover is likely.[101] Two of the most important elements in limiting fire spread are the quick arrival of sufficient numbers of personnel and equipment to attack and extinguish the fire as close to the point of origin as possible, as well as rescue any trapped occupants and care for the injured. Rapid and aggressive interior attack of structure fires, as close as possible to the point of origin, can reduce human and property losses. Sub-optimal staffing of arriving units may delay such an attack, thus allowing the fire to progress to more dangerous conditions for fire fighters and civilians. "If the arriving units have adequate resources to handle the situation, then they will fight the fire aggressively and offensively. They will attack the problem head-on and, following department standards, will accomplish their objectives efficiently, effectively, and safely. If they do not have adequate resources to aggressively handle the situation, then they will have to fight the fire in a defensive mode of attack. This mode will continue until enough resources can be massed to then change to an aggressive, offensive attack."[102]

NFPA 1500 and 1710 both recommend that a minimum acceptable fire company staffing level should be **four members responding on or arriving with each engine and each ladder company responding to any type of fire.** Currently, the Fairview Fire District maintains on-duty staffing of four fire fighters. However, due to cross-staffing practices, fire suppression companies frequently deploy with only two firefighters. At times, when the call volume has depleted on-duty staffing, emergency vehicles deploy with only a single firefighter each, out of compliance with professional standards for the provision of safe and effective fire suppression and rescue operations. At the scene of an emergency, and assuming a crew of two firefighters is available on both the engine and ladder truck, the driver/operator of the engine must remain with the apparatus to establish a water supply and operate the pump. Likewise, the driver/operator of the ladder truck must remain with the apparatus to safely operate the aerial device. Such activities leave a crew of only a single firefighter from each fire suppression company to initiate the fire attack or complete search and rescue activities.

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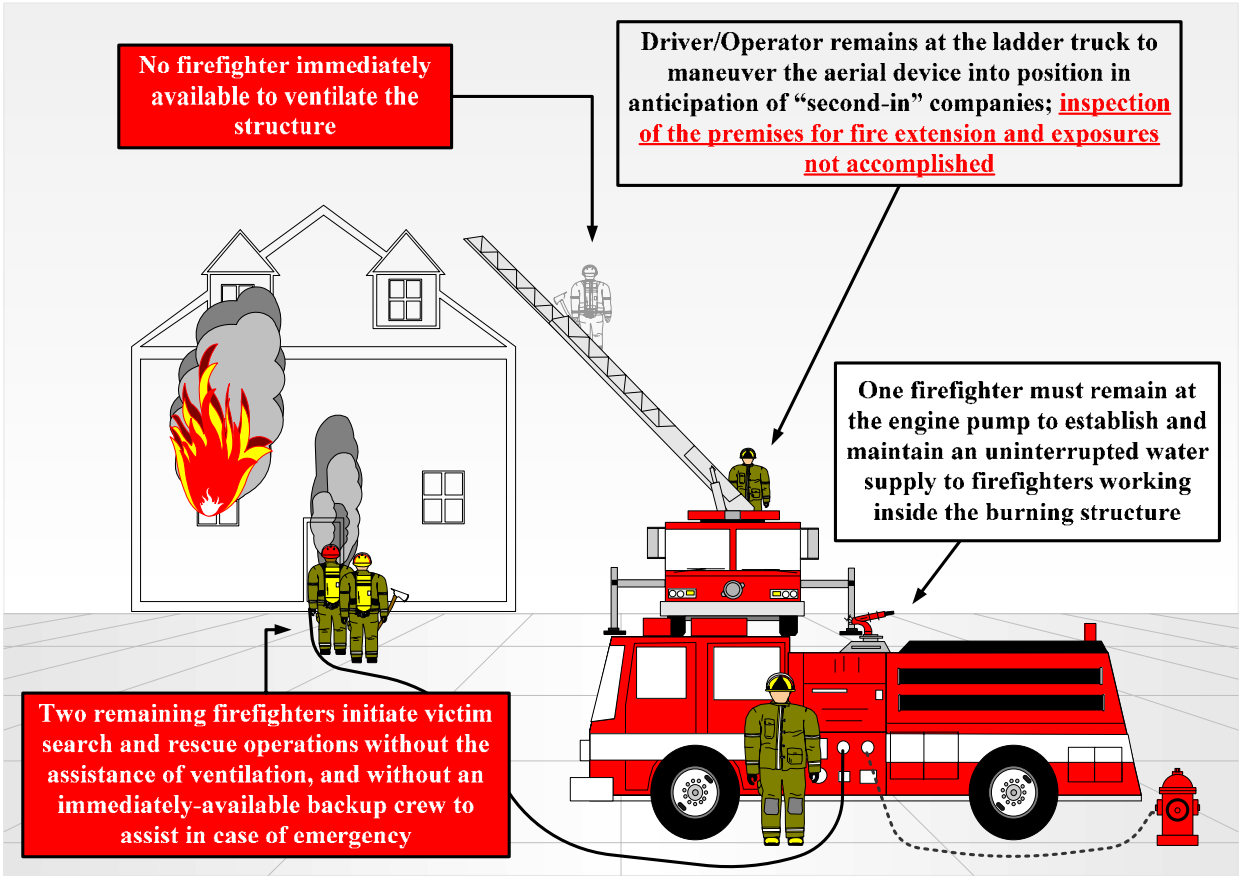
[100] Source: National Fire Protection Association
[101] University of California at Davis Fire Department website; visited February 4, 2004.
< http://fire.ucdavis.edu/ucdfire/UCDFDoperations.htm >
[102] National Institute for Occupational Safety and Health, High-Rise Apartment Fire Claims the Life of One Career Fire Fighter (Captain) and Injures Another Career Fire Fighter (Captain) – Texas, 13 October 2001

FIGURE 25:
"EXISTING ALLOCATION OF PERSONNEL AT A RESIDENTIAL STRUCTURE FIRE"
(Assuming all units in this scenario are available to respond and are staffed with two firefighters each)



Under existing staffing and deployment conditions, and assuming all four firefighters from Fairview Fire Headquarters are available to respond, a fire attack initiated by a single fire company (engine or ladder truck) is not capable of effecting a safe and effective fire suppression and/or rescue operation in compliance with the "2 In/2 Out" regulation until both units are at the scene, and the fire chief or a second mutual aid company arrives with sufficient personnel to support the fire attack and/or rescue operation.[103] Recall, however, that on-duty staffing is frequently depleted as a result of cross-staffing practices, and that the fire chief is available for response on weekdays only, from 6:30 a.m. to 2:30 p.m. The most reliable source of a mutual will be from the City of Poughkeepsie or the Arlington Fire District, both of which are capable of responding into the Fairview Fire District within 8 minutes (reference Figure 15, p. 61). Although the Roosevelt Fire District Station #3 is capable of responding into the Fairview Fire District more rapidly than the Arlington Fire District, the RFD #3 is not able to provide a reliable number of personnel, and there are no guarantees regarding the level to which these individuals are trained and certified in fireground operations. Furthermore, for the fire chief and all mutual aid companies, it is essential to note that *said units are capable of generating a response only if they are available to do so.*

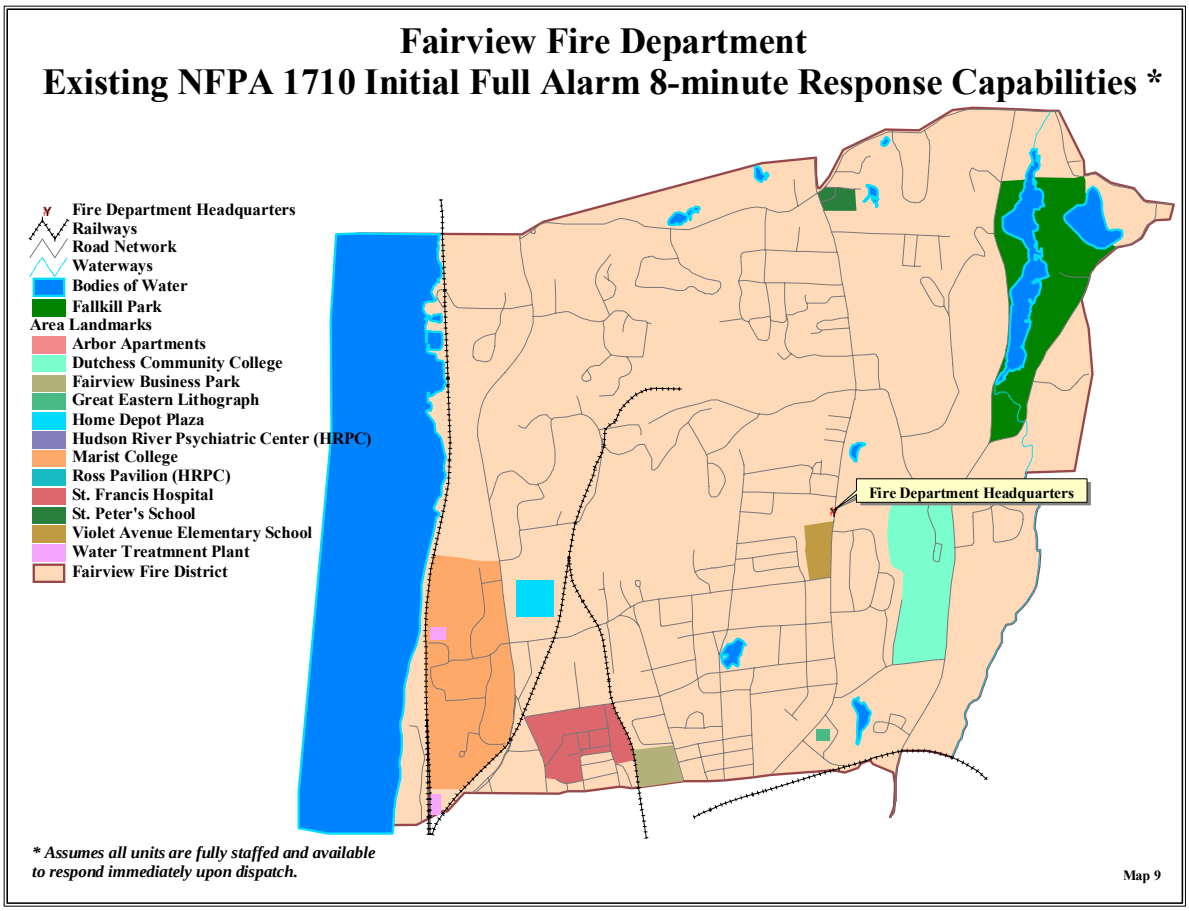
Any delay in the initiation of fire suppression and rescue operations translates directly into a proportional *increase* in expected property, life, and economic losses. It warrants emphasizing

[103] Recall that a four-person fire company may initiate emergency search and rescue operations at the order of the incident commander if there is a "reasonable" and immediate threat to life.

that if a structure has no automatic suppression or detection system, a more advanced fire may exist by the time the fire department is notified of the emergency and is able to respond. Likewise, if an insufficient number of firefighters are present at the incident scene, preventing interior fire attack, firefighters will be forced to fight the fire defensively, allowing for continued fire propagation. Fires of an extended duration weaken structural members, compromising the structural integrity of a building and forcing operations to shift from an offensive to defensive mode.[104] This mode will continue until enough resources can be amassed to then change to an aggressive, offensive attack. Depending upon how long the fire has been burning, however, saving the structure may not be possible. To ensure the rapid, safe, and effective initiation of fire and rescue operations, **it is the recommendation of this report that all fire suppression companies be staffed on a twenty-four hour basis with four EMS cross-trained, multi-role fire fighters, in compliance with NFPA 1500 and NFPA 1710.**

[104] According to the NFPA, "it's important to realize that every 250 GPM stream applied to the building can add up to one ton per minute to the load the weakened structure is carrying."

MAP 9



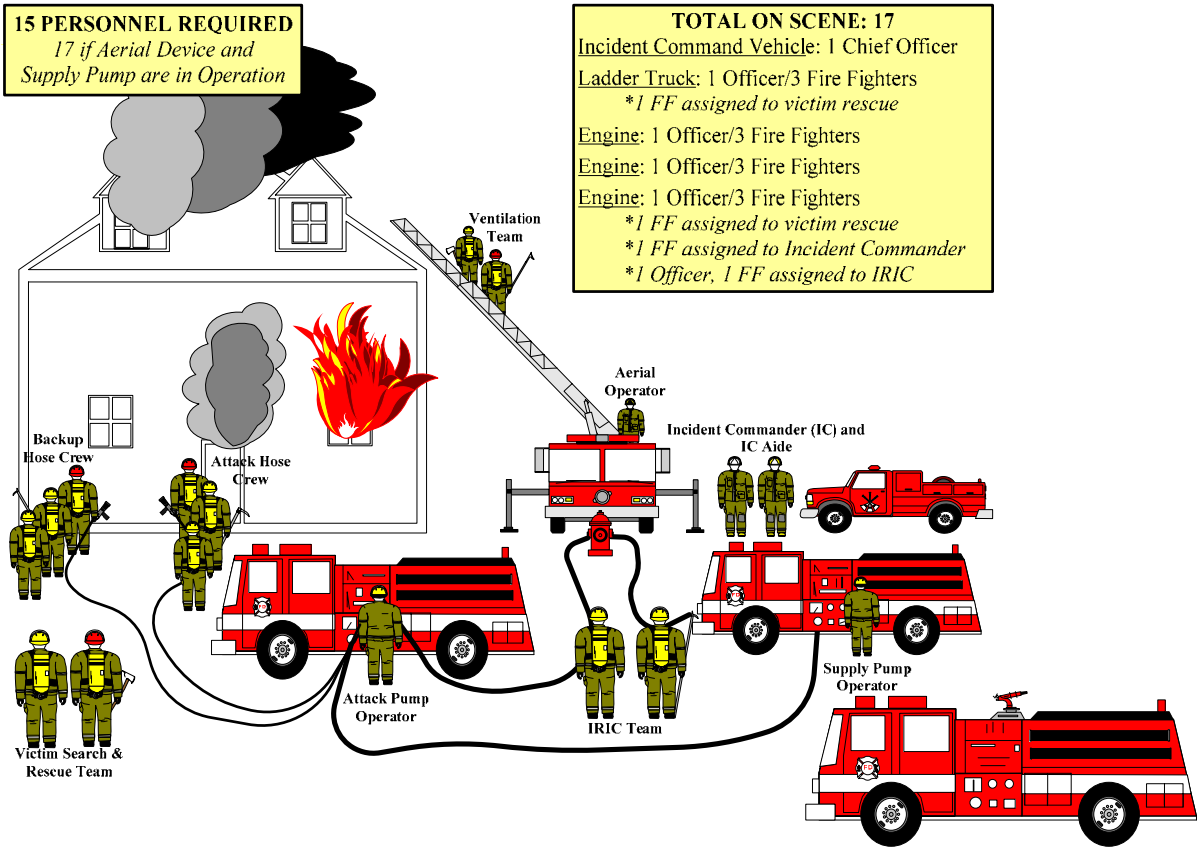
Map 9 examines the ability of the Fairview Fire District to respond to incidents with at least fifteen personnel within an 8-minute time frame. Under existing conditions, it is predicted that **the Fairview Fire Department is completely incapable of initiating safe and effective fire suppression and rescue operations at a residential structure fire, in compliance with NFPA 1710's Initial Full Alarm requirements.**

Initial Full Alarm Assignment Capability, as outlined in NFPA Standard 1710, recommends that the "fire department shall have the capability to deploy an initial full alarm assignment within an 8-minute response time to 90 percent of the incidents… [and that the] initial full alarm shall provide for the following: a minimum of one individual dedicated to establishing incident command outside of the hazard area, assisted by an aide; establishment of an uninterrupted water supply, which shall be maintained by an operator who shall ensure uninterrupted water flow application; establishment of attack and backup lines, operated by a minimum of two personnel each to effectively and safely maintain the line; provision of one support person for each attack and backup line to provide hydrant hookup, assist in line lays, utility control, and forcible entry; a minimum of one search and rescue team, consisting of two personnel; a minimum of one ventilation team, consisting of two personnel; and establishment of an Initial Rapid Intervention Crew (IRIC), consisting of a minimum of two properly equipped and trained personnel."[105] This breakdown of the expected capabilities of a full alarm assignment, in compliance with NFPA Standard 1710, requires a minimum contingent of fifteen fire

[105] NFPA 1710, § 5.2.3.2.1 and § 5.2.3.2.2, (a) – (h)

suppression personnel, including the Incident Commander (IC) and the IC's aide[106], to arrive at the scene of a structure fire within 8 minutes of receiving the alarm.[107]

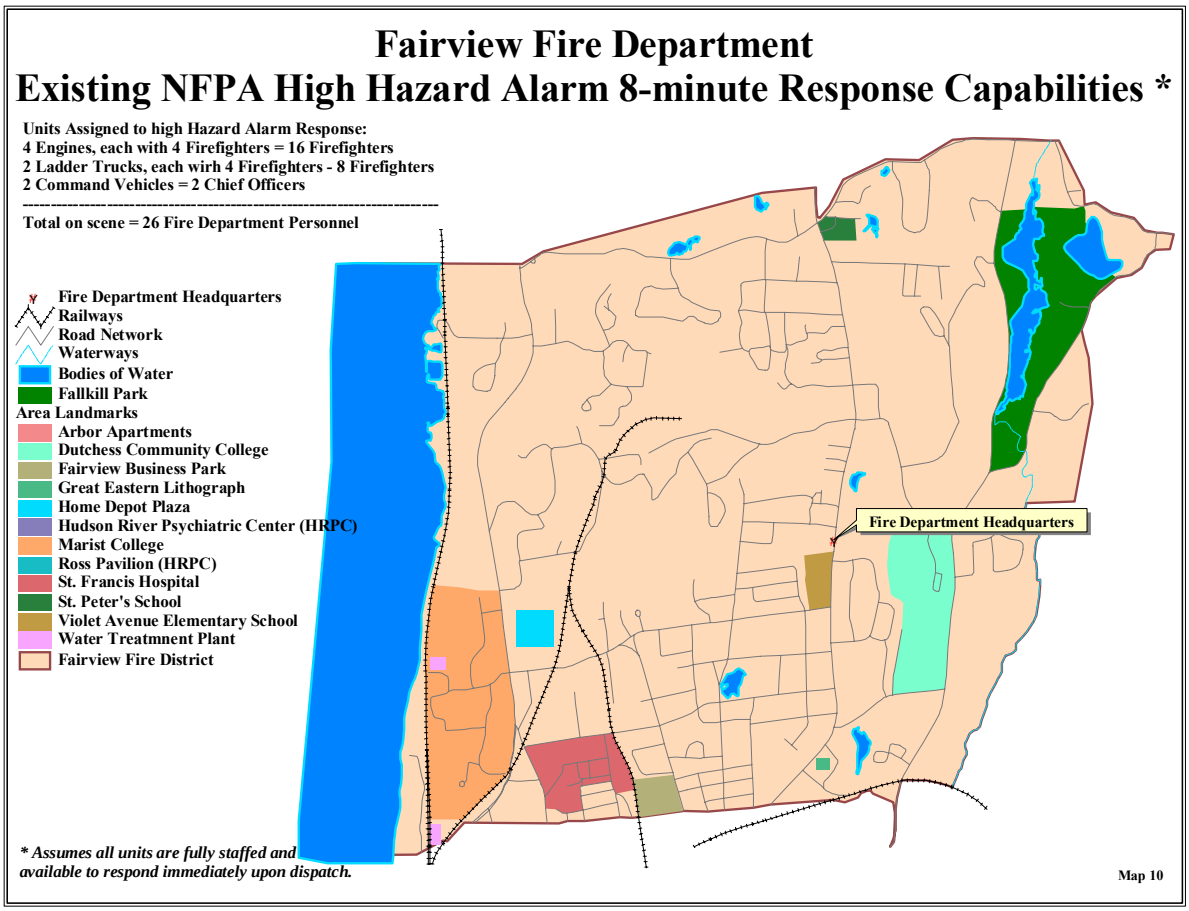
FIGURE 26:
"NFPA 1710 INITIAL FULL ALARM ASSIGNMENT"



[106] NFPA 1710, § 5.2.1.2.5

[107] It should be noted that a minimum on-scene contingent of seventeen fire suppression personnel are required by NFPA Standard 1710 when a second pump and an aerial device are in operation at the incident scene.

MAP 10



NFPA 1710's requirements for the assembly of an Initial Full Alarm Assignment within 8 minutes, as discussed in Map 9, is predicated on "a response to a structural fire in a typical 2,000 ft^2, two-story, single family occupancy without a basement and with no exposures (detached home). All communities respond to fire incidents in this type of structure on a regular basis and therefore the hazards presented by this scenario are not unusual."[108] However, the hazards in the Fairview Fire District far exceed the typical hazards presented by a typical 2,000 ft^2 detached single family residence. Some of the more significant hazards are identified in legend to Map 10. Recognizing that hazards greater than those presented by typical residential dwelling exist in most communities, NFPA 1710 states that, "other occupancies and structures in the community that present greater hazards should be addressed by additional fire fighter functions and additional responding personnel on the initial full alarm assignment,"[109] which is covered in the NFPA's *Fire Protection Handbook*.

The *Fire Protection Handbook* is the preeminent resource guide for the fire service. The *Handbook* takes a systems approach to addressing the many complexities of modern fire protection, from the basics of fire behavior to fire protection information and analysis. In the "Information and Analysis for Fire Protection" section, the *Handbook* identifies initial attack response capabilities for **high hazard occupancies, such as schools, hospitals, nursing homes, explosive plants, refineries, high-rise buildings, and other high life hazard or large fire**

[108] NFPA 1710, § A.5.2.3.2.1
[109] Ibid.

potential occupancies.[110] Recognizing the increased risk to life and the loss of property in these occupancies, the NFPA recommends "at least four pumpers, two ladder trucks, two chief officers, and other specialized apparatus as may be needed to cope with the combustible involved," and recommends that "**not less than twenty-four fire fighters and two chief officers" respond to fires in this hazard classification.**[111]

Map 10 indicates the ability of the Fairview Fire Department to assemble at least twenty-four fire fighters and two battalion chiefs within 8 minutes in the Fairview Fire District, *assuming all units are fully staffed and available to respond immediately upon dispatch*. Under existing conditions, and as a direct result of staffing deficiencies, **the fire department is *completely incapable* of assembling an appropriate number of personnel at the scene of a "high hazard" occupancy.** Even if all on duty Fairview Fire Department personnel are available, including the fire chief, and the maximum number of mutual aid resources are fully staffed and available to respond to a "high hazard" emergency in the Fairview Fire District, a sufficient number of firefighters in the mutual aid response zone simply do not exist to adequately respond to an incident of this magnitude. Moreover, only a limited number of the firefighting personnel responding on mutual aid are actually trained in advanced fireground techniques. Hence, even if twenty-six firefighters could respond to a high hazard emergency in the Fairview Fire District, the problem of inadequate training would continue to compromise safe and effective fire suppression and rescue operations.

[110] John Granito, "Evaluation and Planning of Public Fire Protection," Fire Protection Handbook: 17th Edition, ed. Arthur E. Cote, P.E. (Quincy, MA: NFPA, 1991), §10, Ch.4, p. 41.
[111] Ibid.

CONCLUSIONS

CONCLUSIONS

This analysis reveals the extent of 4- and 8-minute coverage provided within the Fairview section of the Town of Poughkeepsie and Hyde Park, by the Fairview Fire District, under the existing staffing and deployment arrangement. Based on the output of the ArcView apparatus response model, the following conclusions can be reached *(note that the statements below pertain to a single incident only, and do not assume like performance in simultaneously occurring incidents)*:

- The Fairview Fire Department's ambulance currently provides essential emergency medical services on **86.2% of all roads within 4 minutes** and **99.3% of all roads within 8 minutes,** *assuming sufficient personnel are available to respond immediately upon dispatch.* The deployment of this unit, however, reduces available on-duty staffing to only two firefighters.

- Fairview Fire Department engine companies currently provide fire suppression, disaster incident mitigation, and essential emergency medical services on **86.2% of all roads within 4 minutes** and **99.3% of all roads within 8 minutes,** *assuming the unit is available to respond immediately upon dispatch.* However, if the ambulance is deployed, staffing on the engine may fall to as low as a single firefighter. Furthermore, fire department staffing may be reduced to only two firefighters- one on the engine, one on the truck- in the event of simultaneously occurring emergencies.

- Fairview Fire Department truck companies currently provide fire suppression and disaster incident mitigation on **86.2% of all roads within 4 minutes** and **99.3% of all roads within 8 minutes,** *assuming sufficient personnel are available to respond immediately upon dispatch.* The deployment of this unit, however, reduces available on-duty staffing to only two firefighters.

- The Fairview Fire Department is not currently able to initiate *safe* and *effective* fire suppression and rescue operations in accordance with the "2 In/2 Out" regulation. Insufficient staffing exists at the Fairview Fire Department to initiate "2 In/2 Out" operations without mutual aid or the arrival of the fire chief. When there exits an immediate threat to life, and all four on duty firefighters are at the scene, the incident commander may order firefighters into the structure, but only if all four personnel are available, and at great personal risk. In such an instance, no firefighter remains available to establish and maintain a water supply for those firefighters operating in the structure, further increasing what is already a high risk operation. Due to insufficient staffing, however, this is an operation that is frequently performed.

- Fairview Fire Department fire suppression companies are currently able to assemble the units assigned to respond to a residential structure fire on **99.3% of all roads within 8 minutes,** *assuming sufficient personnel are available to respond immediately upon dispatch.* However, at most, only

four Fairview firefighters will arrive at the incident scene within 8 minutes – an insufficient number to initiate safe and effective fire attack and victim rescue.

- The Fairview Fire Department does not maintain a sufficient number of on-duty personnel to assemble an Initial Full Alarm assignment, in compliance with NFPA 1710, within 8 minutes of alarm receipt.

- The Fairview Fire Department does not maintain a sufficient number of on-duty personnel to assemble the resources necessary for an emergency in a "high hazard" occupancy, as defined in the Fire Protection Handbook. Moreover, an insufficient number of adequately-trained firefighters exist in the mutual aid response zone to assemble the twenty-six firefighters needed to engage in *safe* and *effective* fire suppression and rescue operations.

FINAL SUMMARY

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The business of providing emergency services has always been labor intensive, and remains so to this day. Although new technology has improved firefighting equipment and protective gear, and has led to advances in modern medicine, it is the fire fighters who still perform the critical tasks necessary to contain and extinguish fires, rescue trapped occupants from a burning structure, and provide emergency medical and rescue services. When staffing falls below minimum acceptable levels so does service; at this point, the goals and expectations set by the community are essentially abandoned. The staffing deficiencies that prevail in the Fairview Fire District are illustrative of this condition.

It is generally accepted that a municipality has the right to determine the overall level of fire protection it wants. However, regardless of the level of fire protection chosen by the citizens, neither they nor their elected representatives have the right to jeopardize the safety of the employees providing those services. Citizens pay for protection of life and property through their tax dollars, and they assume that their elected and appointed officials will make informed decisions regarding that protection. Too often, however, that decision making process has been based solely on budgetary expedience. Irrespective of the resources provided, citizens continue to believe that fire fighters are prepared to provide an aggressive interior assault on fires, successfully accomplishing victim rescue, fire control, and property conservation. They do not expect fire fighters to take defensive actions- to simply surround a fire and "drown it"- because to do so would be to concede preventable loss of both life and property.

The ramifications of staffing reductions as they pertain to the loss of life and property within a community are essential when considering modifications to a fire department's deployment configuration. While it is impossible to predict where most of a jurisdiction's fire and medical emergencies will occur, the Fairview Fire Department should examine where emergencies have typically occurred in the past and make efforts to ensure these areas continue to enjoy the same level of coverage, while adjusting resources and deployment in an effort to achieve complete compliance with NFPA Standard 1710. Areas with accelerated development and growth will require additional coverage in the future. Any projected increase in emergency response demands should also be considered before changes are implemented, focusing on associated hazard types and planned response assignments.

In addition, a fire department should be designed to adequately respond to a number of emergencies occurring at once in a fashion that aims to minimize the loss of life and the loss of property that the fire department is charged with protecting. Any proposed changes in staffing, deployment and station location should be made only after considering the historical location of calls, response times to specific target hazards, compliance with departmental Standard Operating Procedures, existing national standards, including NFPA 1500 and NFPA Standard 1710, and the citizens' expectation of receiving an adequate number of qualified personnel on appropriate apparatus within acceptable time frames.

GIS MAP DETAIL