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Safe Fire Fighter Staffing

– Critical Considerations –

International Association
of Fire Fighters

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Critical Considerations

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Introduction

This manual identifies those benchmarks by which safe and effective minimum fire suppression services should be assessed. It provides both citizens and municipal officials with the facts they must consider in making informed decisions regarding the appropriate level of service for their communities. Fire fighter staffing directly affects delivery of fire protection service and is therefore essential to any discussion or debate involving service levels.

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, that decision making process has been based solely on budgetary expedience. However, 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, i.e., to simply surround a fire and drown it, because to do so would be to concede preventable loss of both life and property. However, when staffing levels are reduced, misguided economics and community expectations collide, with politicians insisting that potential budgetary savings will not affect the level of service.

Unless citizens understand the relationship between staffing levels and their own life safety and the protection of their property, it is not realistic for fire fighters to expect them to insist on appropriate service levels, including minimum staffing. Elected officials and managers cannot be expected to make appropriate decisions concerning the level of service without an education in **effective** firefighting and an understanding of the impact their policy decisions have on the citizens they represent. Therefore, it is essential to make clear to the community that reduced staffing equates to reduced service levels, and that if they expect a continued aggressive attack on fires, they must provide the department with at least the minimum resources required to meet the community's expectations. To do less forces fire fighters to accept a level of risk to their own health and safety that the community at large finds unacceptable for itself.

Historically, the standard for fire suppression in North America has mandated an **offensive** attack in situations involving structural fire. Study after study has demonstrated that if the force available to initiate an interior fire attack is less than fifteen personnel, the goals of victim rescue, fire control, and property conservation are seriously compromised. These studies state that when fireground staffing is reduced below the level necessary for aggressive tactics, the inevitable result is that fire fighters must resort to **defensive** rather than offensive operations or risk their own safety.

Firefighting has always been labor intensive and remains so. Although new technology has improved firefighting equipment and protective gear, it is fire fighters who still perform the critical tasks necessary to contain and extinguish fires. When staffing falls below minimum acceptable levels, so does service, and the goals and expectations set by the community are essentially abandoned.

A number of court decisions and arbitration awards have recognized that while firefighting is one of the most dangerous occupations in North America, fire fighters should be provided the safest possible working environment. Thus, staffing affects not only the public safety but also the safety of fire fighters and as such is a condition of employment. Although firefighting is by its nature dangerous, that does not justify employers increasing that inherent level of risk by reducing safe minimum staffing under the guise of financial difficulty.

This position has been recognized by many organizations such as the International Association of Fire Fighters, Metropolitan Fire Chiefs' Division of the International Association of Fire Chiefs and the U.S. Fire Administration. Even the International City Management Association has stated:

> *...too few companies or poorly manned ones, can result in property and life loss beyond community accepted norms. Also, the cost of a firefighter death or disabling injury may far exceed the expense of a fire company. This is not to say that there is a fixed value on a life or injury. The point is that the firefighting forces are the asset that protects the economic and tax base as well as its health and welfare. This asset is a valuable one and must be carefully provided and wisely managed.*

Chapter 1

Impact of Initial Fire Attack on Property Loss and Citizen Safety

Successful delivery of fire protection services involves two major elements – fire prevention and fire suppression. Fire prevention can be defined as those "*pre-fire activities that reduce the probability of fires occurring and help limit the loss of property and life in the fires that do occur.*"[1] Since fire prevention will never be 100 percent successful, it is necessary to buttress fire prevention goals with adequate fire suppression services. It is the objective of fire suppression to "*get to the fire as quickly as possible and to extinguish it with minimum loss to persons and property from the fire and from fire fighting activities.*"[2]

The successful attainment of the goals of both prevention and suppression require a balanced approach and commitment of resources. This balance has in recent years been tipped in the direction of fire prevention while largely ignoring fire suppression.

As the data in the following table shows, the concern with fire prevention has been substantially rewarded. According to the NFPA's Annual National Fire Experience Survey, the total number of fires, civilian deaths, and injuries has declined remarkably over the last decade. This data attests to the substantial impact that public education, smoke detectors, and development and enforcement of building codes can have on preventing fires.

However, closer examination of the same data also tells the other side of the story, which is that de-emphasis of fire suppression in recent years has led to increasing rates of civilian deaths and injuries and property loss when fires do occur.

				Rate Per 1,000 Residential Fires			
Year	Total Residential Fires	Total Civilian Deaths	Total Civilian Injuries	Civilian Death	Civilian Injuries	Direct Property Damage Per Residential Fire	Real Property Damage Per Residential Fire [1]
1978	730,500	6,185	21,260	8.47	29.1	$3,000.68	$4,602
1979	721,500	5,765	20,450	7.99	28.3	$3,505.20	$4,828
1980	757,500	5,446	21,100	7.19	27.9	$4,015.84	$4,874
1981	733,000	5,540	20,375	7.56	27.8	$4,446.11	$4,891
1982	676,500	4,940	21,100	7.30	31.2	$4,808.57	$4,983
1983	641,500	4,820	21,450	7.51	33.4	$5,153.55	$5,174
1984	623,000	4,240	19,275	6.81	30.9	$5,521.67	$5,314
1985	622,000	5,025	19,825	8.08	31.9	$6,067.52	$5,623
1986	581,500	4,770	19,025	8.20	32.7	$6,115.22	$5,580
1987	551,500	4,660	20,440	8.45	37.1	$6,707.16	$5,904
1988	552,500	5,065	22,600	9.17	40.9	$7,276.02	$6,150
1989	513,500	4,435	20,750	8.64	40.4	$7,785.78	$6,279
1990	467,000	4,115	20,650	8.81	44.2	$9,107.07	$6,968
1991	478,000	3,575	21,850	7.48	45.7	$11,615.06	$8,547
1992	472,000	3,705	21,600	7.85	45.8	$8,220.00	$5,859
1993	470,000	3,825	22,600	8.14	48.1	$10,304.00	$7,131
1994	451,000	3,465	20,025	7.68	44.4	$9,572.00	$6,394
1978-84	-14.7%	-31.4%	-9.3%	-19.6%	6.2%	84.0%	15.5%
1984-94	-27.6%	-18.3%	4.0%	12.8%	43.7%	73.3%	60.8%

[1] Determined by deflating the direct property damage by the CPI-U.

SOURCE: National Fire Protection Association

During the six-year period 1978-84, measures of both fire prevention and fire suppression exhibited equally impressive results. Through the efforts of fire prevention, the total number of residential fires declined 14.7%, while the total number of civilian deaths and injuries, respectively, dropped by 31.4% and 9.3%.

In those situations where fires did occur, firefighting also scored substantial gains. During the period, the rate of civilian deaths per 1,000 fires declined 19.6%, while the rate of civilian injuries and real property damage showed only modest increases.

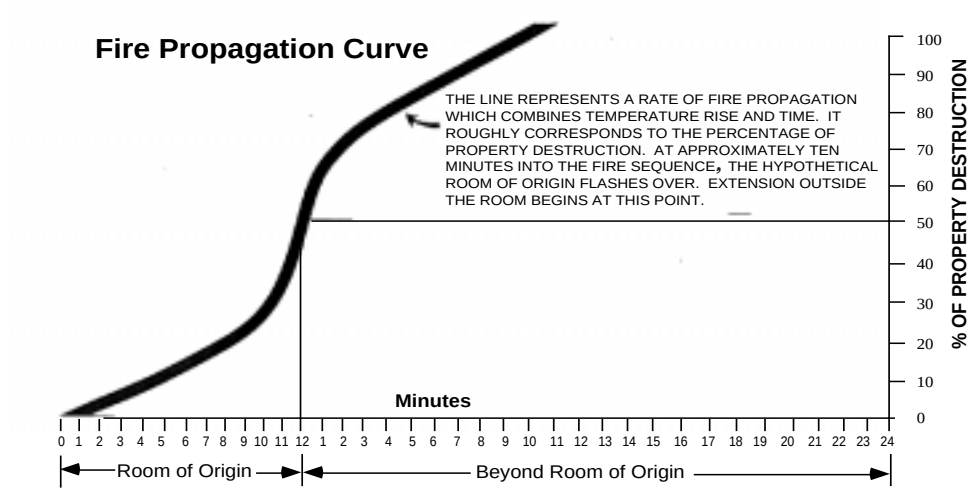
However in the last ten years, the results were substantially different. Between 1984 and 1994, the rate of civilian fire deaths per 1,000 residential fires increased 12.8%, the rate of civilian injuries increased 43.7% and real property loss rose 60.8%.

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.

	Rate Per 1,000 Fires		Average
Fire Extension in Residential Structures:	Civilian Deaths	Civilian Injuries	Property Damage
Confined to Room of Origin	2.07	24.30	$1,505
Confined to Floor of Origin	18.60	80.44	$12,134
Beyond Floor of Origin	27.23	55.37	$21,343

SOURCE: National Fire Protection Association

Clearly, an early aggressive and offensive initial interior attack on a working structural fire results in greatly reduced loss of life and property damage. Consequently, given that 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[3], 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 its origin as possible.



SOURCE: John C. Gerard & A. Terry Jacobsen

Assuming a crew of five fire fighters is 100% effective in performing the critical tasks required for an interior fire attack, the following table shows the impact that reduced staffing has on the effectiveness of fireground operations involving a single-family residential structure.

Impact of Crew Size of First Alarm Assignment on Fire Attack in a Residential Structure

	1st Engine Company		2nd Engine Company		Truck/Ladder Company		
Crew Size:	**Charge Initial Interior Line and Advance**	**Locate & Rescue Victim**	**Charge Interior Sup-port Line & Advance**	**Charge Exterior Line & Advance**	**Roof Ventilation**	**Search and Rescue**	**Check Exposures for Fire Extension**
5 Fire Fighters	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
4 Fire Fighters	**84.7%**	**96.1%**	**77.9%**	**72.9%**	**79.0%**	**90.3%**	**80.2%**
3 Fire Fighters	**71.3%**	**82.8%**	**0.0%**	**62.3%**	**0.0%**	**79.6%**	**0.0%**

SOURCE: "Dallas Fire Department Staffing Level Study," McManis Associates, June 1984.

The conclusions reached in the Dallas Study have recently been confirmed for small fire departments by the Westerville, Ohio Fire Department.[4] Using standard firefighting tactics, the results of the Westerville Fire Department study showed that 4 fire fighters could perform rescue of potential fire victims 80% faster than a 3 fire fighter crew.

The implications that enhanced crew size can have on rescue operations is all the more dramatic when victim survivability is considered. Data produced by the Dallas Fire Department showed that:

> *when rescue occurred between 12 and 15 1/2 minutes, the survival rate was 46.6 percent. The rate dropped to 5.5 percent when rescue occurred between 15 and 17 1/2 minutes.*

Thus, a variance of only 2 to 3 minutes in the speed with which rescue operations could be completed can increase fire victim survivability eightfold.

Consequently, the fire service in North America has for most of the twentieth century accepted the premise and the expectation that fire fighters will perform aggressive interior fire attacks when confronted with a working structural fire. This has been and still is the industry's standard of performance.

ENDNOTES

[1] Measuring Fire Protection Productivity in Local Government, Philip S. Schaenman and Joe Swartz (Boston, MA:NFPA) 1974; p. 5.

[2] Ibid.; p. 30.

[3] "Reduced Staffing: At What Cost?," John C. Gerard and A. Terry Jacobsen, *Fire Service Today*, September 1981, pp. 15 and 17; and "Hazard I Fire Hazard Assessment Method," National Institute of Standards and Technology, U.S. Department of Commerce, June 1991.

[4] National Fire Academy, "Manning Levels for Engine and Ladder Companies in Small Fire Departments" (RR No. 14613), Richard C. Morrison.

Chapter 2
Staffing for Initial Fire Attack and Fire Fighter Safety

The purpose of this manual is to objectively relate staffing to fire fighter safety. Discussion of staffing must also address the level of effectiveness of the fire suppression services. It is expected that fire fighters will aggressively intervene to extinguish a fire. Fire fighter safety and the effectiveness of fire suppression service are closely linked. Fire fighters cannot maintain the same level of aggressive fire suppression services while receiving fewer and fewer resources.

Fire Fighter Safety and Effectiveness of Initial Fire Attack

Inappropriate reductions merely shift the burden of attempting to maintain the expected level of service to the fire fighter at the expense of his/her own safety. Consequently, fireground productivity and effectiveness are seriously compromised.

Over the last 25 years deviations from the industry's standard regarding recommended, acceptable levels of staffing per unit of response have seriously compromised fire fighter safety. In 1967, the International City Management Association (ICMA) recommended that engine companies maintain a minimum of 5 personnel, while those operating in "high value" areas require 7 personnel. The ICMA went further to state that "*ladder companies are governed by similar manpower considerations*." Citing the reason for these requirements, ICMA stated:

> *It is axiomatic that there must be enough men to put fire apparatus into effective use. Three men are needed to place a single line of 2 1/2-inch hose in service. One additional man is needed to operate a pump, plus a foreman so pumper companies require a minimum of five men.*[1]

Thus a reduction in the "industry standard" regarding the appropriate level of fire company staffing would be justified only in those circumstances where the nature and number of tasks to be accomplished at any given structural fire by fire suppression personnel were also reduced. Fire suppression has always been labor intensive and a substantial impact on productivity in the form of reductions in the number of personnel required at the company level can only be offset by major advances in technology or increased risk to the fire fighter.

Some advances have been made in technology. The industry has developed state-of-the-art apparatus, electronic communications, self-contained breathing apparatus, and personal protective gear. However, none of these advances have eliminated the critical tasks that must be performed by fire fighters at the scene of a structural fire. In fact, these advances in many ways have been offset by introduction of more hazardous materials and construction techniques.

New technologies and materials used in construction and furnishings are more combustible and toxic than those in use a quarter century ago, while advances in such areas as SCBA's and personnel protective gear have in some quarters increased the expectation that fire fighters can perform more aggressive interior fire attacks with fewer personnel.

However, just as it is logical to accept that technologies enhancing fire fighter safety also lead to increased fireground effectiveness, it is also logical to accept that diminished safety correspondingly reduces the effectiveness of fireground operations. Given that structural fire suppression is so labor intensive, reductions in firefighting personnel must inevitably lead to increased injuries unless those reductions are accompanied by viable alternative technologies or the number of critical tasks that must be performed are reduced.

The level of available technology and critical tasks that must be performed at the scene of a structural fire remain essentially unchanged. Today, however, very few jurisdictions operate units with staffing levels of more than 4 fire fighters, with many now suggesting that 2 or 3 fire fighters is an adequate and acceptable level of fire company staffing.

But, as an article in *Fire Engineering* succinctly put it:

> *A football coach who sent his team out on the field with six men and then fed the other five in piecemeal as the game progressed would be considered an idiot. Yet this is the same policy that many city officials and their hired consultants are forcing on fire chiefs–always in the guise of greater efficiency and, of course, economy.*
>
> *One man cannot be called a fire company, no matter how many men are available after he has made a sizeup and hollered for help. Neither can two or three men be considered a fire company. (These are not enough to handle a fair-sized grass fire.)*[2]

The requirement for initial arriving apparatus to be staffed with at least 4 personnel to initiate an interior fire attack is not new. It has been the fire service standard and industry practice for most of the twentieth century, as well as recognized and recommended by the National Fire Protection Association (NFPA) since at least 1962. The adherence to a minimum level of safety staffing grew out of intuition and experience and is empirically

grounded in results from study after study showing the causal relationship of deficient fireground staffing and increased fire fighter injuries.

National Fire Protection Association (NFPA)

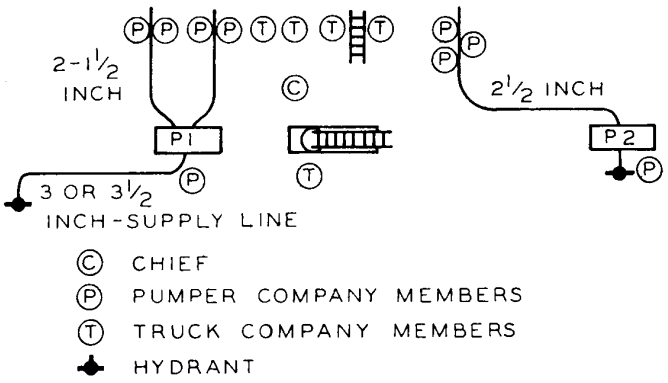
In 1966, the National Fire Protection Association issued NFPA Standard 197, *Training Standard on Initial Fire Attack.* This standard set forth the evolutions required for an initial interior attack on working structural fires. The minimum standard required sufficient number of fire fighters and equipment to deploy two attack one-and-one-half inch hose lines producing at least 150 gpm within 60 seconds of arrival, followed by a two-and-one-half inch backup line providing at least 250 gpm within 180 seconds of arrival.

While the NFPA 197 did not specify the number of fire fighters necessary to deliver this required flow, it does specify the tasks that must be performed within a given time period.

Although NFPA 197 was silent on the minimum number of fire fighters necessary to safely conduct these evolutions, the National Fire Protection Association clearly defined in its book, Fire Attack-1, the number of personnel required:

> *Standard initial fire attack for isolated buildings of average size such as one- or two-story single family dwellings consists of ability to quickly apply 1 1/2-inch attack lines plus at least one standard 250 gpm stream from 2 1/2-inch hose supplied by a pumper. The latter is required for knocking down any heavy volume of fire and for protecting exposures where necessary. Such an attack requires two pumper companies with adequate manning to run the lines and operate the nozzles and pumps, plus a truck company capable of simultaneously performing forcible entry, search and rescue, ventilation, raising of ladders, salvage operations, and operation of the various power tools carried on the truck such as electric generators and lights and smoke removal equipment. The entire operation is directed and coordinated by a chief officer.*
>
> *The desirable number of men normally required to respond with the apparatus to give this level of performance with properly manned hose streams and equipment would be approximately fifteen plus the chief. An aide who assists the chief in giving orders and in serving as radio communications specialist in contact with the alarm office, supplies the chief with one additional man.*
>
> *The operation may be performed with slightly less men (but with reduced efficiency) where weaker truck service is provided. In a standard operation, the truck operator is expected to operate the power ladder if needed for ventilation, rescue or access, and also to operate auxiliary power equipment such as generators and to provide the various tools and appliances that are likely to be required during the fire. Therefore, his basic position is with his truck just as a pump operator or 'engineer' should be provided with each pumper to give the correct volume and pressure to each hose stream. The balance of the truck crew may be divided into teams. One of these teams would normally be assigned to inside search, rescue, forcible entry and ventilation in support of the fire*

attack. The other would be an outside crew for raising ladders (up to 35 feet) for possible rescue as well as for topside ventilation. They would also provide truck support for hose crews assigned to the rear of the fire building. All truckmen should perform salvage operations as soon as practicable.



Hose crew requirements are based upon the need for two men to properly apply each stream from 1 1/2-inch hose and three men to effectively operate a 250 gpm stream from a 2 1/2-inch hand line.[3] (UNDERLINING ADDED)

Hence, adherence to NFPA 197 required two pumpers and a ladder truck with a total complement of at least 15 personnel. NFPA further stated that:

Ordinarily (except where there are major rescue operations), the greatest manpower is needed for fast application and operation of hand hose streams carried directly to the seat of the fire. Thus, adequate manpower on the initially arriving pumper companies is most essential, and large forces mobilized later cannot be accepted as a substitute for deficiencies in the manning of the first alarm response.[4]

The NFPA further cross-referenced the initial attack criteria of NFPA 197 in the Fire Protection Handbook,[5] stating:

Regardless of how companies are organized, response to alarms for structural fires should include sufficient apparatus and manpower under at least one chief officer. Normally, a minimum initial response would be two pumpers, a vehicle for truck service, and 12 to 15 men and a chief.

and

An initial response of this level should be able to handle the immediate tactical fire fighting and rescue requirements for structures where there are no major rescue problems, no serious internal or external exposures,

and where the possible area involved in fire, heat or smoke normally will be less than 12,500 cubic feet.

It is important to note that in the past edition of its Managing Fire Services,[6] the International City Management Association not only subscribed to the NFPA 197 Standard, but also endorsed the National Fire Protection Association's definition relating to the number of personnel required to conduct those initial interior attack operations.

In 1985, a revised Training Standard on Initial Fire Attack was adopted as NFPA 1410. This revised standard continued to maintain that:

The required performance for handlines shall consist of obtaining a water supply through one or two supply lines, placing one initial attack line into operation, and providing immediate backup with another line.

and

The total flow of the required streams shall be a minimum of 300 gpm. The initial attack line shall provide a minimum flow of 100 gpm.

and

The required flow from the back-up line shall be a minimum of 200 gpm.

NFPA 1410 *Training Standard on Initial Attack* also linked for the first time personnel requirements necessary for interior fire attack and fire fighter safety. Appendix A-3-2.1 of NFPA 1410 states:

> *The limitation of emergency scene operations to those that can be safely conducted by the number of personnel on the scene is intended to reduce the risk of fire fighter death or injury due to understaffing. While members may 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 fire fighters operating in companies under the supervision of company officers.*
>
> *It is recommended that a minimum acceptable fire company staffing level consist of four members responding on or arriving with each engine or aerial ladder company responding to any type of fire. Companies responding in high-risk areas should have a minimum acceptable staffing of six fire fighters per ladder company and five fire fighters per engine company. These recommendations are based on experience from actual fires and in-depth fire simulations, critically and objectively evaluating fire company effectiveness. These studies indicate significant reductions in performance and safety when crews have fewer members than the above recommendations. Overall, five-member crews were found to provide a more coordinated approach for search and rescue and fire suppression tasks. (See NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, A-6-2.1.)*
>
> (UNDERLINING ADDED)

This language in NFPA 1410 for complying with safe minimum staffing per unit also appears in NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program:*

> *The limitation of emergency scene operations to those that can be safely conducted by the number of personnel on the scene is intended to reduce the risk of fire fighter death or injury due to understaffing. 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 fire fighters operating in companies under the supervision of company officers.*
>
> *It is recommended that a minimum acceptable fire company staffing level should be 4 members responding on or arriving with each engine and each ladder company responding to any type of fire. The minimum acceptable staffing level for companies responding in high-risk areas should be 5 members responding or arriving with each engine company and 6 members responding or arriving with each ladder company. These recommendations are based on experience derived from actual fires and in-depth fire simulations and are the result of critical and*

objective evaluation of fire company effectiveness. These studies indicate significant reductions in performance and safety where crews have fewer members than the above recommendations. Overall, 5 member crews were found to provide a more coordinated approach for search and rescue and fire suppression tasks.

During actual emergencies, the effectiveness of companies can become critical to the safety and health of fire fighters. Potentially fatal work environments can be created very rapidly in many fire situations. The training and skills of companies can make a difference in the need for additional personnel and in reducing the exposure to safety and health risks to fire fighters where a situation exceeds their capabilities.[7]

This direct linkage between NFPA 1410 and NFPA 1500 specifically indicates that the number of personnel required to successfully conduct an initial interior fire attack is not just a service issue but most importantly an issue of fire fighter safety.

Acknowledging this linkage, the National Fire Protection Association again endorsed a minimum initial attack staffing level. In its 1991 version of the Fire Protection Handbook, the NFPA produced its most strongly worded statements on fireground staffing to date:

The effectiveness of pumper companies must be measured by their ability to get required hose streams into service quickly and efficiently. NFPA 1410, Training Standard on Initial Fire Attack, should be used as a guide in measuring this ability. Seriously understaffed fire companies generally are limited to the use of small hose streams until additional help arrives. Often this action may be totally ineffective in containing even a small fire and in conducting effective rescue operations.[8]

and

Critical task analysis indicates that fewer than eleven fire fighters would be most hard pressed to accomplish safe, effective, initial interior fire attack in a timely manner at a detached single-family dwelling.[9]

The NFPA went further in its recommendations as to the number of personnel and equipment necessary to perform an interior structural fire attack by type of hazard involved as follows:

Typical Initial Attack Response Capability Assuming Interior Attack and Operations Response Capability
High-Hazard Occupancies (Schools, hospitals, nursing homes, explosive plants, refineries, high-rise buildings, and other high life hazard or large fire potential occupancies) At least 4 pumpers, 2 ladder trucks (or combination apparatus with equivalent capabilities), 2 chief officers, and other specialized apparatus as may be needed to cope with the combustible involved, not less than 24 fire fighters and 2 chief officers.
Medium-Hazard Occupancies (Apartments, offices, mercantile and industrial occupancies not normally requiring extensive rescue or fire fighting forces) At least 3 pumpers, 1 ladder truck (or combination apparatus with equivalent capabilities), 1 chief officer, and other specialized apparatus as may be needed or available; not less than 16 fire fighters and 1 chief officer.
Low-Hazard Occupancies (One, two- or three-family dwellings and scattered small businesses and industrial occupancies) At least 2 pumpers, 1 ladder truck (or combination apparatus with equivalent capabilities), 1 chief officer, and other specialized apparatus as may be needed or available, not less than 12 fire fighters and 1 chief officer.
Rural Operations (Scattered dwellings, small businesses, and farm buildings) At least 1 pumper with a large water tank (500 gal [l. 9m3] or more), one mobile water supply apparatus (1000 gal [3.78m3] or larger), and such other specialized apparatus as may be necessary to perform effective initial fire fighting operations; at least 12 fire fighters and 1 chief officer.
Additional Alarms At least the equivalent of that required for Rural Operations for second alarms; equipment as may be needed according to the type of emergency and capabilities of the fire department. This may involve the immediate use of mutual aid companies until local forces can be supplemented with additional off-duty personnel. In some communities, single units are "special called" when needed, without always reporting to a multiple alarm. Additional units also may be needed to fill at least some empty fire stations.

INTERNATIONAL CITY MANAGEMENT ASSOCIATION (ICMA)

In its second edition of Managing Fire Services published in 1988, the International City Management Association (ICMA) supported the minimum level for safe fireground staffing called for in NFPA 1410 and NFPA 1500:

> *Fire suppression operations have three basic functions: (1) rescue; (2) work involving the ladder, forcible entry, and ventilation; and (3) the application of water through hose lines. Rescue and ladder companies handle the first two, and engine companies the third. To raise ladders, ventilate, search, and rescue simultaneously takes quick action by at least four and often eight or more firefighters, each team under the supervision of an officer. The number of firefighters required to search and rescue should never be fewer than two and typically at least four. The number of firefighters needed to advance and operate one hose line varies from two on smaller lines to four on large hand lines.*
>
> *The standard formula for determining the volume of water needed and the number of hose lines to be advanced at a working structural fire is based*

on a minimum of two engine companies with at least eight firefighters. This formula calls for the discharge of three gallons of water per minute for every 100 cubic feet of involved fire area with typical fire loading. An area of 40 feet by 40 feet with 8-foot ceilings requires 384 gallons per minute. Two hose lines are needed to produce that flow, and a third line to cover the floor above. Exposure coverage and search and rescue are not yet taken into consideration, but already eight or nine hosemen are needed, plus the pump operators, plus the supervisor.

Various controlled and statistically based experiments by some cities and universities reveal that if about sixteen trained firefighters are not operating at the scene of a working fire within the critical time period, then dollar loss and injuries are significantly increased, as are the square feet of fire spread.

As firefighting tactics were conducted for comparative purposes, five-person fire suppression companies were judged to be 100 percent effective in their task performance, four-person companies 65 percent effective, and three-person companies 38 percent effective; six person companies are judged 20 percent faster than four person companies.[10]

CENTAUR / FEMA STUDY

The linkage between fire fighter safety and the number of personnel on the initial fire attack has been demonstrated in study after study. In 1982, the U.S. Fire Administration conducted a survey of over 150 fire departments as to current crew size and standard response practices.[11] When asked to identify those factors that were most important in determining crew size and initial response, fire chiefs and city managers ranked crew safety at the top of the list.

COLUMBUS , OH FIRE DEPARTMENT STUDY

Ohio State University, in a 1980 study of actual fireground operations of the Columbus, Ohio Fire Department, developed data on fire fighter injuries and rate of fire spread involving 404 structural fires. The data showed that when the total number of fire fighters at the scene fell below 15 the rate of fire fighter injuries per 10 residential structural fires increased 46.7%, and the number of fires which spread beyond 25 square feet per 10 residential fires increased 24%.

	Rate Per 10 Fires	
Fireground Staffing:	**Fire Fighter Injuries**	**Number of Fires Which Spread Beyond 25 Square Feet**
I. Residential		
Less Than 15 Fire Fighters	**2.2**	**3.6**
15 or More Fire Fighters	**1.5**	**2.9**
Difference	**46.7%**	**24.1%**
II. Large Fire Risk		
Less Than 23 Fire Fighters	**5.9**	**3.4**
23 or More Fire Fighters	**3.4**	**2.9**
Difference	**73.5%**	**17.2%**

SOURCE: Ohio State University

The data associated with large risk fires such as high-rise apartments, etc., showed that staffing had an even more dramatic impact on fire fighter injuries. When fireground staffing was reduced in those types of structural fires to less than 23 personnel, the rate of fire fighter injuries per 10 structural fires increased 73.5%, while the number of fires which spread beyond 25 square feet per 10 fires increased nearly 17.2%.

SEATTLE , WA FIRE DEPARTMENT STUDY

In 1982, the NFPA's *Fire Service Today* published the results of a study conducted by the Seattle Fire Department. Based on a series of textbook training drills and live fire drills, the Seattle Fire Department calculated model effectiveness indices of various levels of manpower as follows:

	3 Person	4 Person	5 Person	6 Person
Engine	**45%**	**59%**	**79%**	**100%**
Ladder	**N/A**	**57%**	**78%**	**100%**

These effectiveness indices related to the time required to successfully complete all the given tasks required by a particular evolution in the initial fire attack. The study concluded that:

> *These effectiveness indices relate to the time taken to accomplish an objective. A large index means a shorter time. Specifically, if a six-man engine takes 5 minutes to accomplish an objective, a three-man engine will require 5 ÷ .45 = 11.1 minutes to accomplish the same objective; a four-man engine will take 5 ÷ .59 = 8.5 minutes, and a five-man engine will take 6.33 minutes. (Seattle did not examine levels of manpower greater than six men.) The same process was used to compare ladder company evolution times.*

The conclusion is that doubling the manpower from three to six men more than doubles the team's effectiveness. There is a synergetic effect at work....

While the Seattle Fire Department's main objective was to produce an appropriateness of service model, unpublished data on fire fighter injuries relating to various levels of staffing were also examined. At the time of the Seattle study, the fire department consistently operated engine and truck companies with varying levels of staffing. To test the relationship between staffing effectiveness and fire fighter injuries, Jon Cushman of the Seattle Fire Department, undertook three separate analyses over a 5-year period.

The results of each analysis yielded the same results:

Average time per disability increased as company strength decreased for both types of companies.

One analysis performed by Cushman examined the Seattle Fire Department's disability report statistics. The results of this analysis indicated that the rate of fire fighter injuries expressed as total hours of disability per hours of fireground exposure were 54% greater for engine companies staffed with 3 personnel when compared to those staffed with 4 fire fighters, while companies staffed with 5 personnel had an injury rate that was only one-third that associated with 4-person companies.

Unit	Average Man-Hours Per Disability	Total Disability Hours	Total Number Disabilities	Total Man-Hours At Fire	Frequency (Column #4 Into #3)	Severity (Column #4 Into #2)
3-Man Engine	**90.607**	**2,537**	**28**	**12,660**	**.00221**	**.20**
4-Man Engine	**58.375**	**1,401**	**24**	**10,460**	**.00229**	**.13**
5-Man Engine	**49.500**	**99**	**2**	**2,125**	**.00094**	**.05**
6-Man Engine	**59.517**	**1,726**	**29**	**12,924**	**.00224**	**.13**
4-Man Ladder	**58.000**	**986**	**17**	**3,964**	**.00429**	**.25**
5-Man Ladder	**20.455**	**450**	**22**	**4,895**	**.00449**	**.09**
6-Man Ladder	**45.857**	**642**	**14**	**6,366**	**.00220**	**.10**

SOURCE: Seattle Fire Department

An even more telling statistic relates to severity rates in Cushman's subsequent analysis that also concluded that average hours per disability associated with 3-person company staffing was nearly 50% greater than those occurring when units were staffed with 4 and 5 personnel.

DALLAS , TX FIRE DEPARTMENT STUDY

The Dallas Fire Department, in 1969 and again in 1984, also conducted textbook drills and live fire tests to compare effectiveness among various levels of staffing.[12] The study concluded that deficient levels of staffing will result in an inability to cover critical tasks. As the numbers of fire fighters decrease without eliminating any of the tasks to be accomplished the Department must delay some of the required tasks or attempt to perform all the tasks unsafely with inadequate staff.

Consequently, the Dallas Fire Department concluded that in a residential fire:

> *The five-person crews demonstrated a more coordinated and effective attack on the fire and search and rescue operation,* while
>
> *The four-person crew was capable of performing satisfactorily in controlling the fire and in effecting the rescue operation.*

The study's conclusion regarding the three-person crew was that not all the required critical tasks could be accomplished within a given time span. Regarding the three-person crew, the report stated:

> *At this level there was little margin for error and any appreciable delay in arrival might place the control of the fire beyond their capability.*

This is an extremely important statement given that the Dallas Fire Department took great care to insure that improvements in the time it took to complete each critical task was not made at the expense of sound operating practices or safety. However, this would not be the situation in actual fireground operations. Fire fighters operating in understaffed environments are too often expected to perform beyond their capabilities.

The Dallas study, in addressing this issue, indicated that inadequate staffing resulted in:

- A cumulative effect created by combined delays and lost functions on the part of each crew resulting in an even greater loss of overall effectiveness;
- Increased physiological stress on fire fighters as they try to compensate for the lower staffing level; and
- Increased risk to the fire fighters when aggressive procedures are undertaken without the support necessary to complete them safely.[13]

The National Fire Academy also noted in a research project developed for its Executive Development III Program that:

> *In 1977 a test was 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 being done to determine how long it took a three, four, or five man team to advance its line to this area, get water on the fire, and to check each individual's physical condition afterwards. Timing began as each engine company entered the school yard.*

The average time of the Engine Companies is revealing. The first consisted of a three-man team and their average was 18.18 minutes. All personnel were exhausted, rubber legged, had difficulty standing up and all three were unfit for further fire fighting.

The four-man team conducting the very same test, averaged 10.29 minutes and upon completing they were nearing exhaustion.

Next came the five-man team which averaged 6.15 minutes, and afterwards all showed little evidence of fatigue. [14]

The Academy's project report went on further to state:

The implication is that when a smaller work force, using the same heavy equipment, has to do the job that was done in the past by a larger workforce, injuries of this nature will continue to increase. Injuries to back and knees are injuries that take a long time to correct. The cost to the city and department are heavy. [15]

U.S. Fire Academy Fire Risk Analysis

In 1984, the U.S. Fire Academy introduced the training manual Fire Risk Analysis: A System's Approach. The manual stated that suppression capability must be measured to include both initial attack operations that attempt to quickly deal with marginal situations before they get out of control, and sustained firefighting procedures that can be put into operation against major fires. In addition to the ability to apply water to the fire, the analysis emphasized that the size of the fireground workforce must be of sufficient size in order to simultaneously have the ability "to engage in search and rescue, forcible entry, ventilation, preservation of property, and additional support activities as required by the situation." The U.S. Fire Academy further stated that time is a critical factor in determining the effectiveness of the tasks with the expectation for the fire to increase until sufficient personnel are assembled to overcome it.

Thus, interior offensive tactics should be measured by the ability to place effective handlines in operation in interior positions and the attempt to gain control of the fire before it exceeds the assembled workforce's capability. This involves assigning personnel to a myriad of activities contingent upon the nature and complexity of the target hazard.

Initial attack capability must be measured in terms of a reflex action by the fire department. Upon receiving an alarm, the department must be able to respond quickly and with the necessary equipment and personnel to put a fire attack into motion without delay.

Based on the above objectives, the U.S. Fire Academy concluded that in order to safely conduct an effective interior attack required at least 15 personnel distributed as follows:

Hoselines:

2 personnel per attack line (1- 1/2 inch lines – 100 gpm)	= 2
2 personnel per attack line (1- 3/4 inch lines – 150 gpm)	= 2
2 personnel per backup line (2 inch line – 200 gpm)	= 2
1 personnel to operate each pumper	= 2

Search and Rescue Operations:

1 of 2 personnel team for every 2,000 sq. ft. (residential occupancies)	= 2

Support Functions:

At least 1 fire fighter to perform forcible entry, utility control, and related support functions for each hand-line placed in operation	= 2

Ventilation:

At least 2 personnel to perform ventilation	= 2

Command:

At least 1 individual assigned as fireground commander	= 1
TOTAL PERSONNEL REQUIRED	15

FIRE DEPARTMENT EVALUATION SYSTEM (FIREDAP)

In December 1991, the Phoenix, AZ Fire Department developed the Fire Department Evaluation System (FIREDAP) to precisely identify the components and objectives for complying with the NFPA's 1410 *Training Standard on Initial Fire Attack.* [16] This evaluation system involved responding to and extinguishing a working fire in a single story residential structure of 2,000 square feet with no exterior exposures.

The Department concluded that to safely conduct an aggressive interior attack based on standard evolutions and the critical tasks that needed to be accomplished required 15 personnel distributed as follows:

4 personnel on each engine	=	8 personnel
4 personnel on truck	=	4 personnel
2 personnel in BC vehicle	=	2 personnel
1 personnel on utility vehicle	=	1 personnel
TOTAL		15 personnel

It is important to note that the Phoenix study indicated that one of the primary objectives of the first arriving engine company was to "*utilize hose line for fire control and personnel protection.*"

It should be further noted in the Phoenix study's findings that the initial attack ultimately required at least 15 personnel on the scene. This is consistent with previous studies such as the Dallas, Ohio State University and Seattle studies, ICMA's Managing Fire Services, NFPA's Fire Attack-1, NFPA's Fire Protection Handbook, and NFPA's *Training Standard on Initial Attack.*

These studies not only form the basis for the "industry standard and practice" for training but also are the basis for the actual response to structural fires which will require aggressive and offensive actions including interior attack.

Austin , TX Fire Department Study

In 1993, the Austin Fire Department embarked on a study to determine whether companies staffed with 4 fire fighters were safer and more effective than the 3 person companies the Department was currently deploying. In order to compare the effectiveness, 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 highrise fire.

These simulations revealed, once again, that regardless of the experience or how prepared fire fighters are, with an insufficient number of personnel to conduct the tasks efficiently, life and property continue to suffer inevitably. 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 improved when the company was increased from 3 to 4 personnel. The Austin Fire Department's report stated:

> *In the two-story residential fire the efficiency or time improvement between the three person and four person crews was 73%.*
>
> *In the aerial ladder evolution the efficiency improvement between three and four person crews was 66%.*
>
> *In the engine company high-rise fire the efficiency improvement between three and four person crews was 35%.*
>
> *Averaging all scenarios the improved efficiency was 58%.*

The Austin study also examined the physiological impact of increased company level staffing had on fire fighters. Before and immediately after the completion of each scenario, medical evaluations including pulse, respiration, blood pressure, EKG strips, body temperature, and visual assessment were given to each fire fighter.

Not surprisingly, the crews consisting of 4 fire fighters recorded a notable decrease in the pulse rate (cardiovascular stress level) and respirations than did 3 person crews:

> *For three person staffs the average pulse rate per minute, post drill, was 127.28; whereas, the average pulse rate per minute for four person staff was 119.69. This is a 16% difference rate increase with the two crews having equal baseline pulse rates.*
>
> *Air consumption for each firefighter working on a four-person crew as opposed to a three person crew decreased by 53%. The dramatic decrease was determined to be a result of less exertion involved in the exercises with four-person crews.*
>
> *Visual assessment of each firefighter verified the additional exhaustion level of the three person crew members.*

In addition to the fireground simulations, 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:

Four- and five-person crews' injury rate was 5.3 per 100 firefighters;

while

Three-person companies experienced an injury rate of 7.77 injuries per 100 firefighters – a 46% higher rate than the larger crews.

Upon its conclusion, the Austin staffing study had exactly confirmed the results the Dallas study conducted some ten years earlier. The Austin Fire Department had found that inadequate staffing directly caused the following problems:

- A higher risk for victims due to delays which are indirectly related to likelihood of survival;
- A loss of critical functions;
- An increased loss of overall effectiveness as a result of combined delays and loss of critical functions;
- Higher physiological stress on fire fighters as they attempt to compensate for lower crew size;
- Higher risk to fire fighter safety as aggressive procedures are conducted without the necessary support.

The Austin study concluded that increased staffing levels from 3 to 4 provided substantial benefits such as:

- A smaller number of multiple alarms;
- Lower fire damage dollar loss and higher loss/save ratio;
- Fewer injuries/deaths for civilians and fire fighters;
- Fewer Worker's Compensation for fire fighters;
- Retainment of tax base properties; and
- Lower civil liability for the City and the Fire Department.

Enforcing an Industry Standard (Clark Co., NV Fire Department)

It was this concept of ignoring "industry standards" that was the basis of a 1989 complaint filed by the Division of Occupational Safety and Health of the Nevada Department of Industrial Relations against the Clark County Fire Department. Nevada OSHA's regulations maintain that an employer shall not:

> *Require, permit or suffer any employee to go or be in any employment or place of employment which is not safe and healthful.*
>
> *Fail to furnish, provide and use safety devices and safeguards or fail to adopt and use methods and processes reasonably adequate to render such employment and place of employment safe and healthful.*
>
> *Fail or neglect to do every other thing reasonably necessary to protect the life, safety and health of such employees....*[17]

Citing that the Clark County Fire Department had prior knowledge that units staffed with 3 personnel were unsafe, N.D.O.S.H. issued a complaint that the Fire Department had willfully violated the industry standards relating to fire fighter safety. In late 1990, the N.D.O.S.H. agreed to vacate the violation when the Clark County Fire Department stipulated that it would immediately "*maintain minimum staffing levels at each fire station so that no engine or ladder truck shall be dispatched from a fire station, manned with less than four persons.*"

In addition, the stipulation entered into by the Fire Department stated that:

> *Any engine or ladder truck manned with less than four persons shall be defined to be "unsafely manned."*

The body of evidence and industry practice over the last quarter century certainly indicates that the adherence to a minimum safe fireground staffing level is professionally appropriate.

Ontario Fire Marshal Study

In 1993, the Fire Marshal of Ontario (Canada) Research Project embarked on a study to thoroughly examine the tasks which 3- and 4- person crews could safely accomplish. The project determined that 3-person crews are very limited in their firefighting capabilities. It is found that until additional assistance has arrived on the scene, the following cannot be accomplished safely:

- deployment of back-up protection lines;
- conducting interior suppression or rescue operations;
- ventilation operations requiring access to the roof of the involved structure;
- the use of large (65mm) hand-held hose lines;
- the establishment of a water supply from a static source within the reasonable time limits.

In addition, the companies' 3-person crews were not of sufficient size in order to provide the necessary breaks to recover from metabolic heat and exhaustion during incidents requiring abstained fireground operations.

Four-person crews were also determined to be substantially more effective versus 3-person crews once a water supply from an external source is established. Such additional tasks which may be accomplished by a 4-person crew include:

- two person interior search and rescue with no hand-held back-up line;
- two person interior structure firefighting with no rescue component and no hand-held back-up line;
- limited roof level ventilation operations:
- laddering operations; and
- salvage operations.

Four-person crews, depending on the circumstance, may also be capable of completing the following:

- use of large (65mm) diameter hand lines;
- establishment of a water supply from a static source;
- establishment of a second point of entry and approach to the fire location in the structure; and
- preparing for a second area of search and rescue for person(s) in need of rescue.

The study further concluded that the addition of one crew member allows for increase command and pumper operations as the driver or supervisor is given a single function.

Metropolitan Fire Chiefs and Minimum Staffing

At their 1992 annual meeting, the Metropolitan Fire Chiefs Division of the IAFC not only endorsed the assembly of at least 4 fire fighters before initiating an interior attack, but went further stating:

> *In order to permit the effective operation of fire companies at the scene of a structure fire, the minimum number of personnel on both engine and ladder companies should be five members per unit.*

In support of its position and addressing the impact that inadequate fireground staffing has on fire fighter safety, the IAFC's Metro Chiefs listed the following points:

A fire company should be able to function as an independent unit at the scene of a fire in order to permit the Incident Commander to employ the proper tactics and strategies to safeguard the occupants of the building, as well as the operating force, and to protect the property of the citizens.

Whenever understaffing necessitates the combination of two companies to accomplish a specific task at the scene of a fire, which normally could be completed by one effective unit, the standard operating procedures are dramatically and adversely affected.

Proper fire fighting procedures require strategies that result in the commitment of fire companies not only to the area involved on arrival, but to the internal and external exposures as well, if the endangered citizens are to be safeguarded and the property damaged limited. Understaffing prevents the Incident Commander from achieving these essential objectives.

To justify the position taken by the Metro Fire Chiefs, there is sufficient documentation available that indicates increased injury rates to occupants and fire fighters, as well as higher property losses, are due to an inadequate firefighting force at the scene of a fire.

The Metro Chiefs recognize that current economic difficulties are affecting public safety organizations nationwide but these factors do not alter the tasks that must be accomplished at the fire scene.

The decline in the number of members per unit, as well as the reduction in the number of fire companies in cities, have already reached a dangerously low level. To accept or support further reductions is inappropriate.

Any fire chief who attempts to obtain sufficient funding to provide adequate personnel for the protection of the community he serves, even if he fails, is performing his sworn duty to the best of his ability. In doing so, he is conscientiously informing the elected officials and the citizenry of their needs according to his professional judgment and experience.

We believe that our, the Metro Fire Chiefs, position is strong enough to assist all fire chiefs in their efforts to obtain adequate staffing.

This firm position has been taken by the Metro Chiefs solely in the interest of the safety of both those we serve and our nation's fire fighter.

Increasing Fireground Injuries

Since the NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program* was promulgated, the average annual rate of fireground injuries per 1,000 fires has increased by 6.4% as the table below shows.

Rate of Fire Fighter Fireground Injuries Per 1,000 Fires

	Total	Smoke Inhalation, Eye Injuries, Burns	Wounds, Dislocations, Fractures, Heart Attack, Strains and Sprains
1981-1986	**25.22**	**8.89**	**13.54**
1987-1993	**26.83**	**7.45**	**15.59**
% Change	**6.4%**	**(16.2%)**	**15.1%**

Note: Prior to 1981, data was not classified in same manner.
SOURCE: NFPA Annual National Fire Experience Survey

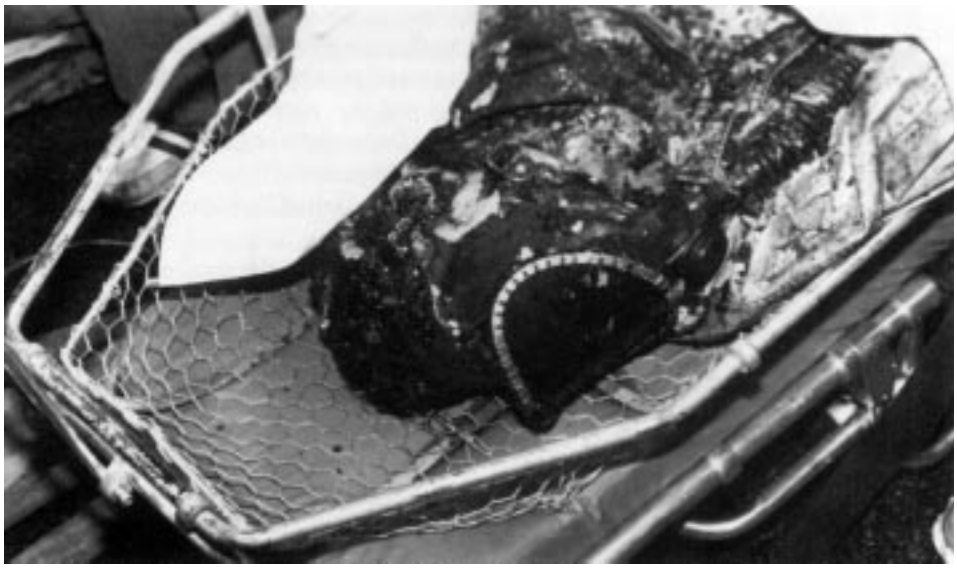
Comparing the average annual rate of fireground injuries for the six-year period prior to the promulgation of NFPA 1500 to the seven-year post NFPA 1500 period reveals that those injuries (i.e., smoke inhalation, eye injuries and burns) most closely associated with SCBA usage and personal protective equipment declined by 16.2%. On the other hand, the rate of fireground injuries for those injuries (i.e., wounds, dislocations, fractures, heart attacks, strains and sprains) associated with understaffed fireground operations increased by 15.1%.

Johns Hopkins University Study

A recent study produced by the IAFF with the cooperation of Johns Hopkins University also reflects the fact that fire fighter injuries are significantly influenced by inadequate staffing. This analysis compared the rate of injuries per 100 fire fighters and per 100 alarms for cities operating 4-person staffing versus those operating 3-person units.

The analysis showed that:

- Cities which operated fire suppression companies with less than 4 personnel had an injury rate per 100 workers that was 36.3% greater than those cities which had staffing levels of 4 or more;
- The percentage of cities having an injury rate of 10 injuries or more per 100 fire fighters was nearly double for those operating with less than 4 person crews as compared to those cities operating with minimum staffing levels of 4 or more;
- Fire fighter injury rates per 100 alarms were an average of 38% greater in cities with minimum staffing of less than 4 personnel per unit; and
- 72.5% of the cities staffing with less than 4 had an injury rate per 100 alarms of 0.5 or greater compared to only 35.3% of the cities staffing with at least 4 per fire suppression unit.



Tests for statistical significance on this data established that such differences in the injury rates associated with 3 versus 4 person staffing are not due to random chance.

PROVIDENCE , RI EXPERIENCE

The significant effect that increasing staffing from 3 to 4 can have on the rate of fire fighter injuries is apparent from a recent trial experience in Providence, Rhode Island. In order to test the hypothesis that 4 person staffing was safer than units staffed with only 3 fire fighters, the City agreed to provide 4 person minimum staffing on 6 of its 15 units and examine the results.

As the following table shows, the resulting 55.4% drop in fire fighter injuries was so dramatic that the Mayor entered into an agreement with the local union to extend the 4 fire fighter minimum staffing level to all 15 of the Providence Fire Department's fire suppression units.

COMPARISON OF INJURY RATES IN PROVIDENCE, RI FOR 3 PERSON VERSUS 4 PERSON STAFFING

Year	Fire Suppression Incidences	Fire Fighters On-Duty	Number of Fire Fighters	# of Injuries at Emergency Scene	Emergency Scene Injuries Per 100 F/F	% Decrease in Emergency Scene Injuries Per 100 FF
1989	3,869	83	479	431	90.0	
1990	3,871	89	479	339	70.8	21.3%
1991	4,143	98	479	192	40.1	43.4%
				TOTAL DECLINE		55.4%

In 1989, minimum staffing per piece was 3 personnel. Beginning in September of 1990, 6 units were staffed with 4 personnel through overtime; beginning in October of 1991, all 15 units were staffed with 4 personnel through overtime.

U. S. Fire Academy's Findings

In conjunction with the Providence study, an applied research project was conducted as part of the U.S. Fire Academy's Executive Officer Program. This project addresses the fire fighter perspective and explores possible areas of discrepancies within the study. Through literature reviews, interviews with the Providence Fire Department Chief, the Fire Department Historian, and a member of the Department of Economic Planning and Development, and examinations of the Providence Fire Department Injury-Exposure Database, the analysis provides substantial evidence in support of the initial Providence staffing study findings:

- a 23.8% decrease in the number of reported injuries;
- a 25% decrease in the number of time loss injuries when staffing increases;
- a 71% decrease in work time lost; and
- a dramatic decrease in the frequency and severity of fire injuries when staffing increases from three- to four-person crews.

The study further concluded that this significant decline in frequency and severity of injuries was not caused by the decrease in the number of fires or incident volume, nor was the drop in fire fighter injuries caused by changes in protective clothing, new safety or operational procedures, substantive training changes, new physical fitness programs, or the implementation of new OSHA programs since these were held constant during the study period. Taking all of these factors into consideration, the analysis concluded that increased staffing from 3 to 4-person crews leads directly to significant reductions in the frequency and severity of fire fighter injuries.

Industry Consensus Standard on Fire Department Occupational Safety & Health (NFPA 1500)

In 1993, the National Fire Protection Association (NFPA) included in its Consensus Standard on Fire Department Occupational Safety and Health (NFPA 1500) a requirement addressing the minimum number of fire fighters necessary to initiate an offensive interior attack on a structural fire. This Tentative Interim Amendment (TIA) to the fire fighter safety standard states:

> *At least four members shall be assembled before initiating interior fire fighting operations at a working structural fire.*

However, while the above language was clear as to the minimum number of personnel required to safely begin interior firefighting operations, it left some confusion as to how personnel would be "assembled."

Consequently, in 1994, Mr. M.E. Hines, Director of the Texas Commission on Fire Protection, sought formal clarification from the NFPA on this issue. NFPA's formal interpretation of how the 4 fire fighters should assemble is as follows:

> *...when a company is dispatched from a fire station together as a unit (which includes both personnel responding on or arriving with apparatus), rather than from various locations, the standard recommends that the company should contain a minimum of four fire fighters.*

The National Fire Protection Association (NFPA) interpretation of the Standard goes even further to address "high risk" fires:

> *It should be noted that four fire fighters is a baseline recommended minimum for 'any type of fire.' For companies responding in 'high risk areas' a higher minimum of 5 responding or arriving with each engine company and 6 responding or arriving with each ladder company is recommended.*

Federal Occupational Safety and Health Act's "2 In / 2 Out" Standard

The Occupational Safety and Health Act of 1970, signed into law on December 29, 1970, was designed to assure so far as possible every working man and woman in the nation safe and healthful working conditions. In administering the Act, the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) issues standards and rules for safe and healthful working conditions, tools, equipment, facilities, and processes. OSHA also conducts workplace inspections to assure the standards are followed. Under the Act, employers have the general duty of providing their workers a place of employment free from recognized hazards to safety and health, and must comply with OSHA standards.

Many of OSHA's standards are not new. Employers have operated under them for years as national consensus standards – those agreed upon by members of groups such as the American National Standards Institute and the National Fire Protection Association – or as federal standards established under other laws, such as the Public Contracts Act. Many of these standards were codified as OSHA standards upon passage of the OSHA act. Included were ANSI standards pertaining to the use of respiratory equipment.

The International Association of Fire Fighters requested officials at Federal OSHA to provide uniform interpretation and compliance information on its standards addressing self-contained breathing apparatus use and the application of these standards to fire fighters responding to hazardous materials incidents and structural fires. On May 1, 1995, Federal OSHA issued a compliance instruction to all OSHA Regional and Area Offices, Compliance Officers and State Agencies having responsibility for enforcing safety and health regulations. This compliance instruction thus not only establishes the link between fire fighter safety and fireground staffing, but also provides for universal interpretation and enforcement of these regulations.

This compliance standard known as the "2 in/2 out" rule provides federally enforced protection for all professional fire fighters, whether state, county, or municipal, in any of the states or territories where an OSHA State Plan agreement is in effect. The following 25 states/territories have State OSHA Plans:

Alaska	Kentucky	North Carolina	Virginia
Arizona	Maryland	Oregon	Virgin Islands
California	Michigan	Puerto Rico	Washington
Connecticut	Minnesota	South Carolina	Wyoming
Hawaii	Nevada	Tennessee	
Indiana	New Mexico	Utah	
Iowa	New York	Vermont	

While there is not universal occupational health and safety coverage for all U.S. and Canadian fire fighters, these regulations must be considered the minimum acceptable standard for safe fireground staffing when self-contained breathing apparatus is required to be used. Thus, this interpretation is appropriate evidence for arbitration and grievance hearings on fire fighter safety.

In addition, Executive Order 12196 issued February 26, 1980 and implemented December 21, 1980 requires that all federal agencies comply with the same safety and health requirements as private employers. Thus, federal fire fighters are protected under Federal OSHA safety and health standards, including this interpretation.

The U.S. Environmental Protection Agency (EPA) has promulgated a standard that adopts the OSHA Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120) to protect employees who work in the public sector where there is not an OSHA approved State program in place (40 CFR 311). Additionally, EPA and OSHA have agreed that all interpretations regarding compliance with HAZWOPER will be made by OSHA. Thus, those fire fighters in the 27 non-OSHA states and other U.S. territories (e.g., Guam, Canal Zone) making a response to emergency operations where there is a potential release of hazardous substances, as defined by this standard, are covered by the interpretation.

The substance of Federal OSHA's "2 in/2 out" standard is as follows:

- *The HAZWOPER standard requires the use of the buddy system with standby personnel for emergency response operations involving the release of hazardous substance(s) producing IDLH conditions for employees responding. The regulation specifies a minimum of four personnel, two as a team in the buddy system and two standby backup personnel, to conduct operations in hazardous areas safely.*

- *The use of SCBA's in IDLH atmospheres for circumstances not covered by HAZWOPER is covered by the Respiratory Protection standard which requires two standby personnel to be present outside the IDLH hazard area. Failure to have two standby persons for a known, existing IDLH, e.g., an interior structural fire, would be a violation of 1910.134 (e)(3)(ii).*

- *The Fire Brigade standard covers employers whose employees perform interior attack on interior structural fires and references the Respiratory Protection standard's requirements above.*

- *The National Fire Protection Association (NFPA) recognizes that fire fighters must operate in teams of two or more when conducting interior structural firefighting operations; failure to respond with teams of two or more would be a violation of the General Duty Clause.*

- ***The Respiratory Protection standard and industry practice (as codified through the NFPA standards) require that a minimum of four fire fighters be involved in emergency operations during interior structural firefighting. Two act as a team in the hazard area, and two stand by outside the hazardous area to monitor the operation and provide assistance should a rescue be necessary.***

- *OSHA regulations and NFPA standards specifically require communication between members of the team. Fire fighters working in teams of two or more (buddy system) in hazardous areas (IDLH atmospheres) are required to maintain communications (voice, visual contact, or tethering with a signal line). Radios or other means of electronic contact shall not be substituted for direct visual contact between employees within the individual team in the danger area.*

- *One of the individuals outside of the hazard area may be assigned more than one role, such as the incident commander in charge of the emergency or operator of fire apparatus, where it does not jeopardize worker safety and health.*

Clearly, the evidence establishes the connection between staffing and fire fighter fireground injuries. So long as understaffed fire suppression units are expected to initiate and perform sustained interior attack operations involving structural fires, the rate of fireground injuries will continue to increase at alarming rates.

ENDNOTES

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[4] Ibid.; p. 44.

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[6] Managing Fire Services, International City Management Association (Washington, DC: ICMA) 1979; p. 80.

[7] *Standard on Fire Department Occupational Safety and Health Program*, NFPA No. 1500, National Fire Protection Association, 1992; Appendix A-6-4.1.

[8] Fire Protection Handbook, 17th Edition, National Fire Protection Association (Quincy, MA: NFPA) 1991; p. 10-41.

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[14] "Fire Engines Are Becoming Expensive Taxi Cabs—Inadequate Manning," National Fire Academy, Executive Development III Program, 1981; p. 4.

[15] Ibid.; p. 2.

[16] "Fire Department Evaluation System (FIREDAP)," Phoenix, AZ Fire Department, December 1991; p. 1.

[17] State of Nevada NRS 618.385.

Chapter 3
Local Jurisdiction's Overall Fire Protection Requirements

In any community, the level of service provided by the fire department is based on factors such as community expectations, financial resources, and political decisions. Fire fighter safety and requirements for performing successful interior structural fire attacks should not be subject to political debate.

These precepts are best described in a statement by the International City Management Association (ICMA):

> *The fire control system is by far the most costly element of a fire department's operations and should be designed and operated in the most cost-effective fashion. (The value of 'cost-effectiveness' is determined by definition at each local level of government and will vary from community to community. This variation results from the process of balancing the accepted or tolerated risk against the actual risk in each community.) One three or four man company costs several hundreds of thousands of dollars per year. A fire control company not needed or poorly utilized represents a significant financial waste. On the other hand, too few companies, or poorly manned ones, can result in property and life loss beyond community accepted norms. Also, the cost of a firefighter death or a disabling injury may far exceed the expense of a fire company. This is not to say that there is a fixed value on a life or injury. The point is that the firefighting forces are the asset that protects the community's economic and tax base as well as its health and welfare. This asset is a valuable one and must be carefully provided and wisely managed.*
>
> *There is no single problem or solution to be found when a community's fire control system is designed, although many fire chiefs and managers are engaged in just such a search. But such an attempt merely illustrates a lack of understanding of the complexities of what constitutes an adequate fire protection delivery system.*[1] (UNDERLINING ADDED)

In its 1988 edition of Managing Fire Services, ICMA suggested an overall master plan for providing safe and effective fire suppression services:

> *A prudent response pattern needs quick response times as well as a sufficient number of firefighters for the immediate attack.*
>
> *Officials need to establish a maximum response time following receipt of the dispatch instructions at the station. In some urban areas, one and a half minutes are considered a desirable maximum, whereas in other urban areas the number is set at two and a half or three. Obviously, the response time policy varies according to the fire danger, the ability of the munici-*

pality to locate stations and staff apparatus, and traffic speed. Average urban response speed is usually about 20 miles per hour. Once fire apparatus and personnel arrive at the scene, their initial activities require several more minutes.

Considering that the time required for flashover in structural fires with standard fuels is typically about seven minutes, the apparatus and firefighters must arrive and get operating very quickly. If it takes a resident two or three minutes to discover and report a fire and three minutes for the apparatus to be dispatched and arrive, the sizing up and initial attack need to be done in a minute or two, or the typical fire will have grown significantly in size. An unconscious person with depleted oxygen will typically suffer permanent brain damage after approximately four minutes. All of this needs to be considered within the context of multiple alarm fires and simultaneous alarms. Delayed response and understaffed response appear inevitable under those circumstances, unless planning is complete.

One task, then, in evaluating suppression ability is to determine how fast adequate firefighting forces can arrive at the scene of an incident and launch rescue operations, if needed, plus initial fire attack. Once the community or the evaluation team has determined satisfactory parameters for the size of the initial attack team and response time and has measured the local situation, it can judge how satisfactory the response is. Often the response time is longer than officials expected, especially if the time span is measured from the moment the alarm was received to the actual initial attack. Team size may not be satisfactory until several vehicles arrive, and this time delay must be considered as well. The efficiency of the attack team will be greatly diminished if an optimum number are not working at the scene.[2] (UNDERLINING ADDED)

Thus, if successful and safe, initial interior structural fire attack minimally requires at least:

- 4 fire fighters arriving with the first due engine,

and

- total fireground resources of 15 to 16 personnel staffing 2 pumpers and 1 ladder truck,

the only additional piece of the equation is response time.

RESPONSE TIME

Response time involves four elements: detection time, alarm processing time, turnout time and travel time. For the first of these elements — detection time — no reliable data or analysis exists.

However, for the two elements involving alarm processing[3] and turnout time,[4] the International Association of Fire Chiefs' Accreditation Committee recently completed an analysis.[5] The study indicated that in "staffed departments" the average time required to process the alarm was 53.76 seconds, while the average turnout time was 57.55 seconds.

On the basis of the International City Management Association statement that fire apparatus in an urban setting can average about 20 miles per hour, travel time involving distances of 1 mile is approximately 3 minutes. Therefore, the total average response time of "staffed departments" approximates 5 minutes from receipt of the alarm to arrival at the scene.

Minimum Staffing and Response Times Required for Delivery of Emergency Medical Care

The response times for fire suppression are also consistent with those recommended by the American Heart Association (AHA) for delivery of pre-hospital emergency medical care. The AHA's emergency medical services maximum response time recommendation has been 4 minutes for initiation of basic life support (BLS) and 8 minutes for initiation of advanced life support (ALS).

Recently the AHA reconfirmed this recommendation by stating:

> *For cardiac arrest, the highest hospital discharge rate has been achieved in patients in whom CPR was initiated within 4 minutes of arrest and ACLS within 8 minutes. Early bystander rescue breathing or CPR intervention and fast emergency medical services (EMS) response are therefore essential in improving survival rates.*[6] (UNDERLINING ADDED)

In 1992, the National Conference on Cardiopulmonary Resuscitation and Emergency Cardiac Care, listed among its recommendations that all fire-fighting units be equipped with and trained to operate automatic external defibrillators and the following recommendation regarding minimum staffing per EMS response:

> *Early ACLS provided by paramedics at the scene is another critical link in the management of cardiac arrest. EMS systems should have sufficient*

staffing to provide a minimum of two rescuers trained in ACLS to respond to the emergency. However, because of the difficulties in treating cardiac arrest in the field, additional responders should be present. In systems that have attained survival rates higher than 20% for patients with ventricular fibrillation, the response teams have a minimum of two ACLS providers plus a minimum of two BLS personnel at the scene. 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...[7]
(UNDERLINING ADDED)

Tactical Fire Suppression Goals

Given the total requirements of firefighting personnel and equipment to safely conduct an initial interior structural fire attack and provide pre-hospital emergency medical care according to the industry's standard, the only politically driven decision that is appropriately within a local community's discretion is response times. For it is through its decision regarding these response times that the local community defines the acceptable level of risk in providing the delivery of fire suppression services.

The International City Management Association (ICMA) defines just such a set of tactical fire suppression goals as the following:

For all structural fires, to deploy one engine company within five (5) minutes and an additional engine company, one ladder company, one paramedic unit, and one chief officer within ten (10) minutes for 90 percent of all alarms in areas with a required fire flow of 4,500 gallons per minute (GPM) or less. For all areas over 4,500 GPM, the first engine and truck (ladder) must arrive within five (5) minutes for 90 percent of all alarms. The lapsed time (reflex time) is to include fire dispatch and response time. The objective is to control the fire before flashover (sudden spread), or before the fire has extended beyond the first (original) area of involvement. (Using the standard time versus temperature curve as a base, flashover is estimated to be eight (8) minutes after ignition in standard fuels.)

The general tactical objective is to develop an attack force that can aggressively advance two standard fire stream hand lines (or the equivalent). For major emergencies beyond the normal capability of the first alarm assignment, the objective is to deploy a programmed reserve and automatic aid fire force of six (6) engine companies, three (3) truck (ladder) companies, and three (3) chief officers within fifteen (15) minutes of a third alarm. The objective is to prevent large fires from extending to other structures.

For all fire and emergencies (i.e., a probability of fire or explosion) in petroleum storage and production areas, to deploy, within ten (10) minutes, special light water or foam firefighting equipment and prepare for long relays and extended pumping operations. The objective is to provide engine companies with adequate petroleum firefighting equipment. For fires in water deficient areas, the objective is to deploy, within ten (10) minutes, a pumper-tanker and relay operation of adequate capacity to augment local supplies.

For fires in harbor areas, to deploy within five (5) minutes for 90 percent of all marine-oriented incidents adequate marine firefighting equipment of 500 GPM.

To maintain and deploy one engine company within five (5) minutes of notification in 90 percent of all light rescue emergencies. In addition, a paramedic unit shall be deployed within five (5) minutes 80 percent of the time. The objective is to provide emergency medical services (EMS) and rescue all trapped persons, including those who need to be extricated with forcible entry equipment.

To deploy a truck company in addition to an engine and paramedic unit on heavy rescue incidents. The truck shall arrive within ten (10) minutes 90 percent of the time. The objective is to rescue all trapped persons regardless of the situation.[8]

The requirement to establish tactical objectives in terms of response times and to provide sufficient personnel and equipment to successfully and safely initiate structural interior fire attacks is also required by NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program.* In this regard, the NFPA 1500 Standard, Section 2-1.2 mandates that:

The fire department organizational statement shall set forth the operational response criteria for the various types of emergency incidents to which the fire department is required to respond. This written criteria for each type of emergency incident shall contain and identify the following:

(a) The types of standard firefighting functions or evolutions, such as incident management, providing a water supply, hose deployment, forcible entry, search and rescue, ladder placement, ventilation, salvage, and overhaul <u>required to safely complete the operation</u>; specifying a determination of functions or evolutions that need to be performed simultaneously;

(b) The minimum number of members <u>required to safely perform</u> each identified fire function or evolution, based on written standard operating procedures;

(c) The number and types of apparatus and members required for the initial response to each type of emergency incident, as well as the total complement of apparatus and members to be dispatched for each type of incident that defines the total response for all incidents up to the level of a major incident for that Jurisdiction;

(d) A description of a typical emergency operation, including alarm time, response time, arrival sequence, initiation of basic function and evolution assignments, and standard operating procedures, as these factors relate to fire fighter safety and health. [9] (UNDERLINING ADDED)

Section 6-4.1 of NFPA 1500 further mandates that fire departments adhere to the industry's standard of safe minimum fire fighter staffing by requiring that a fire department not force any

fire fighter(s) to perform duties that are unsafe.

> *The fire department shall provide an adequate number of personnel to safely conduct emergency scene operations. Operations shall be limited to those that can be safely performed by the personnel available at the scene. No member or members shall commence or perform any firefighting function or evolution that is not within the established safety criteria of the organizational statement as specified in 2-1.2 of this standard.* [10]

These studies and the industry's standard of performance endorse the International Association of Fire Fighters' position that the minimum safe and effective fire fighter staffing per unit of response must be:

> *...at least 4 fire fighters on each engine or pumper company and at least 5 fire fighters on each ladder truck company to any type of structural fire. It must be noted that this is the minimum company staffing for safe and effective operations. Safe fire suppression operations involving high density or high risk occupancies will require additional personnel assigned to each company.*

This position is consistent with NFPA Standards 1500 and 1410. Furthermore, it is supported by the National Fire Protection Association in its Fire Protection Handbook and the International City Management Association's Managing Fire Services.

The IAFF position has been endorsed and supported by the U.S. Fire Administration and the Metropolitan Fire Chiefs Division of the International Association of Fire Chiefs.

Study after study, including the Dallas, Seattle, Ohio State, Phoenix, Providence and Westerville studies, have independently provided additional evidence supporting the IAFF's position. Appropriate unit staffing and station distribution further lead to a reasonable standard of performance for response to fires and medical emergencies that has been endorsed by fire service professionals and city administrators as follows:

- First responding unit shall arrive at the scene within 4 minutes of receipt of the alarm in 90% of the instances,

  and/or

  the initial alarm assignment, consisting of two engine companies and one ladder, shall arrive at the scene within 8 minutes of the alarm in 90% of the instances.

  The initial alarm assigned to a fire shall be comprised of sufficient personnel and equipment to control a fire in a structure up to 5,000 square feet in area and effectively remove or rescue any endangered occupants.

  and

- The initial alarm response to a medical emergency shall be sufficient to provide advanced life support for victim stabilization, including cardiac emergency, in a manner consistent with the American Heart Association and the American Medical Association recommendations.

ENDNOTES

[1] Managing Fire Services, International City Management Association (Washington, DC:ICMA) 1979, pp. 214-215.

[2] Managing Fire Services, 2nd Edition, International City Management Association, (Washington, DC:ICMA) 1988, p. 120.

[3] "Alarm processing time" is defined as the period of time that is required for the Communications Center to identify the fact that an emergency is in progress, collect the information pertinent to making the appropriate dispatch, and access the methodology used by the agency to deploy resources.

[4] "Turnout time" is defined as the period of time that is required for the on-duty emergency system and hazardous material personnel to discontinue the activities they are engaged in, properly attire themselves, and board the vehicle in readiness for response.

[5] "IAFC Accreditation Committee Surveys Fire Department, Charts Response Times," International Association of Fire Chiefs' *On Scene*, September 1, 1992; pp. 7-8.

[6] *The Journal of the American Medical Association*, October 28, 1992; p. 2184.

[7] Ibid.; p. 2291.

[8] Managing Fire Services, International City Management Association (Washington, DC:ICMA) 1979, pp. 218-219.

[9] *Standard on Fire Department Occupational Safety and Health Program*, NFPA No. 1500, National Fire Protection Association, 1992; Chapter 2, Section 2-1.2.

[10] Ibid.; Chapter 6, Section 6-4.1.

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