

with one piece of fire apparatus. The standard allows for an exception in those instances when multiple apparatus are used to make up a company. However, such exceptions require that these multi-piece companies are always dispatched at the same time and arrive together, are continuously operated together and are managed by a single company officer. The standard recognizes and clarifies the limited use of such multi-piece companies.

Examples include:

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

14. What is the basis for a four-person minimum? (5.2.2.1.1)

The NFPA Technical Committee reviewed numerous studies, evaluations and stakeholder reports containing empirical data on departmental response and mitigation of fire. These studies clearly demonstrate that for safe, effective and efficient fire suppression, each responding company needs a minimum of four fire fighters.

The following are some of the studies that support the four-person minimum:

American Insurance Association, “Fire Department Efficiency,” Special Interest Bulletin No. 131, December 1975.

Bulletin prepared by the American Insurance Association on fire department efficiency. Emphasis is placed on the importance of staffing companies with a minimum of four personnel. The bulletin further states that if companies are staffed with two or three personnel, they cannot perform the required functions of either an engine or ladder company.

American Insurance Association, “Fire Department Manning,” Special Interest Bulletin No. 319, December 1975.

Bulletin prepared by the American Insurance Association on fire department staffing levels. Emphasis is placed on the importance of staffing companies with a minimum of four personnel. The bulletin further states that four personnel do not represent an adequately staffed company. It concludes with a statement that progressive fire chiefs believe a company should never respond with fewer than five or six personnel.

Cushman, Jon, Seattle, WA Fire Department's "Abstract: Report to Executive Board, Minimum Manning as Health & Safety Issue," 1981.

This study, performed by the Seattle Fire Department, analyzed the link between staffing and fire fighter injuries by reviewing the average severity of injuries suffered by engine companies of fewer than four fire fighters as compared to companies with four or more fire fighters. The study concluded that the average time per disability increased as company strength decreased for both types of companies. 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 three personnel when compared to those staffed with four fire fighters, while companies staffed with five personnel had an injury rate that was only one-third that associated with four-person companies.

Gerard, John C. and Jacobsen, A. Terry, "Reduced Staffing: At What Cost?," Fire Service Today, September 1981; pp. 15-21.

This study concluded that an aggressive early initial interior attack on a working structural fire results in greatly reduced loss of life and property damage. Given that the progression of a structural fire to the point of flashover generally occurs in less than 10 minutes, two of the most important elements in limiting the spread of fire 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.

International City Managers Association, Municipal Fire Administration (Chicago, IL:ICMA) 1967; pp. 161-162.

The ICMA concluded that there must be enough personnel to put fire apparatus into effective use. It determined that a minimum of five personnel are required for engine (pumper) companies, three personnel are needed to place a single line of 2 ½-inch hose in service, and one additional person, plus a foreperson, is needed to operate a pump.

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.

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 fewer 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 fewer 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.

Kimball, Warren Y., Manning for Fire Attack (Boston, MA: NFPA) 1969.

This book thoroughly covers staffing of fire companies. In summary, effective fireground staffing was demonstrated to involve two fundamentals: first, carefully engineered equipment components designed to deliver specified fire extinguishing capacity under stated conditions and second, personnel assigned and used to deliver specified fire attack capabilities. In other words, the fire fighting capability of a fire department ultimately depends upon a complete systems approach and not a mere massing of random forces when an emergency occurs.

McManis Associates and John T. O'Hagan and Associates, "Dallas Fire Department Staffing Level Study," June 1984; pp. I-2 & II-1 through II-7.

The Dallas Study is a 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.

Metro Chiefs/International Association of Fire Chiefs, "Metro Fire Chiefs - Minimum Staffing Position," May 1992.

In 1992, the Metro Fire Chiefs Division of the ICHIEFS not only endorsed assembling at least four fire fighters before initiating an interior attack, but went a step 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. This firm position was taken by the Metro Fire Chiefs solely in the interest of the safety of both the citizens "we serve and our nation's fire fighters."

Morrison, Richard C., "Manning Levels for Engine and Ladder Companies in Small Fire Departments," 1990.

The conclusions reached in the Dallas study were confirmed for small fire departments by the Westerville, Ohio Fire Department. Using standard fire fighting tactics, the results of the Westerville Fire Department report showed that four fire fighters could perform rescue of potential victims 80% faster than a three fire fighter crew.

National Fire Academy, Executive Development Program III, "Fire Engines are Becoming Expensive Taxi Cabs: Inadequate Manning," February 1981; pp. 2 & 4.

This NFA 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 simulation 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 were unfit for further fire fighting. The four-person team, conducting the very same test, averaged 10.29 minutes and upon completion, were nearing exhaustion. The five-person team averaged 6.15 minutes, and showed little evidence of fatigue at the end of the exercise.

National Fire Protection Association, "Decision of the Standards Council on the Complaint of M.E. Hines, Texas Commission on Fire Protection, concerning a Formal Interpretation on NFPA 1500, Standard on Fire Department Occupational Safety and Health Program," April 6, 1994.

In 1993, the NFPA included in its NFPA 1500 Consensus Standard on Fire Department Occupational Safety and Health a requirement addressing the minimum number of fire fighters necessary to initiate an offensive interior attack on a structural fire. This Tentative Interim Agreement (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."

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 four fire fighters should be assembled 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 4 fire fighters."

National Fire Protection Association, NFPA 1410 Training Standard on Initial Fire Attack, 2000.

The NFPA 1410 Standard contains the minimum requirements for evaluating training for initial fire suppression and rescue procedures used by fire department personnel engaged in emergency scene operations. This standard specifies basic evolutions that can be adapted to local conditions and serves as a standard mechanism for the evaluation of minimum acceptable performance during training for initial fire suppression and rescue activities.

The following are pertinent excerpts from NFPA 1410:

3-2.2* *In addition to the requirements set forth in 3-2.1, the company officer shall ensure that the following are accomplished in interior structural fires:*

- (1) *At least two fire fighters enter the immediately dangerous to life and health (IDLH) atmosphere and remain in visual or voice contact with each other at all times.*
- (2) *At least two fire fighters are located outside the IDLH atmosphere.*
- (3) *All fire fighters engaged in interior structural fire fighting use SCBA.*

A-3-2.2 *One of the two individuals located outside the IDLH atmosphere could be assigned an additional role, such as incident commander in charge of the emergency, or safety officer, as long as this individual is able to perform assistance or rescue activities without jeopardizing the safety or health of any fire fighter working at the incident. Nothing in this section is meant to preclude fire fighters from performing rescue activities before an entire team has been assembled.*

National Fire Protection Association, NFPA 1500 Standard on Fire Department Occupational Safety and Health Program, August 1997.

The NFPA 1500 Standard contains minimum requirements for a fire service-related occupational safety and health program. These requirements are applicable to public, governmental, military, private and industrial fire department organizations providing rescue, fire suppression, emergency medical services, hazardous materials mitigation, special operations and other emergency services.

The following are pertinent excerpts from NFPA 1500:

2-1.2* *The fire department shall prepare and maintain written policies and standard operating procedures that document the organization structure, membership, roles and responsibilities, expected functions and training requirements, including the following:*

- (a) *The types of standard evolutions that are expected to be performed and the evolutions that must be performed simultaneously or in sequence for different types of situations*
- (b) *The minimum number of members who are required to perform each function or evolution and the manner in which the function is to be performed*

- (c) *The number and types of apparatus and the number of personnel that will be dispatched to different types of incidents*
- (d) *The procedures that will be employed to initiate and manage operations at the scene of an emergency incident*

6-4.1* *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 fire-fighting function or evolution that is not within the established safety criteria of the organizational statement as specified in 2-1.2 of this standard.*

A-6-4.1 *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 four 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 five members responding or arriving with each engine company and six 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, five 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.

National Institute for Occupational Safety and Health, Health Hazard Evaluation Reports for Sedgwick County, KS, Nos. HETA 90-395-2117 and HETA 90-395-2121, June 1991.

This NIOSH report details a September 6, 1990, fire in Sedgwick County, Kansas that killed a 25-year-old fire fighter. The cause of death was determined to be heat stroke. In the discussion and findings section of the report, the issue of staffing was addressed as follows:

A two-fire fighter engine company is, at a minimum, 50% understaffed and increases the work effort by a factor of three. In a brushfire where one fire fighter operates the pump, the second is left to pull 200' of booster through rough terrain covered with low-lying undergrowth. At the fatal fire, the pump was left unattended and each of the two fire fighters advanced a separate booster line up to 200' in opposite directions from the engine.

Fire fighters operating at an emergency incident must always operate in teams of two or more. Such a buddy system permits fire fighters to share work, thereby reducing the metabolic heat they produce and reducing the heat stress.

Nevada Occupational Safety and Health Review Board, Administrator of the Division of Occupational Safety & Health v. Clark County Fire Department (Statement of Position and Stipulation), Docket No. 89-385, October 1990.

Citing that the Clark County Fire Department had prior knowledge that units staffed with three personnel were unsafe, the Nevada Department of Occupational Safety and Health issued a complaint that the Fire Department had willfully violated the industry standards relating to fire fighter safety. In late 1990, the NDOSH 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, staffed with less than four persons."

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

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

Office of the Fire Marshal of Ontario, "Fire Ground Staffing and Delivery Systems Within A Comprehensive Fire Safety Effectiveness Model," December 3, 1993.

In 1993, the Fire Marshal of Ontario (Canada) Research Project conducted a study to thoroughly examine the tasks which three and four-person crews could safely

accomplish. The study specifically noted the crucial role played by response times in avoiding flashover conditions. It concluded that “after flashover, the opportunity for successful rescue from other areas in the structure rapidly diminishes.” It also concluded that, once flashover occurs, “there is an increased fire fighting demand if intervention does not take place prior to flashover.”

Onieal, Denis G., “In Response to the Demand for Fire Department Cutbacks,” Ed.D, Fire Engineering, August 1993.

This study concludes that the only reliable available research data obtained under fire conditions indicate that four is the minimum staffing level for a fire fighting engine or ladder company. Cited research firmly and unequivocally concludes that for an engine company or ladder company, the minimum acceptable staffing level is four. That number of fire fighters is the minimum number required to successfully accomplish the fireground tasks required within an acceptable time period. Four is not the number at which negotiations begin, but it is the absolute bare minimum required for an effective and efficient fire company.

Roberts, Bill, Fire Chief, City of Austin, “The Austin Fire Department Staffing Study,” March 1993.

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, 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, preparation or the training of fire fighters, loss of life and property increases when a sufficient number of personnel are 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 fire fighter 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 from 1989 to 1992 to which 1,938

fire fighters responded. 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.

15. If it is deemed that more than four are required, how do you determine whether five or six is the correct number? (5.2.2.1.2)

Deployment using the NFPA 1710 Standard's mandatory requirements for a benchmark fire would typically be met by a response of two engines (each staffed with four members), a truck (staffed with four members) and a chief's vehicle (staffed with a supervisory officer and an aide). However for a high hazard response, four engines, two ladders, a heavy rescue, an EMS unit and two chief vehicles may be required with additional staffing on each of the companies. The number of additional fire fighters above four is predicated on the specific duties to be accomplished at these high hazard locations as well as the time requirements associated with initiating these tasks.

The Technical Committee considered various studies in developing this section of the standard. Some of these studies are described below:

Brunacini, Alan V., "Shrinking Resources vs. Staffing Realities," NFPA Journal, May/June 1992; pp. 28 & 120.

Chief Alan Brunacini concludes that it is illogical to maintain that the requirements, capabilities and conditions of fire department operations differ from one place to another. Fire conducts, convects and radiates the same all over North America. As such, two fire fighters cannot conduct a primary search that requires six fire fighters for effective completion in a survivable time frame.

Casey, James F., "Manpower - How Much Do You Need?," Fire Engineering, October 1969; pp. 111-113.

James Casey concludes that staffing levels are the key to successful fire fighting operations. Response must be prompt and adequate. In order to ensure full potential of personnel and equipment, engine companies should be staffed with no fewer than five personnel. Ladder companies should be staffed with no fewer than six personnel.

Centaur Associates (conducted for FEMA), "Report on the Survey of Fire Suppression Crew Size Practices," June 30, 1982; pp. 18-20.

In 1982, the U.S. Fire Administration conducted a survey of over 150 fire departments to evaluate current crew size and standard response practices. The study determined that there was a direct correlation between fire fighter safety and the number of personnel