

- - -

**PROVIDENCE FIRE DEPARTMENT
STAFFING STUDY**

EXECUTIVE DEVELOPMENT

BY: J. Curtis Varone
Providence Fire Department
Providence, RI

An applied research project submitted to the National Fire Academy
as part of the Executive Fire Officer Program

November 1994

ABSTRACT

The Providence Fire Department Staffing Study in 1990-1991 determined that the costs of adding a fourth person to three-person companies was offset by lower injury costs. The problem which prompted this research project was that while an actuary analyzed the study data from an economic standpoint, the data were never analyzed from the perspective of firefighter safety. As a result, the full implications of the study, in terms of firefighter safety, were not known.

The purpose of this research was to examine the study data and determine what effect increased staffing had on firefighter safety. The historical research method was used. The research questions were

1. Are there nationally recognized staffing standards or formulas for firefighters?
2. How do injuries occurring during the control period compare with those in the study period?
3. How does the time lost due to injury during the control period compare with the time lost during the study period?
4. Are there factors other than staffing that could have affected the results?
5. How do the study results relate to the nationally recognized staffing levels?

An exhaustive literature review was conducted. The department's Injury/Exposure Database was queried to determine pertinent injury information.

The only nationally recognized staffing standard found came from the National Fire Protection Association, which recommended a minimum of four firefighters responding on or with each apparatus. The study data showed that four-person staffing led to a 23.8 percent reduction in injuries, a 25 percent reduction in time lost injuries and a 71 percent decrease in time lost due to injury when compared to three-person staffing. These results led to the conclusion that four-person staffing substantially reduced the number and the severity of injuries compared with three-person staffing.

The recommendations were that the Providence Fire Department continue working toward staffing all companies with four persons. Additional research was recommended to analyze injuries in the years subsequent to the study to determine if the trend continued; attempt to validate the results of the Providence study; identify factors causing injuries in three-person versus four-

person companies; and help resolve labor disputes pertaining to staffing in other departments.

INTRODUCTION

In May of 1990, after several tumultuous years of labor unrest¹, the city of Providence, Rhode Island, agreed to study the effects of increased staffing on firefighter safety. The agreement to conduct a "staffing study" became part of the 1990-1992 collective bargaining agreement between the City and Providence Firefighters Local 799, International Association of Fire Fighters (IAFF).

Since the early 1970s the minimum staffing in engine and ladder companies in Providence was three members: one officer and two firefighters. The firefighters' union had long argued that three-person staffing was unsafe and was leading to increased injuries ("Fire manpower short," 1977; "Too much equipment, not enough men," 1972). The city responded with a variety of explanations, including the fact that the number of fires in Providence had declined over the years, that stations were close together, and that personnel on scene, not personnel on apparatus, had the greatest impact on firefighter safety ("Arbitrator's report," 1990).

The agreed-upon staffing study was conducted from September 1, 1990 to February 28, 1991. During this time, the minimum staffing on each of the three busiest engine companies and three busiest ladder companies was increased from three to four members (one officer and three firefighters). The control period for the study was September 1, 1989 to February 28, 1990. It was determined that the six companies were staffed with three members throughout the control period.

The purpose of the staffing study was to determine, strictly from an economic standpoint, whether the costs of assigning additional personnel at overtime rates to the six "study" companies, would be offset by a savings in terms of a reduction in injury pay, overtime, and medical bills.² The results of this "economic" analysis would then lead to one of three options: a reinstatement of three-person staffing if no savings was recognized, maintaining the additional staffing if there was no net cost; or increasing staffing beyond the additional six members if a cost savings was recognized.

The results of the study were analyzed at the conclusion of the study period by an actuary. A preliminary report was issued by the actuary indicating the increased staffing had led to a substantial savings to the city. (See Appendix A.) As a result, nine additional firefighters per shift were assigned. However, no additional analysis of the data obtained during the staffing study was conducted.

The problem which prompted this research project was that while the staffing study data had been superficially analyzed from an economic

- -

standpoint, they had never been analyzed from the perspective of firefighter safety. As a result, the full implications of this costly study, in terms of firefighter safety, injury rates, and appropriate, safe staffing levels, were not known. Analyzing this information would help the Providence Fire Department determine appropriate, safe staffing levels and improve firefighter safety. Publishing the results of the study also would help the fire service grapple with the thorny issue of minimum staffing.

The purpose of this research was to analyze the results of the Providence Fire Department Staffing Study to determine what effect increased staffing had on firefighter safety. In conducting this research, the historical method was utilized. The following research questions were posed:

1. Are there any nationally recognized staffing standards or formulas for firefighters?
2. How do injuries occurring during the control period compare with those in the study period?
3. How does the time lost due to injury during the control period compare with the time lost during the study period?
4. Are there factors other than staffing that could have affected the results of the study?
5. How do the study results relate to the nationally recognized staffing levels?

BACKGROUND AND SIGNIFICANCE

Providence

The City of Providence, Rhode Island, covers an area of approximately 20.5 square miles, with a resident population of 160,000 that swells to more than 260,000 on the average workday (D. Price, personal communication, September 30, 1994; Providence City Directory, 1993). Providence is the capitol of Rhode Island, and is the home of many major institutions, including Brown University, Providence College, Rhode Island School of Design, Rhode Island College, Johnson & Wales University, Rhode Island Hospital, Roger Williams Hospital, and Women & Infants Hospital.

In many ways Providence is a typical northeastern city, with a housing stock consisting primarily of closely spaced three-story wood-frame tenements. Besides a sizable downtown that includes dozens of highrise buildings, the city

landscape is dotted with sprawling mill complexes that date back to the 1800s (Conley & Campbell, 1985).

Providence has some unique problems as well. According to Conley and Campbell (1985), during the late 1940s the population of Providence was approximately 250,000. Thereafter, as the population shifted to the suburbs, Providence was left with a high vacant building rate. The 1960s and 1970s saw a tremendous increase in building fires while the tax base decreased correspondingly.

Providence is home to a large number of jewelry manufacturers. These manufacturers typically use large quantities of hazardous materials in the jewelry process, including cyanides and acids. The Port of Providence handles large volumes of hazardous materials, including liquefied natural gas (LNG), liquefied petroleum gas (LPG), gasoline, fuel oil, chlorine, and anhydrous ammonia ("Living with chemicals," 1991).

Compounding the above hazards is the fact that Providence is home to a large number of tax-exempt institutions. In 1993, 46 percent of the real estate in the city was tax exempt (Mingis, 1993). With a dwindling tax base, local politicians have repeatedly attempted to find ways of reducing municipal expenditures. The closing of fire companies and the staffing of apparatus with three firefighters for much of the 1970s and 1980s was a reflection of this problem (A. F. Bertoncini, personal communication, August 9, 1994).

Fire Department

The Providence Fire Department has a long and splendid tradition dating back as early as 1754 (Conley & Campbell, 1985). The department became fully paid in 1854, and, at its height, operated 24 engine companies and 13 ladder companies (R. G. Vernon, personal communication, October 1, 1994). According to Conley and Campbell (1985), in the late 1800s firefighters worked 7 days a week, 24 hours a day, and were granted 2 days off per month. This system eventually gave way to a 2-platoon, 84-hour-a-week system in 1923. By 1955, there were three platoons, each working 56 hours per week.

In the late 1800s, engine and hose wagons typically were staffed with 7 to 9 men, and ladder companies were staffed with 9 to 11 men³ (Joslin, 1881). By 1950, the staffing levels were reduced to five- and six-man engine companies, and six- or seven-man ladder companies (A. F. Bertoncini, personal communication, August 9, 1994).

During the control and study periods, the Providence Fire Department operated 15 engine companies, 8 ladder companies, and 5 advanced life

support rescue companies (ambulances). The companies were divided into three battalions, two of which were supervised by Battalion Chiefs, and one of which was supervised by a Deputy Assistant Chief.

Prior to the study, engine and ladder companies were staffed with a minimum of three members, with the exception of Engine 1 which was already staffed with a minimum of four members.⁴ Typically, four members were assigned to each company on each shift. However, due to injury, illness, or vacation, companies operated with three members. Throughout the control and study periods, the five rescue companies operated with two members assigned. At the time of the study, the two Battalion Chiefs and the Deputy Assistant Chief did not have aides. This made the total staffing for a given shift 83 members, prior to the staffing study. If, for any reason, staffing fell below 83 members, overtime was used to ensure that 83 members were on duty.

During the 6-month staffing study the minimum staffing per shift was increased to 89. The additional firefighters were assigned to work on the three busiest engine companies (Engines 3, 8, and 10) and the three busiest ladder companies (Ladders 1, 2 and 5). Overtime was used to maintain the additional six personnel per shift.

Firefighters worked an average of 42 hours per week on a 4-platoon system. Each platoon (referred to as a "Group") worked 2 consecutive 10-hour days (8:00 a.m. to 6:00 p.m.), 2 consecutive 14-hour nights (6:00 p.m. to 8:00 a.m.) followed by 4 consecutive days off.

This research paper was prepared to satisfy the applied research project requirement associated with the Executive Development course at the National Fire Academy. This research relates to the problem-solving unit of the Executive Development course by using a formalized, documented, systematic approach to solving complex, critical problems.

Although the staffing study was completed in 1991, the results continue to have significance to the Providence Fire Department and to the fire service in general, in terms of determining and maintaining appropriate staffing levels. Furthermore, the Providence Fire Department has come under a great deal of public criticism by politicians and the media for having what is perceived as too many firefighters ("Cianci's next challenge," 1994; Frank, 1993). This research provides an analytical framework from which the Providence Fire Department can evaluate and respond to these criticisms.

LITERATURE REVIEW

The subject of minimum staffing has become one of the most controversial subjects in the history of the fire service (Clark, 1994). This subject has polarized groups representing firefighters and fire chiefs, paid firefighters and volunteers, and firefighters and city managers (Butters, 1992; Erwin, 1993; Whitehead, 1992).

In the past, staffing levels have in large measure been viewed as a matter of firefighting "efficiency" as opposed to firefighter safety (O'Hagan, 1984). Only recently has the issue of staffing become linked to firefighter safety (Clark, 1994). In fact, early writings on the subject of staffing in the National Fire Protection Association *Fire Protection Handbook* (NFPA FPHB) were completely devoid of any reference to firefighter safety as a consideration in determining recommended staffing levels (NFPA FPHB, 1954, 1967).

In 1954, the 11th edition of the NFPA *Fire Protection Handbook* cited the National Board of Fire Underwriters' recommendation for minimum staffing of seven members on engine and ladder companies assigned to or near high-value districts, and five members on engines and six members on ladders in other districts. However, by 1969 the NFPA-recommended minimum staffing level was down to four members per engine or ladder (NFPA FPHB, 1969).

In September of 1959, the National Board of Fire Underwriters issued a "Special Interest Bulletin" on the subject of company level staffing. This report analyzed the problem of staffing in light of recent reductions in the working hours of firefighters, but maintained that staffing should remain at a minimum of five members, with six or seven being considered optimum for high hazard areas. In establishing these recommendations, the principal consideration was the efficiency of various crew sizes, not firefighter safety. In fact the only reference to firefighter safety in the entire report was a statement concluding that it was unsafe to allow one firefighter to enter a building alone.

Cortez in 1991 attributed the linkage of staffing to concerns over efficiency with the fact that many of the early writers who addressed the subject of staffing were merely reciting staffing concepts developed by the insurance-based groups, such as the Insurance Services Organization (ISO). Understandably, the ISO's primary concern focused upon firefighting efficiency as a function of fire "risk."

In 1984, O'Hagan wrote a series of articles in *Fire Engineering* about a staffing study conducted by the Dallas Fire Department. He traced the history of staffing recommendations from their early development by insurance companies all the way to the earliest attempts to scientifically measure the "effect of crew sizes on the efficiency of fire strategies and tactics" (O'Hagan, 1984a, p. 16).

- - -

The Dallas study consisted of measuring the time necessary for three-, four-, and five-person crews to accomplish specific tasks during fireground simulations. The results of the Dallas staffing study were best summarized by the following quote from O'Hagan:

As a general rule, the Dallas study indicates that staffing below a crew size of four can overtax the operating force and lead to higher losses. This does not suggest that assignments in the simulations were not carried out acceptably by three-person crews, nor does it ignore the demonstrated ability of three-person crews in controlling test fires. Some of the simulations employed taxed a four-person crew beyond its limits and suggested that a five-person crew would have been more appropriate. These cases are the exception to the rule, however (O'Hagan, 1984, p. 18).

Collectively, the NFPA *Fire Protection Handbook*, the National Board of Fire Underwriters, Cortez, and O'Hagan influenced this research by revealing the fact that the earliest staffing recommendations did not address firefighter safety in any significant manner. As such, it would be inappropriate to rely upon these staffing recommendations in determining a minimum safe staffing level.

Whitehead⁵ wrote in 1992 that minimum staffing was directly related to firefighter safety. He cited numerous statistics and unpublished research tending to show that injuries increased dramatically when staffing went below four firefighters per apparatus.

Stapleton, in 1992, wrote about his experiences in the Boston Fire Department. He concluded that while improvements over the years in equipment have made the job of firefighting less "primitive," they have not lessened the need for appropriate staffing. Stapleton felt the driving force behind staff reductions was purely economic. He noted that as the wages of firefighters increased, personnel reductions followed.

By the start of the 1960s, the seven- and six-member companies were reduced to six and five. In the 1970s, the numbers shrunk to five and four and at the start of the 1980s, all companies, ladder and engine, had only four personnel responding per unit. At one point in 1981, the administration reduced staffing to three members, but there were so many additional injuries that this truly unsafe policy was reversed in a short period of time (Stapleton, 1992, p. 3).

The writings of Whitehead and Stapleton influenced this research by providing support for the position that staffing apparatus with less than four firefighters will lead to an increase in injuries.

- -

On the other side of the staffing issue, Erwin (1993) wrote against the need for a minimum staffing standard. Erwin cited the decline in firefighter deaths witnessed in recent years as justification for leaving the status quo in the issue of minimum staffing. He went so far as to use statistics taken from the National Safety Council and the NFPA to show that the occupational death rate for career firefighters is below that of several other occupations, including commercial fishermen, miners, and loggers.⁶ Erwin expressed a concern that mandated minimum staffing would lead to municipalities having to close some stations to staff others, thereby increasing response times. This would result in increased fire losses and more civilian fire casualties.

Petersen, in 1992, similarly wrote against a nationally recognized minimum staffing standard. Focusing on the reduction of firefighter deaths, Petersen argued that it was firefighters who engaged in unsafe acts, regardless of staffing levels, that ultimately led to deaths and injuries.

The International Association of Fire Chiefs (IAFC), in a position paper on the issue of staffing, stated that the matter of minimum staffing was best left up to the local jurisdiction (Halsey & Briese, 1992). The IAFC position was that local conditions had to be taken into account in determining appropriate staffing levels, and that there was a variety of factors that collectively exerted a greater influence over firefighter safety than staffing. These factors included reinforcement of basic firefighting training concepts; incident command systems; personnel accountability systems; physical fitness programs; no-smoking policies; improved personal protective clothing; and mandatory seat belt use to name a few.

Erwin, Petersen, and the IAFC provided counterarguments to the positions of Whitehead and Stapleton. However, the influence of these writers upon this research was diminished by the fact that, despite the rhetoric, none of the three was willing to affirmatively advocate staffing apparatus with fewer than four persons.

In 1987, the NFPA released NFPA 1500, *Fire Service Occupational Safety and Health Program*. This was the first nationally recognized standard that addressed firefighter safety in a comprehensive manner (NFPA 1500, 1987).

According to the 1987 edition of NFPA 1500, the recommended minimum staffing level was four firefighters responding on or arriving with each engine and ladder company. In high-risk areas the recommended staffing level should be increased to five on an engine and six on a ladder. This recommendation appeared to be the first time that a staffing standard was based upon firefighter safety, as opposed to firefighting efficiency, as the principal criterion. This

- - -

staffing standard was included as a recommendation only, in the nonmandatory "appendix" section of NFPA 1500, instead of the main body of the standard.⁷

In 1992, the NFPA issued the second edition of NFPA 1500 amidst a great deal of controversy over whether the minimum staffing requirement should be in the standard itself, or in the appendix ("Firefighters double-crossed on safety," 1992). When released on August 14, 1992, the only reference to minimum staffing remained in the appendix to NFPA 1500.

In July of 1993, the NFPA Standards Council issued an amendment to NFPA 1500, which required that at least four members be assembled on scene before interior firefighting operations could be initiated at working structure fires (NFPA Standards Action, 1993). In April of 1994, the Standards Council released an interpretation of this amendment to require that "when a company is dispatched from the fire station together as a unit (which includes both personnel responding on or arriving with apparatus) rather than from various locations, the standard (in the Appendix) recommends that the company should contain a minimum of four firefighters" (NFPA Standards Action, 1994, p. 11).

The recommendations found in NFPA 1500 pertaining to staffing influenced this research by providing the clearest articulation of a nationally recognized staffing standard based squarely upon firefighter safety as the primary consideration.

PROCEDURES

The research procedure used in preparing this paper consisted of a literature review that was conducted initially at the Learning Resource Center at the National Fire Academy in July of 1994. Additional literature review was conducted in Providence, Rhode Island, as well as the author's personal library during August and September of 1994.

Alfred F. Bertoncini, the Chief of the Providence Fire Department, was interviewed as well as a fire department historian, Raymond G. Vernon, to gather additional background information of the Providence Fire Department. Darlene Price of the Providence Department of Economic Planning and Development provided background information on the City of Providence.

The 1990-1992 and 1992-1995 collective bargaining agreements between IAFF Local 799 and the City of Providence were examined, together with departmental files pertaining to the staffing study. Additional data, pertaining to activity levels of the department during the control and study period, were obtained from the Fire Prevention Bureau of the Providence Fire Department.

- -

The injury data for the time periods in question were analyzed utilizing the Providence Fire Department Injury/Exposure Database. The database was queried to determine the number of reported injuries, the number of injuries where the member had to report off duty, and the time lost associated with injuries. These data then were classified according to company and month. A composite of all companies and all divisions also was taken.

The results of these queries were then transferred into a computerized spreadsheet. Data were analyzed utilizing the statistical tools of the spreadsheet. Activity level data also were analyzed utilizing a computerized spreadsheet.

Limitations

The injury data used in conducting this research came from the Providence Fire Department Injury/Exposure Database. These data were not the same data used by the actuary who analyzed the economic impact of the staffing study. The actuary utilized daily manpower sheets and weekly injury summaries for his determinations. Both the Injury/Exposure Database and the sources used by the actuary are subject to minor errors such as data entry mistakes, typographical errors, and the failure of members to follow prescribed reporting procedures.

The data used by the actuary was based upon information available as of March of 1991 (Frank, 1993). At that time, there were members who had been injured during both the control and study periods who had not returned to work. As a result, the time lost figures used by the actuary were incomplete. The figures that were utilized in this research were complete figures, available in August of 1994.

In conducting this research the author was limited in the scope of his analysis by the data collection systems in place during part of the control period. The injury report forms used by the Providence Fire Department to document injuries were significantly modified on January 1, 1990. The pre-1990 forms did not categorize injuries by type of incident (structure fire, nonstructure fire, responding/returning, in station, etc.), type of injury (sprain, strain, laceration, fracture, etc.), or body part injured. Therefore, a detailed analysis of these factors for the first four months of the control period could not be conducted.

Without the availability of this information for comparison purposes, an indepth analysis of the types of study period injuries, and where they occurred, would not be valid. For this reason the author has purposely limited the scope of his analysis to the total numbers of injuries, time loss injuries, and time lost due to injuries during the control and study periods.

Use of the period from September 1989 to February 1990 as the control period is another limitation. There is no documentation to establish that the conditions that existed during the study period were identical with the conditions that existed during the control period.

Another limitation is the possibility of bias on the part of study participants. During the study period, Providence firefighters were aware of the fact that a staffing study was being conducted, and the possible ramifications of the study results. Participant bias simply cannot be ruled out in this case. However, the data from the control period would not be subject to this limitation since the study had not yet been conceived during the control period.

This study was conducted in a fairly active paid professional fire department that used traditional engine and ladder (truck) companies as the primary means of delivering fire protection services. The relevance of this study to less active fire departments, to volunteer fire departments, or to fire departments that do not operate traditional engine and ladder companies would also be a limitation.

Definitions

Code Red:	The term "Code Red" was used in the Providence Fire Department as a code word for a working structure fire.
Injury:	The term injury as used in this paper refers to the Providence Fire Department definition of injury. This includes any bodily injury sustained while on duty, or any illness which was sustained or contracted in the line of duty. It expressly includes certain presumptive illnesses, including hypertension, heart disease, lung disease, and cancer.
Injury Exposure Database:	All injuries and exposures incurred by members of the Providence Fire Department were documented and records maintained in an Injury/Exposure Database. The database was created utilizing a relational database for an IBM-compatible computer. Providence firefighters were required by rules and regulations to report all injuries, regardless of how significant, on prescribed reports. These reports then were processed at Fire Department Headquarters and entered into the database by the Department Safety Officer, or his designee.

Time Loss
Injuries:

The term "time loss injury" refers to injuries which result in the member having to report off duty. All time loss injuries that occurred during the control and study periods were documented by the Fire Department Physician: (a) within 24 hours of occurrence, (b) prior to the member returning to duty, and (c) periodically in between.

RESULTS

1. Are there any nationally recognized staffing standards or formulas for firefighters?

The earliest recommended staffing levels were promulgated by organizations such as the Insurance Services Office and the National Board of Fire Underwriters, which viewed staffing primarily in terms of firefighting efficiency, not firefighter safety (Cortez, 1991; NFPA FPHB, 1954). These nationally recognized staffing standards called for a minimum of six-person engine companies and seven-person ladder companies.

The 1987 edition of NFPA 1500 stated in the nonmandatory appendix that, "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. Companies responding in high-risk areas should have a minimum acceptable staffing of six firefighters on ladder companies and five firefighters on engine companies" (NFPA 1500, 1987, p. 20).

The 1992 edition of NFPA 1500, as amended in 1993, had language similar to the 1987 edition, but went further by requiring that, "At least four members shall be assembled before initiating interior firefighting operations at a working structure fire."

These were the only nationally recognized staffing standards that an extensive literature review located. However, not all parties agreed with the appropriateness of these standards. The IAFC, among others, advocated the position that staffing was a matter of local concern that could only be addressed by considering local conditions (Halsey & Briese, 1992).

Nevertheless, the author's research has found no authoritative sources that affirmatively advocate that engine and ladder companies be staffed with fewer than four members. In fact, not even the most vocal opponents of the NFPA's four-person minimum staffing standard have publicly advocated a set number of fewer than four.

2. How do the numbers of injuries occurring during the control period compare with the numbers of injuries occurring during the study period?

Table 1 shows the number of injuries reported by each study company during the six-month control period, from September 1, 1989 to February 28, 1990. Table 2 shows the number of injuries reported in the study companies during the study period, from September 1, 1990 to February 28, 1991.

There were 42 injuries reported during the control period in the study companies. During the study period there were 31 injuries. This represents a 23.8 percent drop in the number of reported injuries in the study companies.

Table 3 shows the number of "time loss injuries" (injuries where a member had to report off duty due to the injury) reported during the control period, while Table 4 shows the number of time loss injuries reported during the study period. Time loss injuries dropped from 31 during the control period to 23 during the study period. This represents a 25 percent drop in time loss injuries when staffing was increased.

**Table 1
Total Injuries - Control Period**

COMPANY	SEP 89	OCT 89	NOV 89	DEC 89	JAN 90	FEB 90	TOTAL
E-3	1	2	2	3	1	0	9
E-8	2	1	3	2	0	0	8
E10	2	1	2	1	1	0	7
L-1	2	0	0	0	2	0	4
L-2	0	2	0	1	1	1	5
L-5	1	1	2	2	3	0	9
TOTAL	8	7	9	9	8	1	42

**Table 2
Total Injuries - Study Period**

COMPANY	SEP 90	OCT 90	NOV 90	DEC 90	JAN 91	FEB 91	TOTAL
E-3	0	0	0	0	1	0	1
E-8	2	0	2	1	2	1	8
E10	2	0	0	1	1	0	4
L-1	0	0	2	0	1	0	3
L-2	1	1	1	1	2	1	7
L-5	0	4	1	0	3	0	8
TOTAL	5	5	6	3	10	2	31

- - -

Table 3
Time Loss Injuries - Control Period

COMPANY	SEP 89	OCT 89	NOV 89	DEC 89	JAN 90	FEB 90	TOTAL
E-3	1	0	1	2	0	0	4
E-8	2	1	3	1	0	0	7
E10	2	1	2	1	0	0	6
L-1	2	0	0	0	1	0	3
L-2	0	1	0	1	0	0	2
L-5	1	1	2	2	3	0	9
TOTAL	8	4	8	7	4	0	31

Table 4
Time Loss Injuries - Study Period

COMPANY	SEP 90	OCT 90	NOV 90	DEC 90	JAN 91	FEB 91	TOTAL
E-3	0	0	0	0	0	0	0
E-8	1	0	2	1	2	0	6
E10	2	0	0	1	1	0	4
L-1	0	0	2	0	1	0	3
L-2	0	1	0	1	2	1	5
L-5	0	3	0	0	2	0	5
TOTAL	3	4	4	3	8	1	23

3. How does the time lost due to injury during the control period compare with the time lost during the study period?

During the control period, there were 1,832 shifts lost due to injury among the study companies. (See Table 5.) During the study period, there were 531 shifts lost due to injury. (See Table 6.) This represents a 71 percent decrease in the time lost due to injury in the study companies with the increased staffing.

4. Are there factors other than staffing that could have affected the results of the study?

According to Karter and LeBlanc (1993), 68 percent of firefighter injuries occur at emergency scenes. Another 6 percent occur responding to or returning from incidents. Thus, at least 74 percent of firefighter injuries (on a national level) are attributable to the number of incidents to which firefighters respond.⁸

Thus, the most likely explanation for the observed decrease in injuries in the study companies would be a decrease in either fires or incident volume during the study period as compared with the control period.

Tables 7 and 8 show the activity levels of the study companies during the control and study periods. Overall responses of the study companies during the study period declined 3 percent during the control period, decreasing from 6,152 during the control period to 5,956 in the study period.

Tables 9 and 10 show the number of working structure fires that the study companies responded to during the control and study periods. Study companies collectively responded to 415 code reds during the control period, and 413 during the study period, a decrease of 0.5 percent. Thus, study companies responded to virtually the same number of working structure fires during the study period as they did during the control period.

Table 5
Time Lost-Control Period (Shifts Lost Due To Injury)

COMPANY	SEP 89	OCT 89	NOV 89	DEC 89	JAN 90	FEB 90	TOTAL
E-3	47	0	9	15	0	0	71
E-8	48	74	359	6	0	0	487
E10	89	1	171	3	0	0	264
L-1	237	0	0	0	39	0	276
L-2	0	12	0	77	0	0	89
L-5	31	1	19	228	366	0	645
TOTAL	452	88	558	329	405	0	1,832

Table 6
Time Lost-Study Period (Shifts Lost Due To Injury)

COMPANY	SEP 90	OCT 90	NOV 90	DEC 90	JAN 91	FEB 91	TOTAL
E-3	0	0	0	0	0	0	0
E-8	5	0	3	40	65	1	114
E10	18	0	0	42	14	0	74
L-1	0	0	208	0	13	0	221
L-2	0	7	0	2	12	29	50
L-5	0	60	0	0	12	0	72
TOTAL	23	67	211	84	116	30	531

Table 7
Runs-Control Period

COMPANY	SEP 89	OCT 89	NOV 89	DEC 89	JAN 90	FEB 90	TOTAL
E-3	311	292	257	292	292	236	1,680
E-8	269	291	251	275	258	228	1,572
E10	276	274	238	250	201	217	1,456
L-1	108	101	85	104	98	92	588
L-2	57	58	63	72	51	60	361
L-5	76	88	81	94	88	68	495
TOTAL	1,097	1,104	975	1,087	988	901	6,152

- -

Table 8
Runs-Study Period

COMPANY	SEP 90	OCT 90	NOV 90	DEC 90	JAN 91	FEB 91	TOTAL	CHANGE
E-3	278	312	290	289	235	243	1,647	-33
E-8	278	273	261	274	237	232	1,555	-17
E10	241	247	239	241	211	194	1,373	-83
L-1	91	93	93	83	84	64	508	-80
L-2	71	78	74	75	64	55	417	56
L-5	82	75	80	81	73	65	456	-39
TOTAL	1,041	1,078	1,037	1,043	904	853	5,956	-196

Table 11 shows the overall activity level for the Providence Fire Department during the three-year period 1989 to 1991. The overall activity level, in terms of runs, code reds, and multiple alarms, remained fairly constant over the three-year period.⁹ Thus, there was no dramatic change in the numbers of runs, working fires, or multiple-alarm fires that would account for a significant change in the number and severity of firefighter injuries.

Another factor that could have influenced the results of the study would be improvements in firefighter safety implemented between the control and study periods. According to the chief of the Providence Fire Department, Alfred F. Bertoncini (personal communication, August 9, 1994), the protective clothing used by members during the study and control periods did not change. No new safety or operational procedures were implemented. No significantly new or different equipment was purchased, and no substantive changes were made in the training curriculum. There were no new programs such as a physical fitness program, accident prevention program, or a comprehensive occupational safety and health program instituted during the time period in question. The department physician and all policies concerning injury leave remained the same.

Table 9
Code Reds-Control Period

COMPANY	SEP 89	OCT 89	NOV 89	DEC 89	JAN 90	FEB 90	TOTAL
E-3	6	13	11	12	16	10	68
E-8	2	12	15	12	10	9	60
E10	10	10	13	18	13	14	78
L-1	9	12	11	14	16	13	75
L-2	5	12	12	10	11	8	58
L-5	10	10	13	17	13	13	76
TOTAL	42	69	75	83	79	67	415

Table 10
Code Reds-Study Period

COMPAN Y	SEP 90	OCT 90	NOV 90	DEC 90	JAN 91	FEB 91	TOTAL	CHANGE
E-3	6	9	17	15	9	9	65	-3
E-8	12	12	13	17	16	4	74	14
E10	10	8	15	20	13	7	73	-5
L-1	9	8	17	12	9	6	61	-14
L-2	12	12	13	16	17	4	74	16
L-5	9	8	12	18	14	5	66	-10
TOTAL	58	58	87	98	78	35	413	-2

Table 11
Activity Level-Department-Wide

YEAR	RUNS	CODE REDS	MULTIPLE ALARMS
1989	36,350	329	11
1990	36,581	310	13
1991	36,942	356	13

Table 12

	CONTROL PERIOD			STUDY PERIOD		
	Time Loss			Time Loss		
	Injuries	Injuries	Shifts Lost	Injuries	Injuries	Shifts Lost
Study Companies	42	31	1,832	31	23	531
Department-Wide	152	115	6,230	134	92	3,702
EMS, HQ, Fire Prev.	34	21	754	41	25	961

An indication that a factor other than staffing influenced the results of the study would have been a corresponding decrease in injuries across the board in all companies. Table 12 shows the injury data totals for both the study companies and the entire department during the control and study periods. Department-wide, injuries decreased 11.8 percent during the study period, from 154 during the control period to 134 during the study. Time loss injuries decreased from 115 to 92, for a 17.4 percent decrease. Time lost due to injury decreased from 6,230 shifts down to 3,702 shifts, for a 41 percent decrease.

Most of the observed decreases were attributable to the decreases in the study companies, although some decreases occurred in nonstudy companies as well, albeit to a lesser extent. However, the decreases observed in the nonstudy companies were not of the same magnitude as those observed in the study companies.¹⁰ Therefore, there is no evidence of a factor other than staffing that would account for the decreases observed.

- - -

5. How do the results of the study relate to the nationally recognized staffing levels?

The number of injuries, the number of time loss injuries, and the time lost due to injuries all decreased substantially in the four-member study companies during the study period, as compared with three-person study companies during the control period. These results support the NFPA recommended minimum safe staffing level of four firefighters per engine and ladder company.

These statistics also support the anecdotal information of writers such as Stapleton and Whitehead that four-person staffing will reduce firefighter injuries when compared with three-person staffing.

DISCUSSION

It is difficult to recall a subject that has factionalized the fire service more than the subject of minimum safe staffing has over the past three years. Partisan camps have formed, political wagons have been circled, and substantiated rhetoric has been propounded on both sides of the issue. In many cases, the parties cannot even reach agreement on the issue to be addressed, as the battle lines seem to be drawn over how to frame the question.¹¹

The best hope for a sound, rational solution to this difficult problem will come from continued research into the impact that staffing has on firefighter safety. The Providence Fire Department Staffing Study should be looked upon as one more piece in an emerging mosaic that indicates that staffing engine and ladder companies with fewer than four persons will lead to more frequent injuries, as well as injuries which are more serious in terms of time lost.

The literature review confirmed the fact that the earliest attempts at establishing standardized staffing levels looked to firefighting efficiency as the primary, if not sole, consideration. That being the case, firefighting efficiency was perceived as the only "real" issue that politicians, city managers and fire chiefs saw as they dealt with dwindling resources by reducing staffing. Since, historically, staffing reductions were considered to be purely economic decisions by fire department managers, objections to staffing reductions from firefighters were easily dismissed, even by well-meaning fire chiefs, as partisan bias.

In Providence, the minimum staffing of apparatus with three persons coincided with the reduction in hours to 42 per week. The literature review showed that, historically, reductions in working hours or increases in other benefits were commonly associated with reductions in staffing. Thus, in Providence, as Stapleton found to be the case in Boston, it was economics, not

- - -

firefighting efficiency or firefighter safety, that dictated the minimum staffing level of three members per apparatus.

The results of the Providence Fire Department Staffing Study showed that four-person companies operated during the study period sustained 24 percent fewer injuries than did the three-person companies that operated during the control period.

Furthermore, time loss injuries decreased by 25 percent in the 4-person companies. The number of time loss injuries is an important measure of injury severity. Only a member who sustained a relatively minor injury would remain on duty. The number of time loss injuries provides a measure of the more serious injuries that required the member to report off duty.

In addition, during the control and study periods, every time loss injury had to be verified by the department physician. This provided a more objective basis for comparison than was the case with all injuries, which included those injuries where the member remained on duty and chose not to be seen by a doctor.

The observed 25 percent decrease in time loss injuries is an indication that not only the number of injuries, but the severity of injuries decreased with the four-person staffing, as compared to three-person staffing.

Probably the most important statistic to come from the staffing study was the remarkable 71 percent decrease in time lost due to injury among the four-person study companies. Time lost due to injury is a vital measure of injury severity (i.e., recuperation time). It is an objective measure, since any time lost had to be approved and documented by the member's attending physician and the fire department physician.

Time lost due to injury carries with it the biggest price tag, in terms of Workers' Compensation payments and, in the case of Providence, overtime necessary to maintain minimum staffing in the absence of the injured member. Decreasing injuries **may** lead to decreased costs; decreasing time lost due to injury **will** lead to decreased costs. This is consistent with the findings of the actuary hired to examine the economic impact of the staffing study. Thus time lost due to injury is a very important measure of injury severity.

It is also worth noting that the time lost due to injury decreased in each of the six study companies over the course of the study period, from a minimum of a 20-percent decrease in Ladder Company 1, to a 100-percent decrease in Engine Company 3.

The decrease in injury-related statistics observed during the study becomes even more significant in light of the fact that the population being observed increased 25 percent during the study period. During the control period, 18 firefighters per shift (6 companies times 3 firefighters) accounted for 41 injuries, 31 time loss injuries and 1,832 shifts lost. Thus, there were 2.28 injuries, 1.72 time loss injuries, and 101.78 shifts lost per firefighter during the control period.

During the study, 24 firefighters (6 companies times 4 firefighters) accounted for 31 injuries, 23 time loss injuries, and 531 shifts lost. This resulted in 1.29 injuries, .96 time lost injuries, and 22.12 shifts lost per firefighter during the study. This equates to a 43-percent decrease in injuries, 44-percent decrease in time loss injuries, and a 78-percent decrease in time lost due to injuries during the study period when the number of firefighters being observed is taken into consideration.

During the staffing study the overall number of injuries for the remainder of the department (those not involved in the study) remained approximately the same. Excluding the study companies there were 110 injuries during the control period, and during the study period there were 103. Department-wide, time loss injuries and time lost due to injury both showed noticeable decreases.

However, the interpretation of the results of the study in regard to nonstudy engine and ladder companies is not as simple a matter as it may appear at first blush. It is complicated by the fact that additional personnel in the study companies may have had a "beneficial" effect on injuries and injury statistics in nonstudy companies.

For example, Engines 10, 11, 8, and Ladders 5 and 2 frequently responded to fires together in South Providence during the control and study periods. In such cases all companies operating at fire scenes during the study period, with the exception of Engine 11, would have had four members. It is plausible (and in the author's opinion probable) that the increased staffing on the study companies (Engines 10 and 8, Ladders 5 and 2) would have had a beneficial impact on the nonstudy company's (Engine 11's) injury statistics. This stands to reason because the additional personnel improve the operational efficiency of their own company, and would at times be available to assist understaffed companies with assignments such as laying feeders, raising ladders, advancing handlines, forcible entry, overhaul, etc.

As such, decreases in injuries, time loss injuries, and time lost due to injuries among nonstudy companies would have been expected, albeit to a lesser extent than that observed in the study companies themselves. Because the study companies were the busiest companies in the city, and frequently worked alongside nonstudy companies, it would be difficult, if not impossible, to

- -

quantify this beneficial effect. Therefore, this author believes it would be inappropriate to speculate further about the significance of injury data from the nonstudy companies.

What the author believes provides significant support for the validity of the study is the fact that the activity level of the study companies during the control and study periods remained so constant. The activity levels in terms of total responses of the study companies during the study period remained within three percent of the level for the control periods. Viewed another way, study companies averaged one fewer run per week during the study period than during the control period.

The number of fires to which the study companies responded remained within 0.5 percent, decreasing from 415 during the control period to 413 during the study. Thus the activity level of the study companies did not vary significantly between the control and study period, certainly not of a magnitude necessary to explain a 71 percent decrease in time lost due to injury.

Thus, the Providence Fire Department Staffing Study supports the conclusion that staffing engine and ladder companies with four persons will reduce injuries, in terms of frequency and severity, over engine and ladder companies staffed with three persons. The results also support the NFPA recommended minimum staffing of four firefighters per engine and ladder company as a matter of firefighter safety.

RECOMMENDATIONS

The Providence Fire Department has embarked upon a program to increase minimum staffing to four persons on as many additional companies as financially possible, given the present economic situation. Eight of 15 engine companies and 5 of 8 ladder companies operate with a minimum of 4 persons. Based upon the results of the study, it is recommended that this program continue. The goal of staffing all apparatus with four persons should continue to be accomplished through the collective bargaining process, and perhaps through personnel realignment, in order to avoid the need to close some companies to staff others.

Additional research and analysis of the Providence Fire Department Injury/Exposure Database should be conducted to determine if the observed decreases in injuries, time loss injuries, and time lost due to injury in the four person companies during the study remained low during the subsequent years. This information would help to validate the results of the study, and resolve concerns over the influence of participant bias in study results.

Research also should be conducted to look at the injury statistics from companies that received the increased staffing in the years after the study, to determine if comparable decreases in injuries were observed.

Additional research by other fire departments is needed to validate the results of the Providence study. Additional research also should attempt to determine the relationship between the activity level of the fire department, injuries, and staffing.

Additional research is needed to attempt to identify factors that influence injury rates in three-person versus four-person companies, something that in the Providence study could not be done because the reporting procedures during the first four months of the control period were inadequate. It may be possible to identify specific firefighting activities or operations that are associated with injuries in three-person companies that are not observed in four-person companies.

Fire departments that presently staff apparatus with three persons or fewer, and have experienced labor discord over the issue of staffing should consider trying a similar type of staffing study as a compromise. Such a study would help separate fact from fiction in regard to the validity of the safety benefits of four-person staffing. The tangible results of such a study then can be used to justify the appropriate staffing decision.

Fire service leaders need to ensure that the subject of minimum safe staffing is addressed on a rational, as opposed to emotional, level. Fire service leaders also must ensure that outdated paradigms that view staffing solely as a firefighting efficiency issue, are recognized as such. The firefighter safety aspect of staffing must be given the due consideration it deserves.

REFERENCES

- Arbitrator's report is hard on firefighters. (1990, March 15). *Providence Journal*, p. B1.
- Chiefs abandon firefighter safety. (1992, January-February). *International Firefighter*.
- Cianci's next challenge. (1994, November 17). *Providence Journal*, p. A18.
- Clark, B. (1994, February). Is there safety in numbers? *Fire Engineering*.
- Conley, P.T. and P.R. Campbell. (1985) Firefighters and Fires in Providence. Providence, RI: Rhode Island Publications Society.
- Cortez, L. (1991) Optimal staffing for fire attack. (Executive Fire Office Research Paper.) Emmitsburg, MD: National Fire Academy.
- Erwin, J.M. (1992, January). Firefighters see red: crew size and deaths or injuries are debated. *Public Management*.
- Firefighters double-crossed on safety. (1992, February). *International Firefighter*.
- Fire manpower short, union president says. (1977, December 14). *Providence Journal*.
- Frank, T. (1993, August 22). City may have needlessly hired 60 new firefighters. *Providence Sunday Journal*, p. A1.
- Halsey, J. and G.L. Briese. (1992, March) An IAFC action guide: the 1991-1992 revision of NFPA 1500. Available from International Association of Fire Chiefs, 1329 18th St., Washington, DC 20036.
- International Association of Firefighters. (1993). 1992 Death and injury survey. Available from International Association of Firefighters, 1750 New York Ave., NW, Washington, DC, 20006.
- Joslin, H.V.A. (1881). Providence City Documents 1880. Providence, RI: Providence Press Company.
- Judge fines firefighters union \$25,000 for 3 day sickout. (1988, February 26). *Providence Journal*.
- Living with chemicals. (1991, February 18). *Providence Journal*, p. A1.

- - -
- Karter, M. and P. LeBlanc. (1993, November-December). U.S. firefighter injuries in 1992. *NFPA Journal*.
- Mack, B.J. (1994). Staffing service safety. (Executive Fire Officer Research Paper). Emmitsburg, MD: National Fire Academy.
- Mingis, K. (1993, May 2). Cianci seeks end to free ride for tax exempt properties. *Providence Journal*, p. A7.
- Moise versus union: bitterness strained relations. (1990, April 21). *Providence Journal*, p. A7.
- National Board of Fire Underwriters. (1959, September). Fire department manning - company strength. (Special Interest Bulletin No. 231). New York: National Board of Fire Underwriters.
- National Fire Protection Association. (1954) *Fire protection handbook* (11th ed.). Boston: Author.
- National Fire Protection Association. (1969) *Fire protection handbook* (13th ed.). Boston: Author.
- National Fire Protection Association. (1976) *Fire protection handbook* (14th ed.). Boston: Author.
- National Fire Protection Association. (1987). NFPA 1500: Standard on fire department occupational safety and health program. (1992 ed.). Boston: Author.
- National Fire Protection Association. (1992). NFPA 1500: Standard on fire department occupational safety and health program. (1992 ed.). Boston: Author.
- National Fire Protection Association. (1993, July) NFPA Standards Action.
- National Fire Protection Association. (1994, April) NFPA Standards Action.
- O'Hagan, J.T. (1984, November). Staffing Levels, A Major New Study, Part I. *Fire Command*.
- O'Hagan, J.T. (1984, December). Staffing Levels, A Major New Study, Part II. *Fire Command*.
- Peterson, W. (1992, April 15). Is There Safety in Numbers. *IAFC On Scene*.

Polk & Co. (1993). *Providence, Rhode Island, City Directory*, Malden, MA: Author.

Safe Staffing Causes Split in IAFC Ranks. (1992, March-April). *IAFC On Scene*.

Stapleton, L.D. (1992, August). The History of Firefighting Staffing. *Commish*.

"Too much equipment, not enough men, says union president." (1972, August 7). *Providence Journal*.

Whitehead, A.K. (1992, September-October). Urgent need for comments on NFPA 1500 staffing. *International Firefighter*.

ENDNOTES

¹ The labor unrest included an alleged three day "sick-out" that led to a contempt citation and fine by a Rhode Island Superior Court Judge against the firefighters union, and a 14-month-long interest arbitration that cost each side in excess of \$250,000. ("Judge fines union," 1988; "Moise versus union," 1990).

² The City of Providence was self-insured for purposes of Workers' Compensation, as well as for payment of medical bills for firefighters injured in the line of duty.

³ Typical engine companies were staffed with a foreman, 1st hoseman, 2nd hoseman, 3rd hoseman, 4th hoseman, 5th hoseman, an engineer, a stoker, and a driver. Typical ladder company staffing included a foreman, 1st ladderman, 2nd ladderman, 3rd ladderman, 4th ladderman, 5th ladderman, 6th ladderman, 7th ladderman, 8th ladderman, tillerman, and a driver. (Joslin, 1881).

⁴ Engine 1 was a two-piece company that operated an engine company and a heavy rescue vehicle known as the "Special Hazards Unit." Prior to the study period, it was the only Providence company staffed with a minimum of four persons.

⁵ Alfred K. Whitehead was the President of the International Association of Fire Fighters in 1992 when the article was written.

⁶ These statistics are cited, but must be looked upon with a great deal of skepticism. They were derived by mixing statistics taken from one source (National Safety Council) with others taken from another source (NFPA), which may not produce an accurate result.

⁷ The material contained in the appendix to an NFPA standard is not considered part of the requirements of the standard, but rather is provided for informational purposes or as a recommendation.

⁸ The figures presented were derived from injury statistics for calendar year 1992. They are similar to statistics provided by the IAFF 1992 Death and Injury Survey (1993) that showed that 76.6 percent of firefighter injuries are incident or response related. According to Providence Fire Department statistics for 1990 and 1991, 73.6 percent of firefighters were injured at incident scenes or while responding or returning from incidents.

⁹ According to A. F. Bertoncini, (personal communication, August 9, 1994) the number of multiple alarms reported may appear artificially low given the number of working structure fires, due to the fact that in Providence, additional companies typically are dispatched to structure fires on "Special Signals" or "Special Calls," one or two units at a time, instead of as part of a multiple-alarm assignment.

¹⁰ This matter is discussed at length in the "Discussion" section.

¹¹ The IAFC and City Managers tend to view the question of staffing as one pertaining to the prerogatives of management: Who should decide a matter that ultimately will have a substantial impact on the level of service to be delivered, and the financial impact to the taxpayer?

Paid firefighters, largely through the voice of the IAFF, view the question in more simple terms: What is the minimum acceptable level of staffing necessary to ensure firefighter safety?

Volunteer firefighters see an entirely different issue: How can we possibly accomplish our mission if each apparatus must be staffed with a designated number of persons before it can leave the fire station?