PROVIDENCE FIRE DEPARTMENT STAFFING STUDY REVISITED

EXECUTIVE ANALYSIS OF FIRE SERVICE OPERATIONS IN EMERGENCY MANAGEMENT

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ABSTRACT

The Providence Fire Department conducted a staffing study in 1990-1991 to determine the effect of increased staffing on injury-related costs. Staffing on the six busiest companies was increased from three members to four. An actuary concluded that a substantial savings was achieved, resulting in permanent staffing increases.

The results of the staffing study were subject to criticism on the basis of participant bias and the Hawthorne Effect, because participating firefighters knew of the study, and of the possibility for permanent staffing increases.

The problem prompting this research was that increased staffing remained highly controversial due to budgetary problems facing Providence. Politicians and the media regularly referred to the department as "bloated."

The purpose of this research was to determine if injury reductions observed during the original staffing study continued during subsequent years. The historical method was used. The research questions were

1. What were the results of the staffing study conducted from September 1, 1990 to February 28, 1991?

2. How do the injury reductions observed during the study period compare with the injuries during the subsequent years?

3. How does time lost during the study compare with time lost during subsequent years?

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

A literature review was conducted on staffing, participant bias, and the Hawthorne Effect. Injury data from the Department Injury-Exposure Database were analyzed.

The results showed that poststudy injuries averaged 35.7 percent fewer than control-period injuries; time-loss injuries averaged 41.9 percent fewer; and time lost was 84 percent lower. The results supported the conclusion that four-person staffing significantly reduces the number and severity of injuries compared with three-person staffing, and that the reductions observed were not the result of participant bias or the Hawthorne Effect.

Recommendations included the Providence Fire Department examining injury data for the study companies annually; an actuary re-examining the economic benefit resulting from the injury reductions; and the department staffing all companies with four persons. Additional research was recommended to identify factors causing injuries in three-person versus four-person companies; validate the results in other fire

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

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INTRODUCTION

In September of 1990, the Providence Fire Department initiated a staffing study designed to determine if increasing engine and ladder company staffing from three members to four would be cost effective due to reduced injury-associated costs. After six months the results of this study were analyzed by an actuary who concluded that the increased staffing resulted in a substantial savings to the City of Providence (Varone, 1994). Thereafter, staffing was permanently increased to 4 members on 8 of the 15 engine companies, and 5 of the 8 ladder companies.

The actuary's results were later criticized by the local media as being incomplete and inconclusive (Frank, 1993). The increased staffing became the source of an intense debate among city officials who questioned the validity of the staffing study and the propriety of hiring additional firefighters to save money ("Cianci's Next Challenge," 1994; Frank, 1993).

In 1994, Varone examined the staffing study from the perspective of firefighter safety, concluding that increasing staffing from three members to four produced a 23.8 percent decrease in injuries where members required time off, and a 71 percent decrease in time lost due to injury.

A significant limiting factor of the Providence Fire Department Staffing Study, as analyzed in the first instance by the actuary and in the second by Varone, was the fact that during the course of the staffing study Providence firefighters were aware that the study was going on, and that the possible ramifications included permanently increasing staffing if a cost savings was achieved. Therefore, the results of the study were subject to criticism on the basis of participant bias (Varone, 1994).

A related concern was the possible impact of the Hawthorne Effect. Simply defined, the Hawthorne Effect refers to the fact that, when study participants are singled out for special attention, they are likely to show improvements in whatever experimental parameters they know are being measured (Jones, 1992).

The problem which prompted this research project was that the minimum staffing of apparatus continued to be a highly controversial subject due to severe budgetary constraints facing the City of Providence (Mingis & Frank, 1995; Dykas, 1995). As a result, politicians and the media have continued questioning the validity of the conclusions drawn from the staffing study, and have repeatedly referred to the department as "bloated" since the staffing was first increased in 1990 (Dykas, 1995).

Examining injury-related statistics for the years subsequent to the staffing study would yield information concerning whether or not the injury reductions observed during the staffing study were merely short-term savings. This information would help resolve the question of participant bias and/or the Hawthorne Effect. It would also be of great value to the Providence Fire Department and the City of Providence in

efficiently managing its scarce resources and developing a long-term management plan for the future of the Providence Fire Department.

The purpose of this research was to determine if the reduction in injuries, time-loss injuries, and time lost due to injuries observed during the original staffing study continued to be realized in subsequent years. In conducting this research, the historical method was used. The following research questions were posed

1. What were the results of the Providence Fire Department staffing study conducted from September 1, 1990 to February 28, 1991?

2. How do the reductions in injuries observed in the study companies during the study period compare with the injuries observed in the study companies during the subsequent years?

3. How does the reduction in time lost due to injury observed in the study companies during the study period compare with the time lost due to injury observed during the subsequent years?

4. Are there factors other than staffing that could have affected the results during the poststudy period?

BACKGROUND AND SIGNIFICANCE

Providence Fire Department

Providence is the capitol of Rhode Island, covering an area of approximately 20.5 square miles. Providence has a resident population of 160,000 that swells to over 260,000 on the average workday. (D. Price, personal communication, September 30, 1994; Polk & Company, 1993.)

Between September 1, 1989 and February 28, 1994, 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 who also served as shift commander. All operational personnel worked an average of 42 hours per week, on a 4-platoon rotating schedule.

Prior to the staffing study, engine and ladder companies were staffed with a minimum of three members, with the exception of Engine 1/Special Hazards Unit, a two-piece company that was already staffed with a minimum of four members. Throughout all periods involved in this research, the five rescue companies operated with two members assigned. During the control and study periods the battalion chiefs and the deputy assistant chief did not have aides. Prior to the study period, minimum

staffing for each shift was 83 members. Overtime was used if necessary to maintain minimum shift staffing at 83 members at all times.

The Staffing Study

VarIn May of 1990 the City of Providence agreed to study the effects of increased staffing on firefighter safety. A contractual provision was included in the collective bargaining agreement between the City and Providence Firefighters Local 799, International Association of Fire Fighters (IAFF) to increase staffing on each of the city's three busiest ladder companies (Ladders 1, 2, and 5) from three to four members for a period of six months. This brought minimum shift staffing to 89 members during the study period (Collective Bargaining Agreement, 1990).

The agreement called for the results of the study, in terms of economic benefit or cost to the city, to be analyzed by an actuary. If the actuary determined that there was a net economic cost to the city, staffing all engine and ladder companies would revert back to the prestudy levels. If the actuary determined that there was no net cost to the city, the staffing of the six busiest companies would remain at four members, and the remainder of the engine and ladder companies would remain at prestudy levels. If it was determined that there was a net savings to the city, any such savings would be used to increase staffing on additional units up to the extent of the savings realized (Collective Bargaining Agreement, 1990).

The additional staffing for the study was accomplished by using overtime. The staffing study began on September 1, 1990, and ended on February 28, 1991. It was agreed that a control period of one year earlier, September 1, 1989, to February 28, 1990, would be used. All study companies were staffed with three members throughout the control period.

At the conclusion of the study the actuary determined that there was an $871,000 net savings to the city as a result of the increased staffing (Varone, 1994). He determined that this savings equated to nine additional firefighters per shift. Thereafter, minimum staffing per shift was increased to 98 members. The City and Local 799 agreed to phase in the increased staffing. On July 1, 1991, staffing was raised to 92, with Engine 14 and Ladder 6 each being staffed with a minimum of 4 members, and the deputy assistant chief receiving an aide.

On January 19, 1992, Engines 2, 12, 13, and Ladder 4 each were staffed with a minimum of 4 members, and both battalion chiefs received an aide, for a total staffing of 98 members per shift. In addition, the authorized strength of the Providence Fire Department was increased from 479 to 539 uniformed members (Frank, 1993).

This research paper was prepared to satisfy the applied research requirement associated with the *Executive Analysis of Fire Service Operations in Emergency Management* course at the National Fire Academy. This research relates to the capability assessment unit of the *Executive Analysis* course by analyzing the best use of available resources. Personnel are a primary resource for fire departments, and determining appropriate staffing levels is an essential component of determining the fire department's capability to safely mitigate emergencies.

The results of the staffing study continue to have tremendous significance to the Providence Fire Department. The City of Providence is facing a projected $41,000,000 deficit for fiscal 1995-1996 and accusations of overstaffing in the fire department have repeatedly been made by members of the city council and the media (Mingis & Frank, 1995; "Cianci's Next Challenge," 1994). This research provides definitive information to the fire department, the fire chief and city officials regarding appropriate staffing levels.

LITERATURE REVIEW

Staffing

The subject of minimum staffing continues to be one of the most controversial subjects in the history of the fire service ("N.F.P.A. Renegs," 1995; Clark, 1994; "Chiefs Abandon," 1992). Historically, staffing has been considered solely a matter of firefighting "efficiency" as opposed to firefighter safety (Varone, 1994; O'Hagan, 1984; National Fire Protection Association [NFPA], 1976; NFPA, 1969; National Board of Fire Underwriters, 1959; NFPA 1954). The linkage of staffing to firefighter safety remains a relatively new phenomena (Clark, 1994).

In 1992, Whitehead wrote in support of a nationally accepted standard calling for a minimum of four firefighters on each piece of apparatus as a matter of firefighter safety. Whitehead offered a considerable amount of statistical data and unpublished research to support his claim that injuries increased when apparatus staffing dropped below four firefighters. Stapleton, in 1992, wrote about his experiences in the Boston Fire Department, concluding that staffing apparatus with fewer than four persons leads to increased injuries.

The work of Whitehead and Stapleton influenced this research by lending support to the position that staffing apparatus with fewer than four firefighters will lead to more injuries.

Erwin, in 1993, wrote in opposition to a proposed nationally accepted minimum staffing standard. He cited a decline in firefighter line-of-duty deaths as a reason why a minimum staffing standard was unnecessary. Erwin also used statistics to show that the occupational death rate for career firefighters was below that of several other occupations, including commercial fisherman, miners, and loggers.

Erwin theorized that mandated minimum staffing would lead to municipalities having to close some stations in order to staff others, thereby increasing response times. Increased response times would then result in increased fire losses and more civilian fire casualties.

Petersen, in 1992, also wrote against the need for a nationally accepted minimum staffing standard, noting the reduction of firefighter line-of-duty deaths. Peterson concluded that firefighter deaths and injuries occurred because firefighters engaged in unsafe acts, not because of understaffing.

In 1992, Halsey and Briese wrote a position paper for the International Association of Fire Chiefs (IAFC), arguing that minimum staffing was best left up to the local jurisdiction. The IAFC position was that local conditions, such as training, physical fitness programs, seat belt usage, no-smoking policies, personnel accountability systems, and incident command systems, had to be taken into account in determining appropriate staffing levels.

Erwin, Petersen and the IAFC influenced this research by countering the arguments advanced by Whitehead and Stapleton. However, neither Erwin, Petersen, or the IAFC affirmatively advocated staffing apparatus with fewer than four members. Thus, despite their rhetoric in opposition to a minimum staffing standard, the overall influence of these writers upon this research was minimal.

National Fire Protection Association (NFPA) Standard Number 1500, *Standard on Fire Department Occupational Safety & Health Program*, was first published in 1987. It recommended that as a matter of firefighter safety there be four firefighters responding on or arriving with each engine and ladder company. In high-risk areas the recommended staffing level increased to five on an engine and six on a ladder. This staffing standard was included as a recommendation only, in the nonmandatory "appendix" section of NFPA 1500, as opposed to the main body of the standard.

The second edition of NFPA 1500 was issued in August of 1992 amidst an unprecedented controversy over whether the minimum staffing requirement should be in the standard itself, or in the appendix ("Firefighters double-crossed," 1992; "Safe Staffing Causes Split," 1992). When originally released by the NFPA in August of 1992, the only reference to minimum staffing remained in the appendix to NFPA 1500.

In July of 1993, an amendment to NFPA 1500 was issued by the NFPA Standards Council, requiring at least four members to be assembled on the scene of a working structure fire before interior firefighting operations could be initiated (NFPA Standards Action, 1993). The Standards Council released an interpretation of this amendment in April of 1994 that stated, "when a company is dispatched from the fire station together as a unit (which include 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 staffing recommendations stated in NFPA 1500 influenced this research by providing a nationally accepted minimum staffing standard developed with firefighter safety as the primary consideration. In fact, no authoritative sources were found that advocated staffing fire apparatus with fewer than four members.

Participant Bias And The Hawthorne Effect

The principal limitation of the original staffing study was the fact that study participants know that reduced injury-related statistics over the course of the six-month study period could lead to a permanent increase in staffing on the study companies, and perhaps to a permanent increase in staffing on additional nonstudy companies (Varone, 1994). Thus, study participants had a substantial motive to intentionally skew the results.

Despite an exhaustive literature review at the Learning Resource Center, Providence Public Library, Brown University's John D. Rockefeller, Jr., Library, and the Providence College Library, no definitive works were found that addressed the subject of participant bias in a comprehensive manner. Rather, most authors of books on "research methodology" casually referenced the possibility of participant bias, or of participants intentionally influencing research outcomes, as a concern of research design (Sproull, 1988; Cooke & Campbell, 1979; Struening & Guttentag, 1975; Sundberg, Tyler & Taplin, 1973).

However, a great deal of literature was available on the so-called "Hawthorne Effect." This term arose out of a series of experiments conducted at the Western Electric Company's Hawthorne Works plant in Chicago by a team of researchers from Harvard, headed by Elton Mayo (Roethlisberger & Dickson, 1939). Roethlisberger and Dickson chronicled these experiments, which involved the manipulation of the workers' environment to determine the impact on productivity. Surprisingly, the investigators found that every manipulation of the workplace (even dimming lights or eliminating breaks) had a positive effect upon productivity. The unexpected results were attributed to the fact that the participants knew they were taking part in an experiment. By virtue of being singled out and having special attention paid to them, their productivity improved.

In 1992, Jones assailed the generally accepted and widespread conclusions drawn from "Hawthorne Experiments." Jones wrote that much of what had been written by others about the existence of a Hawthorne Effect was based upon an uncritical acceptance of Roethlisberger and Dickson's work. Jones analyzed the statistics from the Hawthorne experiments and theorized that the conclusions drawn by Roethlisberger and Dickson simply were not supported by the actual figures.

The works of Roethlisberger and Dickson, and Jones affected this research by highlighting the fact that when subjects are aware they are participating in an experiment, there is an inherent risk that results may be affected, but not all experts agree upon the quality or quantity of such an effect. The principal concern to be addressed by a researcher confronted with such a problem is to control for such an effect through good research design.

PROCEDURES

The research procedure used in preparing this paper consisted first of a literature review that was conducted initially at the Learning Resource Center at the National Emergency Training Center in March and April of 1995. Additional literature review was conducted between March and July of 1995 at the Providence Public Library in Providence, Rhode Island, the Providence College Library located in Providence, Rhode Island, Brown University's John D. Rockefeller, Jr., Library located in Providence, Rhode Island, and the author's personal library.

Personal interviews were conducted with Alfred F. Bertoncini, who was the Chief of the Providence Fire Department from December of 1991 to December of 1994, and Chief R. Michael DiMascolo, who succeeded Chief Bertoncini. Chief Bertoncini was interviewed on June 19, 1995, and Chief DiMascolo was interviewed on July 29, 1995.

The author's prior research project, entitled "The Providence Fire Department Staffing Study," was thoroughly examined and analyzed (1994). Injury data for the control, study, and poststudy periods was analyzed using the Providence Fire Department Injury-Exposure Database.

The time periods used for poststudy analysis were September 1 to the following February 28, for three years following the original staffing study. This time period was used in order to be consistent with the time periods used in the original staffing study and to control for injury fluctuations that may have been seasonally or weather related.

The Providence Fire Department Injury-Exposure 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. This information was then categorized by unit and month for the time periods of September 1 to February 28 for the years 1989-1990, 1990-1991, 1991-1992, 1992-1993, and 1993-1994.

The results of these queries were then analyzed using a computerized spreadsheet. Activity level data obtained from the Providence Fire Department Fire Prevention Bureau were also analyzed using a computerized spreadsheet.

Limitations

This research was subject to a number of limitations. First of all, most of the limitations of the original staffing study apply equally to this study. The injury data used in conducting this research came from the Providence Fire Department Injury/Exposure Database. These data were subject to minor errors such as data entry mistakes, typographical errors, and the failure of members to follow prescribed reporting procedures (Varone, 1994).

The injury reports used prior to January 1, 1990, 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, the "type of injury" data for the first four months of the control period could not be analyzed.

Without this information, a detailed analysis comparing the types of injuries that occurred during the control period with injuries that occurred during the study and poststudy periods, would be invalid. For this reason the author has purposely limited the scope of his analysis to three injury related statistics: the total number of injuries reported, the number of time-loss injuries reported, and time lost due to injury (Varone, 1994).

The validity of September 1, 1989, to February 28,1990, as a control period was another limitation. There was no documentation that the timeframe of September 1, 1989, to February 28, 1990, was a representative period in terms of the injuries likely to occur with three-person staffing. Because injury and time lost data were not centralized or maintained in an organized manner prior to January 1, 1990, it was not possible to reconstruct this information to determine if the injury-related statistics observed during the control period were representative of years past with three-person staffing. Without such information, this research remains subject to the limitation that the use of September 1, 1989, to February 28, 1990, as a control period may be based upon a potentially faulty assumption.

While there were relatively few, if any, changes that took place in the Providence Fire Department between the control period and the original study period, the same cannot be said for the poststudy period. On the contrary, the poststudy period was one of great change in the area of firefighter safety (A. F. Bertoncini, personal communication, June 19, 1995). Examples of some of the changes were that the department created a full-time safety officer position, established written Standard Operating Procedures, instituted a formalized health and safety program, switched from 3/4 length boots to bunker pants, acquired lighter weight turnout gear, instituted mandatory rehab at major incidents, implemented an accountability system, issued each member his/her own self-contained breathing apparatus (SCBA) facepiece, acquired lighter weight SCBA cylinders, and eliminated the position of fire department physician. The breadth of these changes, which will be discussed at length below, is a

limitation on the ability to rule out factors other than staffing as having an impact on poststudy injury-related statistics.

The author's research was "historical research," which by its nature involved data that were already in existence, could not be changed or manipulated, and over which the researcher had no control (Sproull, 1988). As such, the author had no ability to design in a control group capable of ruling out participant bias or the Hawthorne Effect. However, during the poststudy period Providence firefighters in the "study companies" were aware that the study had been completed (R. M. DiMascolo, personal communication, July 29, 1995). By examining injury-related data for the years subsequent to the original staffing study, it was possible to determine if the injury-related statistics returned to the high, prestudy levels (consistent with participant bias or the Hawthorne Effect), or remained low. Nevertheless, the lack of a control group for participant bias and/or the Hawthorne Effect remains a limitation.

In the original staffing study, the number of "Code Reds," or working structure fires, to which each study company responded was used as an important measure of the activity level of the study companies. Activity-level data of the study companies were used to rule out the possibility that a decrease in the number of fires accounted for the decrease in injuries (Varone, 1994).

Starting in 1993, the Providence Fire Department stopped keeping track of Code Reds on the company level (R. M. DiMascolo, personal communication, July 29, 1995). Instead, the department began tracking "structure fires," which conformed with the National Fire Incident Reporting Systems (NFIRS) definition of "structure fire." The NFIRS definition of a structure fire was any fire "inside a structure, or on, under or touching a structure," while the term Code Red would only apply to more serious structure fires (R. M. DiMascolo, personal communication, July 29, 1995); NFIRS Handbook, 1984, p. 230). Because of this difference in definitions, it would be inappropriate to compare company-level structure fire activity with company-level "Code Red" activity.

In the absence of company-level data on Code Reds after January 1, 1993, the total number of Code Reds for the entire department each year, from 1989 to 1994, was used as a measure of activity. However, the total number of Code Reds for the department annually included fires occurring during nonstudy periods, as well as fires to which no study company responded. As such, the total number of Code Reds annually was of limited usefulness as a measure of the activity level of the study companies during the control, study, and poststudy periods.

Finally, at all relevant times the Providence Fire Department was a paid, professional fire department that used traditional engine and ladder (truck) companies as the primary means of delivering fire protection services in an urban setting. Readers should exercise due care in extrapolating data from the Providence Fire

Department to less active fire departments, to volunteer fire departments, or to fire departments that do not operate traditional engine and ladder companies.

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 using 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 were then processed at fire department headquarters and entered into the database by the department safety officer, or his/her designee.

STILL BOX: The telephone report of a fire in a building in Providence was dispatched as a "still box." A building fire may also be reported by someone pulling a fire alarm box, which was dispatched as a "box alarm." All other alarms were dispatched as "still alarms."

STUDY COMPANIES: The six companies that took part in the original Providence Fire Department Staffing Study: Engine 3, Engine 8, Engine 10, Ladder 1, Ladder 2, and Ladder 5.

TIME-LOSS INJURIES: The term "time-loss injury" refers to injuries which resulted 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. After March of 1992, time-loss injuries were only documented by the member's personal physician, as the position of fire department physician was eliminated.

TIME LOST DUE TO INJURY: The number of shifts a member missed as a result of a time-loss injury that occurred during either the control, study, or poststudy periods. If a member was injured in a study company during one of the time periods under consideration, all of the shifts that the member missed as a result of the injury would be included in the total time lost for that period, regardless

of how long it took for the member to return. On the other hand, if a member was injured anytime other than during the control, study, or poststudy period, then that member's time lost would not be included in the time lost due to injury total even though the member may have been out of work during one of the periods under consideration. For example, if a member from Engine 3 was injured on August 1, 1992, and he/she remained out of work from August 1, 1992, to March 5, 1993, the shifts lost would not be counted as part of Engine 3's "time lost due to injury" during the second poststudy period, because the injury did not occur during the second poststudy period.

CONTROL PERIOD:	September 1, 1989 to February 28, 1990
STUDY PERIOD:	September 1, 1990 to February 28, 1991
POSTSTUDY PERIOD:	September 1, 1991 to February 28, 1992
	September 1, 1992 to February 28, 1993
	September 1, 1993 to February 28, 1994

RESULTS

1. What were the results of the Providence Fire Department staffing study conducted from September 1, 1990 to February 28, 1991?

The data from the staffing study showed that reported injuries in the study companies decreased from 42 during the control period when staffing was 3 members per apparatus, to 31 during the study period when the study companies were staffed with 4 members (see Table 1). This represented a 23.8 percent reduction in injuries (see Figure 1).

Time-loss injuries decreased 25 percent during the study period, from 31 to 23. Time lost due to injuries decreased from 1,832 shifts lost during the control, to 531 shifts lost during the study period. This represented a 71 percent decrease in time lost (see Figure 2). Time lost due to injury was considered to be a vital measure of injury severity (i.e., recuperation time) and was said to be the most significant statistic to come from the staffing study (Varone, 1994).

Thus there was a very obvious decrease in injury-related statistics during the study period, when study companies were staffed with four members, as compared to the control period, when study companies were staffed with three members. This decrease occurred both in terms of the number of injuries that occurred and their severity.

Table 1

	CONTROL Sep 89-Feb 90	STUDY Sep 90-Feb 91	Percent Decrease
Injuries	42	31	23.8%
Time-Loss Injuries	31	23	25%
Time Lost (Shifts)	1,832	531	71%

FIGURE 1

Pasteup Figure 1

FIGURE 2

Pasteup Figure 2

2. How do the reductions in injuries observed in the study companies during the study period compare with the injuries observed in the study companies during the subsequent years?

In the 3 years following the staffing study, the number of reported injuries in the study companies ranged from a low of 21 to a high of 33 (see Table 2). The poststudy average was 27. Compared to the control period where there were 42 reported injuries, there were on average 35.7 percent fewer injuries in the poststudy period (see Figure 3). Poststudy period injuries also averaged 12.9 percent lower than injuries reported during the study period.

Time-loss injuries during the poststudy period ranged form a low of 14 to a high of 21, with an average of 18 (see Figure 4). This represented an average 41.9 percent decrease over the time-loss injuries during the control period, and a 21.7 decrease over the study period.

3. How does the reduction in time lost due to injury observed in the study companies during the study period compare with the time lost due to injury observed during the subsequent years?

The time lost due to injury during the poststudy period ranged from a low of 156 shifts to a high of 374 shifts, with an average of 291.7 shifts lost (see Table 2). This represented an average 84 percent decrease in time lost compared with the time lost during the control period, and a 45 percent decrease over the time lost during the original study period (see Figure 5).

4. Are there factors other than staffing that could have affected the results during the poststudy period?

Unlike the relative uniformity of conditions that existed during the control and study periods, the poststudy period was one of dramatic change in the area of firefighter health and safety (A. F. Bertoncini, personal communication, June 19, 1995).

In December of 1991, the department appointed its first full-time safety officer. This position was based directly upon NFPA 1500 and NFPA 1501 (later renumbered as NFPA 1521). Shortly thereafter, a number of safety-related programs were instituted, including a formalized written plan for the implementation of NFPA 1500; use of NFPA-approved turnout gear, including the use of bunker pants in place of 3/4 length boots; establishment of written standard operating procedures; field testing and acquisition of lighter weight SCBA cylinders; development and implementation of an accountability system; mandatory rehab at major incidents; and the use of infrared tympanic thermometers to monitor members for signs of heat stress at major incidents. All of these actions, individually and collectively, were intended to, and in fact may have served to, help decrease injuries during the poststudy period.

Table 2

	CONTROL Sep89-Feb90	STUDY Sep90-Feb91	Poststudy 1 Sep91-Feb92	Poststudy 2 Sep92-Feb93	Poststudy 3 Sep93-Feb94	Poststudy Average	Poststudy Standard Deviation
Injuries	42	31	21	33	27	27	6
TL INJ	31	23	14	19	21	18	3.61
Time Lost (in shifts)	1,832	531	345	156	374	291.7	118.38

FIGURE 3

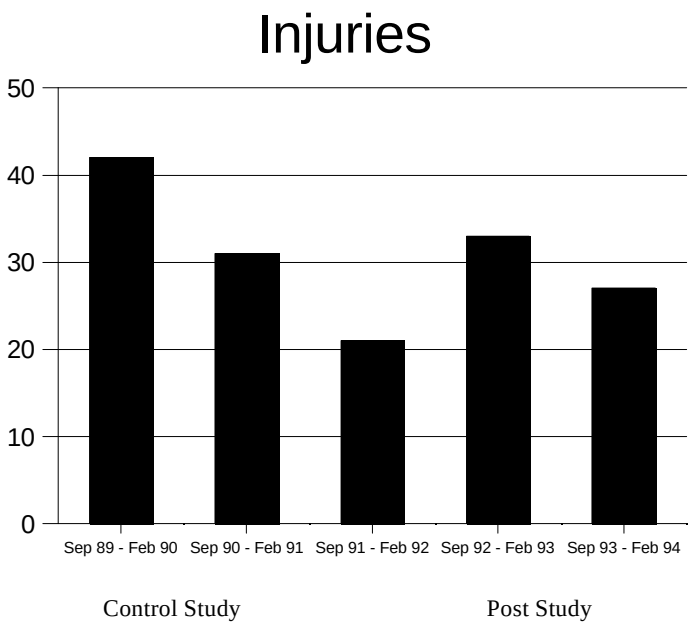

FIGURE 4

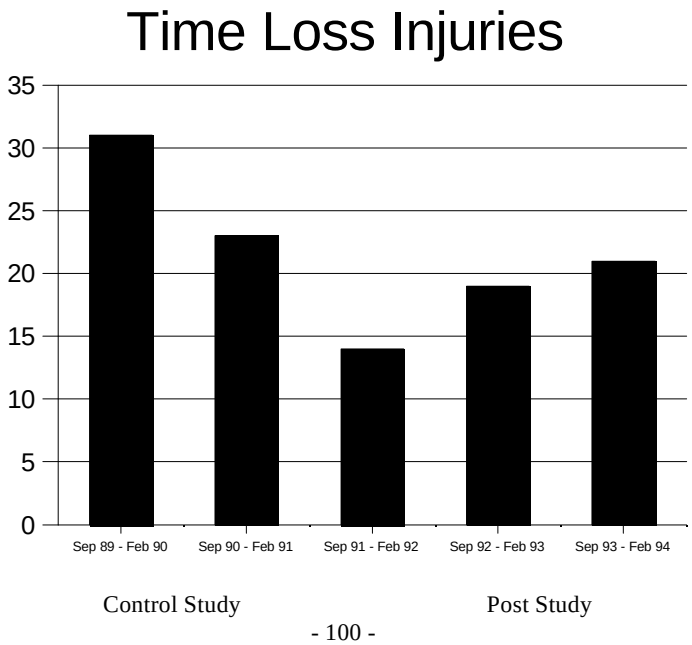

FIGURE 5

Pasteup Figure 5

Another significant change that took place during the poststudy period was the elimination of the fire department physician's position in March of 1992, as a cost-cutting measure (A. F. Bertoncini, personal communication, June 19, 1995). Injured members were no longer required to report periodically to the department physician to document their disability and/or obtain the physician's clearance to return to work. Members were merely required to provide the department with documentation of their disability status from their personal physician.

Studies have shown that approximately 75 percent of firefighter injuries are "incident related," in that they occur either at incident scenes or while responding/returning from alarms (Varone, 1994; Karter & LeBlanc, 1993). Thus a change in the number of incidents and/or fires could explain a change in injury-related statistics. The activity level of the study companies remained surprisingly steady throughout the poststudy period in terms of runs (see Table 3). Total responses for each study company remained within two standard deviations of the mean throughout the control, study, and poststudy periods, with most falling easily within one standard deviation of the mean. Figure 6 shows the combined total runs for all six study companies during each of the five periods under consideration.

Table 3
Runs (Study Companies)

	CONTROL Sep 89-Feb 90	STUDY Sep 90-Feb 91	Poststudy 1 Sep 91-Feb 92	Poststudy 2 Sep 92-Feb 93	Poststudy 3 Sep 93-Feb 94	Average	Standard Deviation
Engine 3	1,680	1,647	1,600	1,637	1,805	1,673.80	78.69
Engine 8	1,572	1,555	1,322	1,497	1,629	1,515.00	117.71
Engine 10	1,456	1,373	1,503	1,376	1,417	1,425.00	55.26
Ladder 1	588	508	554	538	587	555.00	33.96
Ladder 2	361	417	431	466	518	438.60	58.31
Ladder 5	495	456	389	450	427	443.40	39.03
	6,152	5,956	5,799	5,964	6,383	6,050.80	223.90

FIGURE 6

Pasteup Figure 6

Department-wide statistics indicated that the overall activity level of the department remained stable throughout the six years under consideration (see Table 4). Total runs for the department remained well within one standard deviation of the mean throughout the period. Still boxes, which were a measure of the number of reported structure fires received by telephone as opposed to those reported by fire alarm box, similarly remained within one standard deviation through the six years.

The number of working structure fires (Code Reds) to which the department as a whole responded also remained quite consistent and well within one standard deviation of the mean. The number of multiple-alarm fires remained within two standard deviations of the mean. Thus, the overall activity level of the Providence Fire Department remained relatively steady throughout the time periods in question and probably was not a factor affecting the injury-related statistics (see Figure 7).

Another factor that could have affected the injury-related statistics of the study companies was the increased staffing of the nonstudy companies that was phased in from July of 1991 to January of 1992. Increased staffing on other apparatus would, in theory, increase the operational efficiency of such companies and reduce the overall workload on all firefighters operating on the scene (O'Hagan, 1984).

Closely associated with increased staffing of nonstudy companies was the hiring of 60 additional firefighters to increase the authorized strength of the department from 479 to 539 uniformed members (Frank, 1993). The hiring of the 60 additional firefighters substantially reduced the department's reliance upon overtime to maintain shift staffing at 98 (A. F. Bertoncini, personal communication, June 19, 1995).

Any or all of the above factors, with the exception of changes in activity level, may have affected the injury-related statistics of the study companies during the poststudy period. It is impossible to objectively gauge the impact that each factor may have had upon poststudy period injuries.

DISCUSSION

The principal criticism of the original Providence Fire Department Staffing Study was that the participating firefighters were aware that permanent increases in staffing would result if injuries in the study companies decreased substantially (Varone, 1994). The firefighters had a great deal to gain if the results showed a reduction in injuries during the six-month study period.

Table 4
Activity Levels - Department-Wide

	1989	1990	1991	1992	1993	1994	Average	Standard Deviation
Runs	36,350	36,581	36,942	36,905	36,954	37,633	36,894.17	18,615.16
Still Boxes	1,303	1,171	1,211	1,296	1,258	1281	1,253.33	477.53
Code Reds	329	310	356	391	343	324	342.17	174.47
Multiple Alarms	11	13	13	5	6	13	10.17	3.71

FIGURE 7

Pasteup Figure 7

The literature review found surprisingly little information on participant bias, and what little was found dealt primarily with ensuring that participant bias be controlled through proper research design. No suggestions were found on how to disprove or rule out participant bias in a historical research context. The nature of historical research is such that the researcher has no ability to manipulate the experimental environment (Sproull, 1988). The researcher is left with data only, from which conclusions can be drawn.

A great deal of information was found on the Hawthorne Effect, but again it was considered primarily a matter to be addressed through proper research design. No literature was found that addressed the subject of how long the Hawthorne Effect could be expected to last, or how to disprove its effect in a historical research context.

The Providence Fire Department Staffing Study ended on February 28, 1991, with the actuary's report being issued on March 28, 1991 (Varone, 1994). The permanent staffing increases were agreed to and incorporated into the then-existing Collective Bargaining Agreement that ran from July 1, 1990, to June 30, 1992. The first phase of the permanent staffing increases took effect on July 1, 1991. By the start of the first poststudy period (September 1, 1991) it was apparent to all Providence firefighters that the study was over and the permanent staffing increases were a reality (R. M. DiMascolo, personal communication, July 29, 1995).

Furthermore, by September 1, 1991, the "study companies" were no longer the only companies being staffed with four members. Thus, in the language of Roethlisberger and Dickson (1939), the study companies were no longer being singled out for special recognition, nor were the members assigned to the study companies aware that they were still participating in an experiment.

By examining injury-related data for the poststudy period, when concerns about participant bias and/or the Hawthorne Effect were minimized, it was possible to determine if injuries in the study companies had returned to their high "prestudy" levels, or whether the injuries remained low, consistent with the results of the original staffing study.

Analysis of the injury-related statistics for the poststudy period showed that the injury reductions observed during the Providence Fire Department Staffing Study continued to occur after the original staffing study was completed. In the three years following the Providence Fire Department Staffing Study, the number of reported injuries, time-loss injuries, and time lost due to injury in the study companies consistently remained well below the statistics reported during the control period.

The number of reported injuries remained an average of 35.7 percent lower during the poststudy period compared to the control period, and 12.9 percent lower than that observed during the study. The number of reported injuries during the second poststudy period (September 1, 1992, to February 28, 1993) actually exceeded

the number of reported injuries during the original study period. During the original study period there were 31 reported injuries, while during the second poststudy period there were 33 reported injuries. However, the 33 reported injuries in the second poststudy period were within the normal range of variation (plus or minus one standard deviation of the poststudy mean of 27).

Furthermore, the high number of reported injuries during the second poststudy period did not correlate with a high number of shifts lost (see Table 2). On the contrary, the second poststudy period had the least number of shifts lost during the entire five time periods under consideration. This is an indication that while there may have been more injuries reported during the second poststudy period, fewer of these injuries were significant enough to warrant a member reporting off duty and/or losing time out of work.

During the poststudy period, the number of time-loss injuries also remained well below the time-loss injuries reported during the control period. The statistics showed that time-loss injuries were an average of 41 percent below those of the control period and 21.7 percent lower than time-loss injuries during the original study period.

Time lost due to injury in the poststudy period remained significantly below the time lost during either the control or the study period. The poststudy average was 291.7 shifts lost, which was an amazing 84 percent less than that observed during the control period, and a 45 percent decrease over the time lost during the study period. Time lost due to injury is the most important injury-related statistic to consider, since it serves as a vital measure of injury severity (Varone, 1994). Time lost is also an important economic consideration because in Providence, as in many departments, injured members frequently must be replaced for the duration of their disability by members working overtime.

Thus, all three of the categories used to assess the safety of personnel in the study companies: injuries, time-loss injuries, and time lost due to injury, remained low during the three-year period following the original staffing study.

The statistics lend themselves to a number of interesting observations. First of all, there was no obvious correlation between injuries, time-loss injuries, and time lost due to injury during the poststudy period. Reported injuries and time-loss injuries were the lowest during the first poststudy period, while time lost due to injury was lowest during the second poststudy period. This second poststudy period was also associated with the largest number of reported injuries in either the study or poststudy periods.

Secondly, during the poststudy period the three categories of injury-related statistics not only remained low, but they decreased well beyond the decreases

observed during the original study. There are a number of possible explanations that account for this decrease.

One explanation for this phenomenon would be that the additional staffing added to the "nonstudy" companies enhanced the safety of the companies already staffed with four members. This phenomenon would be analogous to that cited in the original staffing study, where the increased staffing on the study companies was said to have had a "beneficial impact" on the nonstudy companies' injury-related statistics (Varone, 1994).

Another possible explanation for the decrease in injury-related statistics during the poststudy period would be that the various safety programs and efforts undertaken by the Providence Fire Department paid dividends in terms of improved injury-related statistics.

A third explanation may be the hiring of 60 additional firefighters in January of 1992. These new firefighters were hired in order to decrease the reliance upon overtime to staff the additional positions (Frank, 1993). Prior to January of 1992, the increased staffing was made possible exclusively via the use of overtime (A. F. Bertoncini, personal communication, June 19, 1995). Thus, during the study period, the increased staffing frequently consisted of firefighters who had already worked their regular shifts, and who were working an additional shift, as well as firefighters who were working their regular shift after having just worked an overtime shift. Fatigue has been identified as a significant cause of firefighter injuries (International Fire Service Training Association, 1991). The decreased reliance on personnel working overtime, and the increased availability of "fresh" (nonovertime) members after January of 1992 may have been responsible for some of the poststudy injury decrease.

One change that took place during the poststudy period that was particularly difficult to assess was the elimination of the position of fire department physician. In Providence, the fire department physician served three important functions: to ensure that firefighters injured in the line of duty received appropriate medical care; to ensure that firefighters who were returning to duty from an injury or illness were medically fit to do so; and to ensure that injured members returned to duty as soon as medically able (R. M. DiMascolo, personal communication, July 29, 1995).

The elimination of the fire department physician could have resulted in members remaining off injured longer that was medically necessary, which would potentially have increased the time-loss statistics for the poststudy period. On the other hand, firefighters who were not medically fit for duty may have been allowed to return to duty prematurely, potentially resulting (at least initially) in a decrease in time lost. Such firefighters would then be at increased risk of sustaining a re-injury. Obviously such a discussion becomes highly speculative, and the true impact of the elimination of the fire department physician on injury-related statistics simply is not clear.

The activity level statistics for the Providence Fire Department are also an important consideration in evaluating the decrease in injuries observed during the poststudy period. Approximately 75 percent of firefighter injuries occur at incident scenes or while responding/returning from alarms (Varone, 1994; Karter & LeBlanc, 1993). Thus, a decrease in the number of incidents and/or fires could explain a decrease in injuries.

The number of incidents that the study companies responded to remained remarkably consistent from the control period through to the third poststudy period (see Table 3). In addition, the overall activity level of the Providence Fire Department in terms of runs, still boxes, and "Code Reds" from 1989 to 1994 remained stable (plus or minus one standard deviation on the mean) (see Table 4). This fact would tend to disprove any significant influence of activity level on the results.

Another interesting observation is that the various health and safety programs that were undertaken by the Providence Fire Department during the poststudy period were gradually phased in over the three year poststudy period (A. F. Bertoncini, personal communication, June 19, 1995). For example, the lighter weight turnout gear was phased in by being issued as replacements for existing gear that became worn out or damaged; lighter weight SCBA cylinders were phased in as part of a capital improvement program with approximately 20 cylinders being purchased each year; while programs such as the accountability system (January 1993) and mandatory rehab at structure fires (July 1993) were implemented at various points throughout the three years (A. F. Bertoncini, personal communication, June 19, 1995).

However, despite the fact that health- and safety-related programs were being phased in, the injury-related statistics did not continue to decrease throughout the poststudy period. Injuries and time-loss injuries were lowest during the first poststudy period, while time lost due to injury was lowest during the second poststudy period.

If factors such as the implementation of new health and safety programs, or the issuance of lighter weight turnout gear, were driving the massive injury reductions observed, then it would seem logical that injuries would have been at their lowest during the third poststudy period. Yet, time-loss injuries and time lost due to injury were the highest during the third poststudy period (see Table 2). While hardly dispositive of the issue, the fact that injury-related statistics were not the lowest in the third poststudy period supports the conclusion that the various health and safety improvements implemented during the poststudy period played a supporting role, as opposed to a major role, in reducing injuries compared to the role played by the increased staffing.

In summary, the results clearly indicate that injuries, time-loss injuries, and time lost due to injury in the study companies remained low during the three years subsequent to the original staffing study, when four-person staffing was maintained.

These results indicate that the injury reductions observed during the original staffing study were not the result of participant bias, the Hawthorne Effect, or even a conscious effort on the part of firefighters to report fewer injuries.

The sustained reductions in injury-related statistics provide clear support for the validity of the conclusions drawn from the staffing study that four-person staffing significantly reduces the number and severity of firefighter injuries compared to companies staffed with three members.

RECOMMENDATIONS

The results of the analysis of the injury-related statistics for the poststudy period support the conclusions of the original Providence Fire Department Staffing Study. Therefore, all of the recommendations made in the original study should be reemphasized here. The Providence Fire Department should continue to work toward staffing all engine and ladder companies with four firefighters; this implementation should take place through the collective bargaining process to avoid the need to close some companies in order to staff others; additional analysis is needed of the injury-related statistics in the companies that received the increased staffing in July of 1991 or January of 1992 to determine if comparable decreases in injuries were observed; additional research is needed from other fire departments to validate the results observed in Providence; research is needed to determine if there are types of injuries that are more common among companies staffed with fewer than four members as opposed to four-member crews; and fire departments that presently staff their apparatus with three persons or fewer, and have experienced labor discord over the issue, should consider trying a similar type of staffing study as a compromise (Varone, 1994).

The Providence Fire Department should examine the injury-related statistics for the study companies annually in order to determine whether or not the injury reductions observed to date continue to be realized. Such monitoring should serve to shed more light on the author's results, while at the same time providing a basis for the department to measure the success of future firefighter health and safety programs.

The department should retain an independent actuary to analyze the economic benefit to the City of Providence as a result of the injury reductions experienced since staffing was increased in September of 1990. The actuary would have four full years of statistics to analyze, as opposed to the six months used by the actuary who conducted the original economic analysis in 1991. The actuary could then compare the calculated savings for the four years with information on the actual cost of the increased staffing to determine whether or not it has been cost effective to staff engine and ladder companies with four members instead of three. This information would be of tremendous value to the City of Providence, as well as to fire departments, fire chiefs, and municipal managers, in making responsible, informed decisions about appropriate staffing levels.

Additional research is needed in regards to the Hawthorne Effect. As Jones pointed out in 1992, the existence of the Hawthorne Effect has been uncritically accepted by most authorities. This is not to suggest that the Hawthorne Effect does not exist. Rather, the uncritical acceptance has led to there being surprisingly little research into the parameters of the Hawthorne Effect itself. Important questions need to be addressed, such as how long will the Hawthorne Effect exert an influence over research results; will the Hawthorne Effect continue after the participants become aware that the experiment has ended; how can a researcher control for the Hawthorne Effect in the context of historical research; and is there a way to specifically identify and/or measure the Hawthorne Effect, so that its impact can be factored into research results?

Finally, the fire service in the United States needs to approach the historically divisive issue of minimum staffing from an open-minded, analytical point of view. Unsubstantiated rhetoric, even from an authority as august as the Pope, did not keep Galileo from proving the earth rotated around the sun, nor did it keep Columbus from finding the "New World" and proving the earth was round. Continued research, not rhetoric, will give the fire service the answers needed to resolve the issue of minimum staffing.

REFERENCES

Chiefs abandon firefighter safety. (1992, January-February). International Firefighter, p. 1.

Cianci's next challenge. (1994, November 17). Providence Journal, p. A18.

Clark, B. (1994, February). Is there safety in numbers? Fire Engineering, p. 24.

Collective Bargaining Agreement Between the City of Providence and Providence Firefighters Local 799, International Association of Fire Fighters, effective July 1, 1990 to June 30, 1992. (available from City Clerk, City Hall, Providence, RI, 02903).

Cooke, T.D. & Campbell, D.T. (1979). Quasi-experimentation: design and analysis issues for field testing. Chicago: Rand-McNally College Publ. Co.

Dykas, L. (1995, April 4). Fire department staffing study sought. Providence Journal, p. D1.

Erwin, J. M. (1993, January). Firefighters see red: crew size and deaths or injuries are debated. Public Management, 75 (1), 2-5.

Firefighters double-crossed on safety. (1992, February). International Firefighter, p. 1.

Frank, T. (1993, August 22). City may have needlessly hired 60 new firefighters. Providence Sunday Journal, p. A1.

Halsey, J. & Briese, G.L. (1992, March). An IAFC action guide: the 1991-1992 revision of NFPA 1500. (available from International Association of Fire Chiefs, 1329 18th St., NW, Washington, DC 20036).

International Fire Service Training Association (1991). Fire department occupational safety (2nd Ed.). Stillwater, OK: Fire Protection Publications.

Jones, S.R. (1992, November). Was there a Hawthorne Effect? American Journal of Sociology, 98, 451-468.

Karter, M. & LeBlanc, P. (1993, November-December). U.S. firefighter injuries in 1992. NFPA Journal.

Mingis, K. & Frank, T. (1995, May 7). Budget cuts test Cianci's friendship with fire union. Providence Sunday Journal, Page A1.

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 Information Council (1984). National fire incident reporting system (NFIRS) handbook. Washington, DC: Author.

National Fire Protection Association (1954). Fire protection handbook (11th Ed.). Boston: Author.

_____. (1969). Fire protection handbook (13th Ed.). Boston: Author.

_____. (1976). Fire protection handbook (14th Ed.). Boston: Author.

_____. (1987). NFPA 1500: Standard on fire department occupational safety & health program. (1987 Ed.). Boston: Author.

_____. (1992). NFPA 1500: Standard on fire department occupational safety & health program. (1992 Ed.). Boston: Author.

_____. (1993, July). NFPA Standards Action.

_____. (1994, April). NFPA Standards Action.

N.F.P.A. renegs on commitment for professional ffs [sic] committee. (1995, January-February). International Firefighter, p. 1.

O'Hagan, J.T. (1984, November). Staffing levels, a major new study, part I. Fire Command, pp. 16-19.

Peterson, W. (1992, April 15). Is there safety in numbers. IAFC On Scene, p. 1.

Polk & Company (1993). Providence, Rhode Island, city directory, Malden, MA: Author.

Roethlisberger, F.J. & Dickson, W.J. (1939). Management and the worker. Cambridge, MA: Harvard University Press.

Safe staffing causes split in IAFC ranks. (1992, March-April). IAFC On Scene, p. 3.

Sproull, N.L. (1988). Handbook of research methods. Metuchen, NJ: Scarecrow Press, Inc.

Stapleton, L.D. (1992, August). The history of firefighting staffing. Commish.

Struening, E.L. & Guttentag, M. (1975). Handbook of evaluative research, Vol I. Beverly Hills: Sage Publications, Inc.

Sundberg, N.D., Tyler, L.E., & Taplin, J.R. (1973). Clinical psychology: expanding horizons. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Varone, J.C. (1994). Providence Fire Department staffing study. Executive Fire Officer Research Paper, Emmitsburg, MD: National Fire Academy.

Whitehead, A.K. (1992, September-October). Urgent need for comments on NFPA 1500 staffing. International Firefighter, pp. 12-14.