Executive Analysis of Fire Service Operations in Emergency Management

Evaluating the Safety and Effectiveness of Standpipe Kits

Utilized by the Asheville Fire Department

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed: ____

Abstract

The problem was the Asheville Fire Department did not have a means to evaluate its standpipe kits. The purpose of this research was to assess the safety and effectiveness of the kits. The author researched this problem using evaluative research. The research questions were:

1. What national standards exist for standpipe kits?
2. What is the safest type of standpipe kit configuration?
3. What is the most effective standpipe kit configuration?
4. What are the capabilities of the standpipe systems in AFD's coverage area?

The author researched literature and evaluated the systems. The study identified that 2-½ inch hose and smooth bore nozzles are best for standpipe kits. The author recommends further study of standpipe kits in other departments.

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Introduction

The problem is the Asheville Fire Department (AFD) does not have a means to evaluate the safety or effectiveness of its standpipe kits. The purpose of this research is to assess the standpipe kits used by the department. The author will research this problem using evaluative research. Literature will be reviewed to identify national standards that exist for standpipe kits, the safety of different standpipe kit configurations, and the effectiveness of different types of standpipe kit configurations. Different standpipe kit configurations will be flow tested to evaluate their effectiveness. Representative standpipe systems in AFD’s coverage area will be flow tested as well to determine their capabilities. The research questions are:

1. What national standards exist for standpipe kits?
2. What is the safest type of standpipe kit configuration?
3. What is the most effective standpipe kit configuration?
4. What are the capabilities of the standpipe systems in AFD’s coverage area?

Background and Significance

AFD currently serves a population of approximately 75,000 people living in a 54 square mile area. The fire department operates out of nine stations and employs 213 personnel. The coverage area that the department is responsible for consists of urban, suburban, and rural segments. The department offers public fire education, injury prevention, code enforcement, fire suppression, basic emergency medical first response, regional hazardous materials response, and heavy rescue services in the coverage area.

In the past, the department has relied on residential and dwelling fire experience to estimate the capability of its standpipe kits. In residential and dwelling fires attended by AFD, fire streams have been created using 1 ¾" diameter hose and an Elkhart SM 20 automatic nozzle. The standpipe kits used by AFD utilized the same configuration of hose size and nozzle. It has been perceived in the past that the same gallons per minute and nozzle pressure experienced at residential and dwelling fires would be experienced when using the standpipe kits. This seemed logical because if the configuration was the same, then the results should be the same. The only difference was the apparatus that supplied the water to the hose configurations. The apparatus that supplied water to the hose configuration for residential and dwelling fires was a fire engine. The apparatus that supplied water to the standpipe kits was a standpipe.

Testing of the capability of the standpipe systems in AFD's coverage area has been very limited. The systems that include fire pumps are the only systems that were tested. Systems that rely on municipal water main pressure and dry standpipe systems were not tested. The systems that have been tested were tested upon initial installation and every five years thereafter. This has been performed by sprinkler contractors. The testing required that the system provide 250 gallons per minute (gpm) at 65 pounds per square inch (psi) at the farthest outlet from the fire pump. This test was conducted at the outlet on the standpipe system farthest from the fire pump. The results of this test were maintained by the building owner. The fire department reviewed this data when code enforcement fire inspections were performed. This data was not relayed to operational personnel or stored by the fire department.

AFD currently has a need to evaluate its standpipe kit capabilities. This is necessary in order to provide the safest and most effective fire streams in occupancies equipped with standpipes. To determine this, the capabilities of standpipe systems in the department's coverage area need to be assessed first. This will give the department a baseline to evaluate the standpipe kits.

The future of the department indicates that evaluating its abilities to fight fires in buildings equipped with standpipes is paramount. The construction activity in the City of Asheville increased 72% from 2004 to 2005 as reported by the Asheville Chamber of Commerce. If this growth continues in the future, a massive increase in new buildings will be included in the City of Asheville. The possibility that much of this construction will include standpipes will require the department to protect an even greater number of such occupancies. As the population and number of buildings increases in density, the number of fires in this type occupancy will also likely increase.

The research problem addresses whether the department is utilizing the safest and most effective standpipe kit for the occupancies in its coverage area. The research problem relates to the National Fire Academy's Executive Analysis of Fire Service Operations in Emergency Management course. This relation is through the terminal objective taught in the course for students to "analyze their department's level of preparedness for the fire service and the community in emergency management." (National Fire Academy, 2004, p. SM 1-1). This research problem also relates to the United States Fire Administration's operational objective "To appropriately respond in a timely manner to emergent fire and all-hazard issues." (NFA, 2004, USFA Operational Goals, ¶ 3). This research will evaluate the level of preparedness the department has in fighting fires in standpipe equipped occupancies. If the department could be better prepared, this research will direct department decision makers to respond to the issue.

Literature Review

A literature review was conducted to explore the works of others on the topic of standpipe kits to gain insight into the research problem. The majority of the literature review took place at the National Fire Academy's Learning Resource Center utilizing a free text search of their database for "High Rise" on March 7th, 2005. The search was limited to literature published within the last eight years to ensure that the references were current. The search was further limited to publications related to high rise fire operations. Three questions were asked during the literature review:

1. What national standards exist for standpipe kits?

There were no national standards specifically related to standpipe kits found in the literature. There were two National Fire Protection Association (NFPA) standards found that contained references to standpipe kits. *NFPA 13E* (2005) provides guidance for standpipe kit configuration development by stating that "fire personnel should determine the needed pressure and quantity of water at the highest outlets, and they should develop procedures to provide appropriate amounts of water for firefighting when using the system" (chap. 4-2.2). *NFPA 13E* provides further guidance for standpipe kit configuration in that "fire personnel should provide hose and nozzles of appropriate size and length along with proper accessory equipment for the anticipated fire conditions" (chap. 4-3.5).

NFPA 14 (2003) provided even further guidance for standpipe kit configuration by stating:

It is very important that fire departments chose an appropriate nozzle type for their standpipe fire-fighting operations. Constant pressure- (automatic-) type spray nozzles should not be used for standpipe operations because many of this type require a minimum of 100 psi of pressure at the nozzle inlet to produce a reasonably effective fire stream. In standpipe operations, hose friction loss could prevent the delivery of 100 psi to the nozzle…the 2 ½-in. smoothbore nozzle with a 1 1/8-in. tip produces a usable stream [250 gpm] at 50-psi inlet pressure requiring 65 psi at the valve outlet with 100 ft of 2 ½-in. hose or 73 psi at the outlet with 150 ft of hose. (chap. A-5-7)

NFPA 14 also discusses requirements for standpipe kits used in buildings under construction by stating "a quantity of hose sufficient to reach all parts of the floor, a 1 1/8 –in. nozzle, spanner wrenches, and hose straps should be kept" (chap. A-10-5).

The literature review indicated that there were no national standards that directly applied to standpipe kits. Two NFPA standards were identified, however, that referenced standpipe kits. These standards recommended that fire departments should evaluate fire flows available and carry appropriate sized hose and equipment to deliver effective fire streams. The standards also stated that automatic nozzles should not be used in standpipe kits. The standards stated that a standpipe kit configuration of 2 ½ inch hose with 1 1/8 inch tip smooth bore nozzle would provide a usable fire stream.

2. What is the safest type of standpipe kit configuration?

The literature supported that the type of nozzle used in the standpipe kit was the most important component for safety. Powers (2003) reports about the dangers of using fog streams from a combination nozzle "the dangers and problems of using fog to attack all structural fires have been down played and forgotten" (p. 4). Gustin (1997) also cautions against using combination nozzles:

> Application of PPV or use of a fog pattern prior to search and rescue can make conditions much worse for these unfortunate occupants because smoke and heat will be driven toward the windows where they are trapped. Never implement fire attack with fog streams or PPV without first considering the effect on occupants who may be trapped. (p. 52)

Dunn (2000) recommends against combination nozzles and states "use a solid stream nozzle at a high-rise office building fire. Window venting that is required for safe use of a fog nozzle is not an option" (p. 22). McGrail (2005) suggests:

> Fire departments equipped with only 1 ¾-inch hose and combination nozzles, specifically the automatic type, need to take proactive steps and change their operational policy with regard to equipment use for standpipe operations. If for no other reason, this must be done for firefighter safety and survival. (p. 75)

The reasons stated in the literature for not using combination nozzles on standpipe kits are primarily due to the large amounts of steam and air produced when operated. Knapp, Pillsworth, and White (2003) after discovering the large quantities of air that fog streams introduced into a fire environment reported that "it seems reasonable to conclude that not driving large quantities of air into the fire area will have a positive influence on the fire attack by not stimulating fire growth in areas not being reached by the water" (p. 72). Knapp, Pillsworth, and Flatley (2004) stated after their testing:

> Supporters of using fog nozzles for an interior fire attack profess that the fog will

> drive all the heat and smoke away from the nozzleman and out the vent opening. This test proved that this is not the case when the nozzle is used inside a building. This is a great theory, much like positive pressure ventilation; but if the ventilation is not adequate, not accomplished, or not big enough, you will quickly drive heat and smoke and likely spread the fire with deadly results. (p. 52)

Fredericks (2000) emphasizes the danger of combination nozzles to civilians by saying that "while many an interior fire attack has failed when the nozzle team had to quickly retreat because of steam burns, the full impact of live steam on civilians trapped within the fire building remains uncertain" (p. 72).

Other authors wrote about the inability to protect firefighters with a combination nozzle. Bruni and Edwards (2000) stated regarding testing done in St. Petersburg, Florida that "the theory taught about fog streams went right out the window. There was no protection offered from fog streams inside the structure. The fog stream inside an unventilated structure did not protect the firefighters – it burned them" (p. 63). Burnette (2004), recognizing flashover as the greatest safety concern for a crew using a standpipe kit states that "the best, safest, and most efficient way to minimize flashover is to use a straight or solid stream" (p. 108).

The possibility of combination nozzles getting clogged with debris was another safety concern identified in the literature. A fire in Edina, Minnesota in October of 2002 underscores the risk of debris reducing the flow of nozzles. The incident grew into a fully involved apartment fire when two separate combination nozzles became clogged with weeds and a birds nest while the other was clogged with a tennis ball (Obstructed Nozzles, 2004).

One author reported fire departments changing their operations after firefighter fatalities occurred involving combination nozzles and standpipe kits. Ward (2003) writes about firefighter fatalities in New York City and Houston. Both departments now require that firefighters use 2 ½ inch hose with smoothbore nozzles as a result of lessons learned from their line of duty deaths (p. 116).

The literature that was reviewed was very clear that the safest standpipe kit configuration included a smooth bore nozzle. The literature cautioned very strongly against using combination nozzles due to the large volumes of air and steam produced, the lack of protection it offered, and the possibility of the nozzle becoming obstructed by debris.

3. What is the most effective standpipe kit configuration?

The literature focused primarily on how differing pressures affected standpipe kits and their effectiveness. One reason identified for this focus is due to the low pressures experienced when using standpipe systems. Norman (1998) addresses the low pressures experienced when operating off of standpipe systems prior to an apparatus connecting to fire department connections (FDC) by mentioning "the low operating pressures commonly encountered at first" (p. 144). These low pressures are compounded by the fact that buildings built with systems prior to 1993 followed an even lower pressure requirement guideline than those constructed after 1993. Shapiro (2003) discusses the standards for standpipe systems built prior to 1993 and after 1993:

> NFPA 14 was modified in the 1993 edition to increase the minimum outlet pressure for Class I and Class III outlets from 65 psi to 100 psi because of

> questions raised regarding the adequacy of a 65-psi minimum design pressure on automatic and semi-automatic standpipes. (p. 10.355)

Standpipe systems were designed to be used with low pressure nozzles and large diameter hose lines. Norman (1998) states that "when departments decide to use 1 ½-, 1 ¾-, or 2-inch hose and fog nozzles, they violate the design of standpipe systems" (p. 134). Shapiro (2003) comments that the "use of piston-type automatic nozzles is not advised for standpipe systems because such nozzles require high pressures to produce satisfactory streams" (p. 10.364).

Norman (1998) writes about the need to have hose of sufficient diameter in your standpipe kit to "ensure that the needed volume of water is available right at the start by initially providing the proper size hose" (p. 146). He also recommends that the kit include "a spanner wrench, any necessary hose thread adapters, as well as a 10-inch or 14-inch pipe wrench" to open a valve that is missing a hand wheel (p. 147). McGrail (1999) recommends to:

> Use solid stream /smooth-bore nozzles for standpipe and high-rise operations. This type of nozzle is associated with low pressure and high volume; it effectively passes debris; it is durable (it has only one moving part); it reduces the chances of pushing fire around a typical center core-'donut effect'; and it provides overall effectiveness and minimal steam production in the typically unventilated, high-heat atmosphere of a high rise fire-or any other interior structural fire, for that matter.

Regan and Fredericks (2000) state "A major benefit of solid stream nozzles is that at equal flows, a solid stream nozzle will produce approximately, one-third less reaction force than a 100-psi fog nozzle set to straight stream position" (p. 70).

Several authors wrote about testing that fire departments had conducted to determine the optimal standpipe kit configuration. Comella (2003) reports the results of testing performed in Oakland, California. He reports that companies were delivering fire flows lower than perceived with 1 ¾ inch hose and combination nozzles. Attempting to provide 125 gpm, "various engine companies showed flows ranging from 60 to 105 gpm" (p. 67). Accardi (2001) reports that the results of his testing in Delray Beach, Florida, were "it is more advantageous to use either 1 ¾ inch or 2 ½ inch smooth bore nozzles for high-rise hose pack operations" (p. 41). He also recommends that Delray Beach Fire Department begin using "150' of pre-strapped 2 ½ inch hose and 1 ¼ inch smooth bore nozzles for the high rise packs" based upon the results of his research into improving water flow delivery capabilities (p. 46). Edwards (2003) states "feedback from ten large, busy municipal fire departments indicated that a majority use 2 ½ inch hose with 1 1/8 inch smooth bore nozzles" (p. 22). He also states:

> New high-rise hose packs consisting of 2 ½ inch hose and 1 1/8 inch smooth bore nozzles for commercial high-rise standpipe applications and 1 ¾ inch hose with 7/8 inch smooth bore tips for select residential high-rise standpipe applications should be implemented in the Oakland Fire Department. (p. 30)

Shapiro (2004) reports the results of tests performed by the Las Vegas Fire Department that at 50 pounds per square inch (psi) standpipe outlet pressure, the 1 ¾' automatic nozzle delivered 65 gpm and the 2 ½" smooth bore nozzle delivered 198 gpm (p. 98).

Tracy (2001) recommends a smooth bore nozzle in the standpipe kit configuration and offers that:

> Many departments choose to use combination (fog) nozzles exclusively. Most of the reasons they do this are outdated for interior structure firefighting. The increased flows, reach of stream, and reduced nozzle reaction of smooth-bore nozzles are less arduous and offer superior penetration and safety from extreme heat and injury from collapse that distance provides. (p. 16)

The literature that was reviewed strongly suggested that the most effective configuration for standpipe kits included 2 ½ inch hose and a smooth bore nozzle. The main reason provided was the higher flow rates afforded by the smooth bore nozzle and 2 ½ inch hose when operating with low pressures. Lower nozzle reaction was another reason given for the increased efficiency of the smooth bore nozzle.

Procedures

Nozzle Testing

The first phase of the research project involved testing different types of nozzles to determine what capabilities each would have as part of a standpipe kit configuration. AFD's current standpipe kit was constructed with a 2-½ inch female gated wye that had two 1 ½ inch male outlets, two 50 ft. lengths of 1-¾ inch hose, and an Elkhart SM 20 automatic combination nozzle. To keep the appliance and hose variables constant, the same configuration was used when testing the nozzles. Twelve nozzles were tested.

Since NFPA 14 prior to 1993 required an outlet pressure of 65 psi at the farthest outlet, this pressure was used as a starting point. After 1993, NFPA 14 required 100 psi at the farthest outlet on the standpipe system. It was decided to use this as an endpoint.

This would give a range of the lowest possible pressures encountered regardless of when the system was installed. Water was pumped into the standpipe kit from a fire engine at 65, 75, 90 and 100 psi outlet pressures. A flow meter recorded gpm. Nozzle reaction was calculated using the formulas: Nozzle Reaction=0.0505 x √Nozzle Pressure x gpm for combination nozzles, and Nozzle Reaction=1.57 x diameter^2 x Nozzle Pressure for smooth bore nozzles. Reach was measured with a rolling measuring tape. Effective reach was measured from the nozzle to the point were an estimated 90% of the water landed.

During the testing of the 2 ½ inch nozzles, 100 feet of 2 ½ inch hose was used in place of the 1 ¾ inch hose. There also was no gated wye used in the 2 ½ inch test. The test pressures remained the same.

Standpipe System Testing

To determine if selected standpipe systems in AFD's coverage area would deliver 65 psi or 100 psi at the furthest outlet, two properties were selected to flow test the standpipe systems. The properties chosen did not have a fire pump incorporated so that the least possible pressure scenario could be evaluated.

The current AFD standpipe kit configuration was used to flow the furthest outlet on the standpipe. A static pressure was obtained, and then outlet flow pressure and nozzle pressure were recorded using in-line gauges. A flow meter recorded flow rate of the standpipe in gpm. System pressure only was used to evaluate the performance of the standpipe kit.

Secondary Nozzle Testing

The results of the standpipe system testing were used to test the nozzles a second time. This time the lowest nozzle pressure obtained from the standpipe system test was used to obtain a real world worst case scenario of low pressure. The standard operating guideline (SOG) for pumping standpipe kits at AFD is to add 5 psi per floor of elevation to 125 psi. This is what the engineer is to pump into the fire department connection. This theoretically results in a 120 psi outlet pressure. The nozzles were also tested again at 120 psi pump pressure to evaluate nozzle performance at AFD's SOG.

Limitations

The testing exhibited several limitations. The standpipe system test only evaluated the outlet pressure and nozzle pressure utilizing the current 1 ¾ inch standpipe kit configuration. If a 2 ½ inch standpipe kit configuration would have been used, different outlet pressures and nozzle pressures would have been exhibited due to the greater amount of water flow. Other limitations involved the number of standpipe systems that were tested. Testing a standpipe system was found to be very disruptive to the building occupants. A place for the discharged water had to be identified with each building. This proved to be difficult in the downtown area.

Definition of Terms

Automatic Nozzle - An appliance designed to attach to the end of fire hose to produce a fire stream. This type of combination nozzle uses an internal plunger that narrows or widens the opening to allow more or less water to flow out of the nozzle. The plunger responds to pressure increases or decreases at the base of the nozzle. This allows water flow to increase or decrease and correspondingly increases or decreases nozzle pressure.

Combination Nozzle - An appliance designed to attach to the end of fire hose to produce a fire stream. This type nozzle incorporates internal deflectors that breaks up the fire stream into small particles of water. The nozzle can be adjusted to flow a wide fog pattern of water or a straight stream of water.

Coverage Area - The land area in which the Asheville Fire Department has primary responsibility to provide emergency services. This 54 square mile area includes the corporate limits of the City of Asheville, Town of Biltmore Forest, and the Biltmore Estate.

Fire Engine - Motorized apparatus equipped with a water pump, hose, and water. This apparatus has the capability to pressurize water and send it through fire hose to create a fire stream.

Fire Flow - The rate at which water is applied to extinguish a fire. Fire flow is expressed in the English System of Measurement as gallons per minute (gpm).

Fire Pump - A water pump included in some standpipe systems. This allows the water in the system to be pumped to a greater pressure than what is provided by the municipal water system.

Fire Stream - A stream of water directed for the purpose of controlling a fire. This stream is typically directed by firefighters from a fire hose.

Fog Nozzle - A combination nozzle.

Smooth Bore Nozzle - An appliance designed to attach to the end of fire hose to produce a fire stream. This type nozzle is a hollow, tapered opening, usually with a control valve as its only moving part.

Standpipe - A built-in fire protection feature consisting of pipes and outlets that facilitate the movement of fire protection water throughout a large building. These pipes are typically placed in stairwells and provide an outlet at each floor landing. Firefighters utilize these outlets by connecting to them with a standpipe kit. This built-in fire protection feature prevents firefighters from having to hand deploy large lengths of fire hose to get a fire stream close to the fire. Some standpipe systems incorporate a fire pump which allows the water to be pumped through the system at a higher pressure than what the municipal water pressure provides.

Standpipe Kit – A configuration of hose, appliances, and a nozzle used to connect to a standpipe.

Results

A review of literature and evaluation of standpipe kit configurations and standpipe systems provided insight into each of the research questions.

1. What national standards exist for standpipe kits?

The literature review indicated that there were no national standards that directly applied to standpipe kits. Two NFPA standards were identified, however, that referenced standpipe kits. These standards recommended that fire departments should evaluate fire flows available and carry appropriate sized hose and equipment to deliver effective fire streams. The standards also stated that automatic nozzles should not be used in standpipe kits. The standards stated that a standpipe kit configuration of 2 ½ inch hose with 1 1/8 inch tip smooth bore nozzle would provide a usable fire stream.

2. What is the safest type of standpipe kit configuration?

The literature that was reviewed was very clear that the safest standpipe kit configuration included a smooth bore nozzle. The literature cautioned very strongly against using combination nozzles due to the large volumes of air and steam produced, the lack of protection it offered, and the possibility of the nozzle becoming obstructed by debris.

The evaluation of the standpipe kit configurations measured two safety factors: effective reach of the fire stream, and fire flow. The shorter the effective reach, the closer the firefighters would have to get to the fire. The lower the gpm or fire flow, the less protection from flashover and rapid fire advancement the firefighters would have. The results of these tests are summarized in Tables 1 and 2.

The testing resulted in the low pressure nozzles, particularly the smooth bore nozzles as having greater reach and higher fire flow.

Table 1

Effective Reach

Nozzle type	Outlet pressure 65 psi	Outlet pressure 100 psi
1 ¾” Elkhart SM-30F 300 gpm Automatic	40 ft.	NA
1 ¾” TFT Midforce Dual Pressure 70-200 gpm Automatic	40 ft.	80 ft.
1 ¾” Elkhart Chief 95 gpm	61 ft.	80 ft.
1 ¾” Elkhart SM-20F 200 gpm Automatic	62 ft.	95 ft.
1 ¾” Akron 150 gpm Turbojet 1722P	70 ft.	102 ft.
1 ¾” Akron 15/16” Break Apart	72 ft.	102 ft.
1 ¾” Akron 15/16” Smooth bore	70 ft.	105 ft.
1 ¾’ Elkhart Chief 150 gpm Low Pressure 4000-14	72 ft.	108 ft.
2 ½” Akron 1 ¼” Smooth Bore	80 ft.	110 ft.

Table 2

Fire Flow

	Outlet pressure	
Nozzle type	65 psi	100 psi
1 ¾" TFT Midforce Dual Pressure 70-200 gpm Automatic	10 gpm	190 gpm
1 ¾" Elkhart SM-30F 300 gpm Automatic	40 gpm	105 gpm
1 ¾" Elkhart Chief 95 gpm	55 gpm	76 gpm
1 ¾" Elkhart SM-20F 200 gpm Automatic	45 gpm	180 gpm
1 ¾" Akron 150 gpm Turbojet 1722P	120 gpm	135 gpm
1 ¾' Elkhart Chief 150 gpm Low Pressure 4000-14	130 gpm	162 gpm
1 ¾" Akron 15/16" Break Apart	160 gpm	230 gpm
1 ¾" Akron 15/16" Smooth bore	165 gpm	230 gpm
2 ½" Akron 1 ¼" Smooth Bore	300 gpm	385 gpm

3. What is the most effective standpipe kit configuration?

The literature that was reviewed strongly suggested that the most effective configuration for standpipe kits included 2 ½ inch hose and a smooth bore nozzle. The main reason provided was the higher flow rates afforded by the smooth bore nozzle and 2 ½ inch hose when operating with low pressures. Lower nozzle reaction was another reason given for the increased efficiency of the smooth bore nozzle.

The test results from the evaluation of the standpipe hose and nozzle tests state that 2 ½ inch hose with a smooth bore nozzle is the best configuration for reach and fire flow. This is represented in Table 1 and 2 above.

4. What are the capabilities of the standpipe systems in AFD's coverage area?

The standpipe systems flow tested showed that the department could expect an even lower than 65 psi outlet pressure on its systems. Table 3 represents the findings of the flow tests.

Table 3

Standpipe System Flow Tests

		Pressures	
Location	Static	Outlet flow	Nozzle pressure
Bartlett Arms Apartments	175 psi	75 psi	60 psi
Aston Park Towers	90 psi	55 psi	30 psi

It is evident by the testing that AFD could encounter pressures far less than even pre-1993 NFPA 14 requires.

Discussion

The results of this research correlate well with the findings of others identified in the literature review. The national standards applicable to standpipe kits are NFPA 13E and NFPA 14. Neither standard directly applies to standpipe kits specifically, but reference them indirectly.

The safest configuration for standpipe kits was found through the evaluation to be 2 ½ inch hose with a smooth bore nozzle. This was directly in line with the literature identified in the literature review.

The most efficient configuration was also 2 ½ inch hose with a smoothbore nozzle. This matched the findings in the literature review due to the configurations ability to perform well in low-pressure settings.

The capabilities of the standpipe systems in AFD's coverage area are marginal. The expectation was that they would at least meet the 65 psi outlet pressure identified by pre-1993 NFPA 14. This unfortunately was not the case.

The author's interpretation of the study results is that there is much support in the literature for changing the standpipe kit used by AFD. The evaluations also showed preliminary evidence that larger diameter hose and smooth bore nozzles would increase the safety and effectiveness of AFD's standpipe kits.

The author believes that the findings of this study indicate that the safest and most effective standpipe kit is one with 2 ½ inch hose and a smooth bore nozzle. This implementation is one that would increase the overall operational effectiveness of the department at high rise incidents or any occupancy that has a standpipe system.

The organizational implications of this study are important. AFD can utilize this information to greatly improve the safety and effectiveness of its operations at high rise incidents. The benefits to the department gained through this study could have long lasting implications by the potential life and property saved if an incident occurs at an occupancy containing a standpipe system.

Recommendations

AFD should begin training its personnel on using standpipe kits that utilize 2 ½ inch hose and smooth bore nozzles. The training aspect should be heavily emphasized and incorporated into company operations. Construction of the standpipe kits should take place and be issued to each company after the training component has been completed. Quarterly or bi-annual refresher training needs to be implemented as well to ensure that all operational personnel are well versed in standpipe operations.

The department should further explore the flows of standpipe systems in the coverage area. A schedule to flow test all standpipe systems should be coordinated with the Fire and Life Safety Division and the results of this testing shared with all personnel.

Future readers of this research are encouraged to utilize standpipe kits that incorporate large diameter hose and low-pressure nozzles. Smooth bore nozzles and 2 ½ inch hose would serve these purposes best.

References

Accardi, R. (2001). *Operational considerations for the Delray Beach Fire-Rescue Department at high-rise fires.* National Fire Academy, Executive Fire Officer Program, Emmitsburg, MD.

Asheville Chamber of Commerce. (n. d.). *Asheville area economic indicators.* Retrieved August 20, 2005, from http://www.ashevillechamber.org/pdf/EI08_05.pdf

Bruni, J. & Edwards, R. (2000, April). Retooling the one-inch smooth-bore tip. *Fire Engineering.* pp. 62-63.

Burnette, S. T. (2004, June). Flashover risk management. *Fire Engineering.* pp. 106-108.

Comella, J. (2003, April). Planning a hose and nozzle system for effective operations. *Fire Engineering.* pp. 67-78.

Dunn, V. (2000, November). High-rise firefighting strategy and tactics – part 1. *Firehouse.* Pp. 18-22.

Edwards, J. D. (2003) *High-rise firefighting: an analysis of procedures for operational effectiveness.* National Fire Academy, Executive Fire Officer Program, Emmitsburg, MD.

Fredericks, A. A. (2000, February). Little drops of water: 50 years later, part 1. *Fire Engineering.* pp. 63-76.

Gustin, B. (1997, November). Fog streams and PPV: their effects on two fires. *Fire Engineering*. pp. 49-55.

Knapp, J., Pillsworth, T., & Flatley, C. (2004, February). Nozzle tests prove fireground realities, part 3. *Fire Engineering*. pp. 50-55.

Knapp, J., Pillsworth, T., & White, S. P. (2003, February). Nozzle tests prove fireground realities. *Fire Engineering*. pp. 71-80.

McGrail, D. M. (1999, March). High-rise firefighting and standpipe training. *Fire Engineering.* pp. 69-88.

McGrail, D. M. (2005, February). Engine company standpipe operations: Pressure-regulating devices. *Fire Engineering.* pp. 63-76.

National Fire Academy. (2004). *Executive Analysis of Fire Service operations in Emergency Management.* Emmitsburg, MD: Author.

National Fire Academy. (2004). *U. S. Fire Administration 2004-2005 training catalog* [Catalog]. Emmitsburg, MD: Author.

National Fire Protection Association. (2005). *Recommended Practice for Fire Department Operations in Properties Protected by Sprinkler and Standpipe Systems* (NFPA 13E). Quincy, MA: Author.

National Fire Protection Association. (2003). *Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems* (NFPA 14). Quincy, MA: Author.

National Fire Protection Association. (2002). *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems* (NFPA 25). Quincy, MA: Author.

Norman, J. (1998). *Fire officer's handbook of tactics* (2nd ed.). Saddle brook, NJ: PennWell.

Obstructed nozzles block fire attack. (2004, Winter). *Rapid access*, 11-1.

Powers, C. (2003, July). *Fire streams, ventilation, and firefighter safety.* Paper presented at the meeting of the Ontario Association of Fire Chiefs, Ontario, Canada.

Regan, J. & Fredericks, A. A. (2000, April). Improving the quality of your solid streams. *Fire Engineering.* pp. 59-72.

Shapiro, J. M. (2003). Standpipe and hose systems. In A. E. Cote et al. (Ed.), *Fire Protection Handbook* (19th ed.) (pp. 10.351 – 10.367). Quincy, MA: National Fire Protection Association.

Shapiro, P. (2004, August) Project high-rise handlines. *Fire Rescue Magazine.* pp. 96-103.

Tracy, J. (2001, March) Do your SOPs measure up? *Fire Engineering.* pp. 14-20.

Ward, M. J. (2003, February) Dying with a great view. *Fire Rescue Magazine.* pp. 115-117.