City of Spartanburg

Fire Department

Hose and Nozzle Committee

&

Training Division

Attack Package Evaluation Report

2019

Table of Contents

Executive Summary

In February 2019, Assistant Chief of Operations, Brad Hall created a committee work group to evaluate the Spartanburg Fire Department's Engine Company attack packages. The committee's focus was to evaluate and recommend nozzle and hose packages for Department wide implementation. The committee was also tasked with developing a comprehensive plan to implement those recommendations.

The Nozzle and Hose Evaluation looked at a wide variety of nozzle and hose manufacturers. The testing and field evaluation process looked at current and cutting edge technology in fire suppression equipment, minimum flow required for residential and commercial structures, nozzle reaction, hose kink/whip and compared it with the current equipment being used.

The evaluation results showed that a combination of Elkhart Brass and Ponn TRU-A-TAK hose allowed for the delivery of targeted fire flows with low nozzle reaction, less stream break up, low friction loss and more kink resistance than any other combination of nozzle and hose. The ability to reach our targeted fire flow with low nozzle reaction and more kink resistance leads to increased firefighter safety and effectiveness during interior fire attack operations.

Background

The Spartanburg Fire Department is a career fire department protecting 37,000 residents and covering 20 square miles. The Department provides protection from five stations through four Engine Companies. The majority of the equipment for the Engine Companies attack packages have not been updated in the past twenty years, leading to a wide range of nozzle and hose manufacturers, styles and models being found throughout the fleet.

During the Winter of 2018-2019, a dedicated group of firefighters spurred an effort to improve and standardize the attack package equipment carried on all Engine Company apparatus.

In February of 2019, the Department created a committee work group to evaluate and recommend nozzle and hose packages for Department wide implementation. The evaluation process would look at the Department's current nozzle and hose packages. These packages would be evaluated on flow, reaction, whip, kink, durability, maintenance and cost. The results of the current attack package evaluation showed that we had multiple styles of nozzles manufactured by Akron Brass and Task Force Tips. All combination nozzles were 150gpm @ 100psi. All smoothbore nozzles were 7/8" tip @ 50psi. Most of the current 1 ¾" attack hose was the standard 1.88" inside diameter version, manufactured by Firequip. This model hose paired with our 50psi smoothbore nozzles allows for extreme hose whip/kink, which lessens the effectiveness of our Engine Company Hose Teams. The 150gpm @ 100psi combination package produced too much nozzle reaction. That over exerted our hose teams and lessened our effectiveness. The evaluation also showed that our 2 ½" hose was manufactured by different companies and was intermixed.

Data from the initial evaluation showed that there was a need to look at hose and nozzle manufacturers and attempt to determine the best nozzle and hose combination for the Spartanburg Fire Department.

Evaluation

All evaluations were conducted at the Piedmont Interstate Fairgrounds located at 575 Fairgrounds Rd. Spartanburg S.C. 29303.

The SFD Nozzle and Hose Evaluation Committee consisted of Lt. Paul Sisk, Lt. Stephen Elder, Lt. Justin Harris, Lt. Kevin Tate, Sgt. Hunter Dorsey, Sgt. Jared Van EK, Sgt. Trent Inman, FF. Travis Millwood, FF. Shannon Grier, FF. Brian Winder.

SFD personnel utilized for the evaluations consisted of Capt. Ben Baker, Lt. Brad Bennett, Lt. Kirk Glymph, Lt. Andy Chalk, Sgt. Zack Comer, Sgt. Taylor Martinez, Sgt. Josh Martin, Sgt. Thomas Merck, Sgt. Josh Alexander, Sgt. Jacob Brown, FF. Jarod Teter, FF. Johnathon Emory, FF. Julia Viznyak, FF. A'Najee Browne, FF. Moses Baraniuc, FF. Andrew Mostiler. Personnel from Engine 62, Engine 64 and Engine 65 assisted with the evaluations.

All evaluations were pumped by SFD Engine 63 (2012 Pierce Impel Job #25663 with a 1500 GPM Waterous Pump)

Initial Testing of Current Attack Packages

The initial testing was performed with the equipment that is currently operating on Engine 61, Engine 62, Engine 63, Engine 64, Engine 65, and Engine 66. This allowed us to get familiar with a testing process and evaluate a standard to which we could compare all other hose and nozzle manufacturers.

Three different styles of hose all made by Firequip were found on all engines within the city that are currently being used for the attack lines.

- Firequip DJ-800 Nylon Rubber Lined
- Firequip Attack Lite Poly
- Firequip Attack Lite Nylon

A wide range of nozzles were found to be operating on all engine companies attack lines.

1 ¾ Attack Lines were equipped with;

- Zero Torque SB Nozzle Akron with 7/8” Tip
- Zero Torque SB Nozzle Akron with 15/16” Tip
- Akron Shut Off with 7/8” Tip
- Akron Shut Off with 15/16” Tip
- TFT Shut Off with 7/8” Tip
- TFT Fog Nozzle 150gpm at 100psi with 1 3/8” waterway
- TFT Fog Nozzle 150gpm at 100psi with 1” waterway
- TFT Automatic Fog 50-350gpm at 100psi

2 ½ Attack Lines were equipped with;

- TFT Automatic Fog 50-350gpm at 100psi
- Akron Automatic Attack Tip Fog 250gpm at 100psi
- Akron 2 ½” SB playpipe (Steel)
- Akron 2 ½” SB playpipe (Pyrolite)
- TFT SB 1 1/8” tip with 1 ½” waterway

After identifying our current attack packages, the next step was to evaluate our current lines using the following testing process.

Equipment

North Spartanburg Fire Department has provided a Flow Meter, in-line pressure gauges, and scale. The equipment was used to keep the results of the testing as consistent as possible.

Flow Meters were used to test the gallon per minute of water flow through the hose lines and nozzles on the intake side of apparatus. This setup helped prevent any miss readings from the flow meter.

In-line Gauges were used to measure the friction loss throughout the hose line and to measure nozzle pressure on fog nozzles.

Scales were used to measure the amount of pressure from nozzle reaction.

Process

To test the GPMs of the lines, the flow meter was attached to the intake side of the engine and an in-line gauge was placed at the end of the line, behind the nozzle, to ensure that the proper nozzle pressure is obtained. The flow was tested stationary and around Canvas Corners. The Canvas Corners were setup into a hallway configuration. The hallway walls were 4ft from the door forcing the nozzle person to go to the left 12ft, then make a right turn another 6ft. This allowed us to test the maneuverability of the line while flowing and obtain a more real world flow.

To test Kinks in the hose and how it effects flows while advancing, we started with the NFPA 1961 doorway kink test. Then the hose was tested at 90, 45, and 180 degree kinks. We had wooden forms to keep the kink test consistent. This showed how the line and nozzle operate with real world kinks.

To Test the Nozzle Reaction the line was secured to a railing by webbing behind the nozzle and the scale was secured between the railing and the line. This measured how many pounds of nozzle reaction was present with the nozzle fully opened.

Results from Initial Testing

When the initial testing was performed on our current hose, a problem was immediately identified. The hose was marketed and purchased as 1 ¾" but the inside diameter is actually closer to 2". NFPA 1961 does not set a standard for what the actual inside diameter of a hose has to be. It only has to meet a required flow for the listed size. This creates a problem for our department. Our Standard Operating Guidelines for pump discharge pressures on our target flows are inaccurate. We are also adding unnecessary water weight to our attack lines that increases the exertion on our firefighters. We are creating much higher nozzle reactions due to the increased flows, and found that each hose had a significant difference in kink resistance.

This convinced the committee to focus on target flows of 150-160gpm for 1 ¾" handlines and 250-265gpm for 2 ½" handlines. Kink resistance was also identified as being a very important requirement. Our current hose was almost impossible to advance while flowing due to the extremely low kink resistance. When a nozzle person was flowing and a backup person attempted to feed hose, the hose would immediately kink between them.

A wide range of problems were also identified with the current nozzles. The nozzles had different size waterways that caused different flows. High pressure and low pressure nozzles created different back pressures, which created a wide range of results in how the line would operate. The playpipe nozzles were identified to be too heavy and bulky to be considered an attack line and were unable to be advanced.

All GPM flow and sizes will be listed under SFD Testing Section

SFD Testing Results

Hose

Firequip Attack Lite (1 ¾")

This is the most common hose found on our **current** attack lines.

ID 1.937

Flow

SB 185 GPM NR 65LBS

FOG 189 GPM NR 95LBS

Kink

90 degree -	SB 104 GPM	Fog 114 GPM
45 degree -	SB 86 GPM	Fog 95 GPM
180 degree -	SB 8 GPM	Fog 15 GPM
Opening Nozzle -		YES, Kinked at nozzle when start flowing
Whip / Kink @ Nozzle -		YES, Hose would whip if nozzle was released
One Person Advance -		NO, NR was too high due to flow and kinking
Backup Person Hose Feeding -		NO, Hose would kink when pushed forward

Overall, this hose was found to have a very high flow. The flow was way above the target flow of 160 GPM. This caused the nozzle to have a much higher nozzle reaction and made it very difficult for personnel to maneuver the line with limited staffing. The hose kinked very easily, which made it impossible to have the nozzle out in front of the operator. The line was also unable to be pushed by the backup person due to kinking. The large inside diameter of the hose increased water weight and the large outside diameter caused the line to be noticeably larger and harder to grip.

Firequip Exact (1 ¾")

ID 1.750

Flow

SB 160 GPM NR 59LBS

FOG 164 GPM NR 58LBS

Kink

90 degree -	SB 148 GPM	Fog 157 GPM
45 degree -	SB 120 GPM	Fog 126 GPM
180 degree -	SB 8 GPM	Fog 13 GPM
Opening Nozzle -		NO, Did not kink when opening nozzle
Whip / Kink @ Nozzle -		YES, Nozzle would whip if moved
One Person Advance -		YES, kink resistant enough to move slowly
Backup Person Hose Feeding -		YES, could be pushed slightly before kinking

Overall, the hose had good kink resistance compared to our current lines. The hose would kink when the nozzle was moved in a swiping action causing the nozzle to whip some. When the line was advanced the hose was able to be pushed in but would kink if extra hose was forced in. The nozzle person was able to advance and flow without issues.

Ponn TRU-A-TAK (1 ¾”)

ID 1.750

Flow

SB 168 GPM NR 59LBS

FOG 168 GPM NR 57LBS

Kink

90 degree -	SB 162 GPM	Fog 157 GPM
45 degree -	SB 125 GPM	Fog 126 GPM
180 degree -	SB 35 GPM	Fog 47 GPM
Opening Nozzle -		NO, Did not kink when opening nozzle
Whip / Kink @ Nozzle -		NO, Did not kink when moving nozzle
One Person Advance -		YES, kink resistant allowed movement
Backup Person Hose Feeding -		YES, could be pushed hard before kinking

Overall, the hose performed very well. When the line was advanced the hose was extremely kink resistant. If a loop was formed in the line and then the hose was advanced, the loop would roll itself out and not kink. The hose felt smaller in the hand and was easy to grip. Hose had less drag on the ground. The nozzle could be moved aggressively while flowing and the nozzle would not whip. When advancing the line, the backup person could push hose in and the hose would not kink.

Key Hose Tru-ID (1 ¾”)

ID 1.750

Flow

SB 161 GPM NR 57LBS

FOG 150 GPM NR 57LBS

Kink

90 degree -	SB 161 GPM	Fog 151 GPM
45 degree -	SB 127 GPM	Fog 125 GPM
180 degree -	SB 27 GPM	Fog 37 GPM
Opening Nozzle -		NO, Did not kink when opening nozzle
Whip / Kink @ Nozzle -		YES, Did kink when moving nozzle
One Person Advance -		YES, kink resistant allowed movement
Backup Person Hose Feeding -		YES, could be pushed hard before kinking

Overall, the hose was kink resistant. When the nozzle was opened the hose would not kink. When the nozzle was moved aggressively the line would kink close to nozzle allowing the nozzle to whip. The nozzle person was able to flow while advancing but if the nozzle was moved quickly it would whip. The hose was kink resistant enough to be advanced by one person while flowing but once a kink was created the hose would easily kink again in the same area.

Hose Kink Comparison Photos

Below are photos of our current attack lines in operation (Firequip Attack Lite). This line has very low kink resistance and is difficult for one person to manage.

This is a photo of the hose that is recommended by the committee (Ponn Tru A Tak). It has very high kink resistance.

Nozzles

All nozzles tested were low pressure nozzles.

TFT

Model

H-VO Shutoff (1 ¾)

1 3/8” Waterway

7/8” tip 162 GPM

Fog tip 165 GPM

H-2V0 Shutoff (2 ½)

1 3/8” Waterway

1 1/8” tip 265 GPM @ 50 PSI , 238 GPM @ 40 PSI

Fog 250 @ 50 PSI flowed 262 GPM

The TFT nozzles performed well. They had a detent design that created steps for the bail. This helped prevent the bail from being bumped open. The ball valves were machined true to the rest of the waterway. This helped prevent the water in the nozzle from becoming turbulent and breaking the stream up early. The stream began to break up on the SB roughly 5ft from the end of the nozzle (Pictured Below). The handle was oversized and easy to grip with a gloved hand. The nozzle would not rotate easily so that the bail could be positioned comfortably.

Elkhart

Model

XD Shutoff (1 ¾”)

1 1/2” Waterway

7/8” tip 168 GPM

Fog tip Chief XD 160 GPM @ 50PSI flowed 168 GPM

XD Shutoff (2 ½”)

1 1/2” Waterway

1 1/8” tip 266 GPM @ 50 PSI, 242 GPM @ 40 PSI

Fog 265 @ 50 PSI flowed 266 GPM

These nozzles performed the best of all nozzle manufacturers tested. The bail opened and closed smoothly. The bail was also resistant to being bumped open while advancing the line. The nozzle would swivel very easily allowing the bail to be set comfortably. The SB and Fog tips had the most reach and maintained the tightest stream, which would equate to the least amount of steam conversion while performing interior attacks.

Akron

Model

2127 1 ½” X 1 ½” Shut off (1 ¾”)

1 3/8” Waterway

7/8” tip 153 GPM

Fog tip 4866 Mid-Range Assault 150 @ 50PSI flowed 152 GPM (did not offer 160 @ 50Psi)

2126 2 ½” X 1 ½” Shutoff (2 ½”)

1 3/8” Waterway

1 1/8” tip 252 GPM @ 50 PSI, 232 GPM @ 40 PSI

Fog 250 @ 50 PSI flowed 254 GPM

Out of all the nozzles tested, Akron failed to meet our expectations. Akron did not offer a 160 GPM @ 50PSI option on break apart nozzles. The SB tips were the shortest out of all nozzle manufacturers. It had the shortest stream and broke apart the fastest. The ball valve created a lip inside the nozzle which caused more turbulence, resulting in more broken stream. The handles were the smallest of all manufacturers and were the only one made of plastic. The nozzle was very easy to bump open or shut depending on the operation. The nozzle did not rotate easily so that the bail to be positioned comfortably.

Commercial Attack Package Justification

Our current commercial attack line package consists of 200ft. of 2 1/2” hose and a 2 1/2” playpipe nozzle with stack tips. We have multiple manufacturers and models of 2 1/2” hose in service. The actual inside diameter of these hoses are not 2 1/2”. They can range from 2.65” to 2.85”. With these inside diameters, the high end flow of our commercial attack packages can be well over 330gpm and have a nozzle reaction over 120lbs. Hose of these sizes are almost useless in handline operations because of low water velocity (below 17 feet per second). This causes kink issues and pump discharge pressures that are too low, plus up to 70 lbs. extra of water weight per 100ft. at common flows between 266gpm – 325gpm. One advantage these size lines do have is that the higher flows allow us to use them for both supply and attack. They work well when being flowed as a stationary attack line or with our Blitzfire package.

Retired Commander Vincent Dunn is the author of “Strategy of Firefighting”. Retired Deputy Assistant Chief John Norman is the author of “Fire Officer’s Handbook of Tactics”. Both men were firefighters in the FDNY for over 40 years and are considered to be nationally recognized experts on firefighting. Vincent Dunn and John Norman both viewed flows greater than 300gpm in handlines as not practical for flow and advance handline operations. Pairing their views with our short staffed Engine Companies, we feel that at target commercial attack package flow of 265gpm is where we need to be for our Companies to be effective. If we combine Ponn TRU-A-TAK 2 1/4” hose with an Elkhart Brass smoothbore nozzle containing a 1 1/8” tip, we can flow 265gpm at 50psi nozzle pressure and 99lbs of nozzle reaction. That hose has a true internal diameter of 2 1/4”. It will have a smaller outside diameter for a more ergonomic grip that will allow our hose teams to maneuver and advance the line more efficiently. The 2 1/4” line, when charged, will eliminate over 30lbs of water weight per 50ft. versus our current 2 1/2” hose. This will assist with our hose team’s efficiency while also reducing fatigue. If we utilize this attack package as an interior commercial line and use our 3” leader line to supply our Blitzfire operations, we can meet our fire flow targets without the handicap of having it to be a dual purpose line. When we can meet our fire flow target range with less nozzle reaction and reduce the weight that we drag by close to 140lbs for a 200ft line, we feel that we will give our hose teams a fighting chance to be successful.

Summary

The Ponn TRU-A-TAK fire hose delivered and exceeded the expectations of the SFD.

Ponn TRU-A-TAK performed the best at our target flows of 160 GPM for 1 ¾" handlines and 265 GPM for 2 1/4" handlines. (less hose whip/kink)

Ponn TRU-A-TAK provided one of the highest durability ratings available.

Ponn TRU-A-TAK had the lowest drag coefficient of all hoses.

Ponn TRU-A-TAK hose had 9lbs less water weight per 50ft section of hose.

Ponn TRU-A-TAK hose came with a 5yr warranty and life time delamination warranty which matched all competitors.

The Elkhart Nozzles are rugged, require minimal maintenance and priced very close to or the same as competitor's nozzles.

Elkhart provides in house training on nozzle maintenance if the department would like to perform in house maintenance.

Elkhart nozzles came with a 10-year warranty (All manufacturers offered the same warranty).

The nozzles and hose will allow our personnel to increase fire ground effectiveness, reduce nozzle reaction, provide better maneuverability, and reduce fatigue.

The 2 piece nozzles (ball valve) with separate shutoff and tips will allow the tip to be removed and hose can be added without having to shut down the line at the Engine.

Recommendations

The recommendation of the committee is:

1. All attack line hose should be replaced with Ponn TRU-A-TAK hose as soon as possible.
2. All 1 ¾” attack lines should be equipped with Elkhart XD Shutoffs with Smooth Bore 7/8” tip and Chief XD 160 GPM @ 50PSI fog tip.
3. All 2 ½” attack lines should be equipped with Elkhart XD Shutoffs with Smooth Bore 1 1/8” tip and Chief XD 265 GPM at 50psi fog tip.
4. All 2 ½” attack lines should be replaced with 2 ¼” hose. (see commercial attack package justification)
5. All Engines should have their attack lines tested with flow meters and the data mapped out in a flow chart.
6. SFD Standards for pump operations should be updated.
7. All Akron and TFT nozzles should be phased out due to high pressures, automatic nozzles, heavy materials, oversized/undersized waterways, and overall inconsistencies.
8. All current attack hose should be phased out as soon as possible.
9. Equipment inventories will need to be standardized.
10. All personnel should receive training on new nozzles and hose.
11. Operators should receive training on friction loss for new hose and nozzle technology.

12. Hose and nozzles should be purchased and assigned to each station. This will allow companies to track and reload hose as needed. All attack lines (1 ¾" and 2 ¼") should be white in color. Color coding attack lines will significantly increase the amount of spare hose being purchased. Hose couplings should also be marked for easy station identification.
13. Each Engine should have 22 sections of 1 ¾" hose. This accounts for the new hose lengths and 10 sections of spare for the station. (32 total sections)
    a. Bumper 150ft 1 ¾" (3 sections)
    b. Crosslay #1 200ft 1 ¾" (4 sections)
    c. Crosslay #2 250ft 1 ¾" (5 sections)
    d. Rear Hose load 300ft 1 ¾" (6 sections)
    e. 100ft Bundle 1 ¾" (2 sections)
    f. 100ft spare on apparatus (2 sections)
    g. 500ft spare in the station (10 sections). This allows for almost any combination of lines to be replaced after a fire.
14. Each Engine should have 14 sections of 2 ¼" hose. This includes high-rise packs and 4 sections of spare for the station. (18 total sections)
    a. Crosslay 200ft 2 ¼" (4 sections)
    b. Rear Hose Load 200ft 2 ¼" (4 sections)
    c. High-Rise Pack 200ft 2 ¼" (4 sections)
    d. 100ft spare on apparatus (2 sections)
    e. 200ft spare in the station (4 sections). This allows one line to be replaced after a fire.

References

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