Montgomery County Fire and Rescue Service

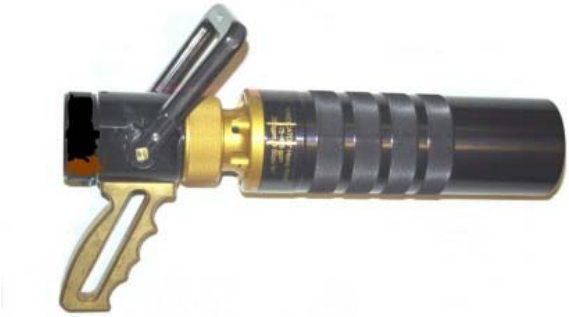
Division of Fire and Rescue Services

Fire & Rescue Training Academy

Montgomery County, Maryland

Vindicator Nozzle & Hose Evaluation Report

September 2003



By: Captain Michael E. Nelson Jr.

TESTING LOCATION

All testing was conducted at the Montgomery County Fire and Rescue Training Academy located at 9710 Great Seneca Highway Rockville, Maryland 20850.

MCFRS Testing Team consisted of Captain Michael Nelson, MCFRTA, Lieutenant Dave Polikoff, Fire Station 6. FF3 Chris Conroy, Fire Station 28 and the C-Shift at Fire Station 28.

1 ¾” Hose data provided by Paul Shapiro, Engineer, Las Vegas Fire Department.

Contents

Executive Summary

The Fire Administrator in December, 1999, created a joint-committee work group to modify the Draft Report of the Water Supply Work Group (WSWG), and to develop a comprehensive plan to implement recommendations for water supply enhancements. The Water Supply Study Implementation Work Group (WSSIWG) reported on the initial report and concluded that the majority of the recommendations for water supply enhancement could be endorsed with few or no changes.

The two group's conclusions showed issues affecting the Montgomery County Fire and Rescues Service's (MCFRS) ability during fire suppression operations. The one concern from the study that triggered this test was the "minimal" standardization concerning hose, hose appliance, and their configuration.

The Vindicator Nozzle and Hose Study looks at a wide variety of nozzles and hose being carried on the 32 Engine Companies in Montgomery County. The testing and field evaluation process looked at current and cuffing edge technology in fire suppression equipment, minimum flow required for residential and commercial structures, nozzle reaction, and compared it with the current equipment being used in the fleet.

The test results showed that a combination of a Vindicator nozzle and Ponn Conquest hose allowed for delivery of greater fire flows with lower nozzle reaction, more water without stream breakup and lower friction loss than any other combination of nozzle and hose. The increase in fire flow with reduced nozzle reactions leads to increased firefighter safety during interior fire attack operations!

The recommendation of the study is to place a Vindicator Heavy Attack nozzle (VHA) on one 200 foot I ¾" crosslay, a Vindicator Blitz Attack nozzle (VBA) on 200 feet of 2" line on one of the rear discharges and placing a VBA nozzle on the standpipe line and converting this hose to 2". All attack line hose should be replaced with Ponn Conquest hose when it is due for replacement. The Elkhart Chief low-pressure fog nozzles currently being used by many of the companies should be retained along with the 15/16" smooth bore nozzle.

BACKGROUND

The Montgomery County Fire and Rescue Service is a combination service made up of the Division of Fire & Rescue Services and the Division of Volunteer Fire and Rescue Services with its 18 independent corporations. The majority of the equipment for the engine companies is purchased through the volunteer corporations and there is a wide range of hose, hose appliances and hose configuration throughout the fleet.

The delivery of the Water Supply Work Group report and several significant fires within the county has spurred an effort to standardize the equipment carried on all apparatus. This report can be viewed at:
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During the summer of 2002, 1st Strike Technologies, Inc. was contacted to set up a demonstration and subsequent field evaluation of their nozzles by MCFRS. The evaluation process would look at the departments current nozzle complement and evaluate each nozzle for flow, nozzle reaction, cost, maintenance issues, training requirements, and durability.

Prior to the test, a survey was sent to each station to identify the type, manufacture, model, and standard flow for each nozzle carried on its engine company and the attack line diameter, length, manufacture and model. Results of the survey showed we carried nozzles manufactured by: Elkhart, Task Force Tips (TFT), and several other manufactures and 150 gallons per minute (gpm) were the base flow for *I ¾"* attack lines. Hose results showed that we use from I ½" on a trash line up to 2 ½" attack lines and the hose was manufactured by many different companies and was intermixed.

Data gathered from the survey showed that there was a need to look at the current hose loads and hose manufactures also, to try to determine the best hose and nozzle combination for MCFRS.

INITIAL TESTING

The initial testing period was set for September 12, 13, *&14,* 2002 at the Montgomery County Fire and Rescue Training Academy (MCFRTA). A classroom and practical session was conducted. This allowed all three shifts and volunteer personnel to become familiar with the nozzles.

The five test engine companies chosen for the test were selected by their diversity of occupancy make-up in their first due area, construction type, and geographical setting. The engines t\chosen were E22 (Takoma Park), E61 (Bethesda), ESI (Gaithersburg), E271 (MCFRTA), and E291 (Germantown).

The classroom session consisted of a presentation by Kirk Allen of First Strike Industries and Bob Halton, the Chief of Training for the Albuquerque, New Mexico Fire Department. The presentation explained the principle behind the Vindicator Nozzle and showed how they operated and their inner workings. It also allowed the participants to ask questions and clear up any misconceptions that they may have had about the nozzles.

The practical evolution consisted of building a flow chart of all five engines, 4 Seagraves and 1 Emergency One pumper, for their current hose and nozzle configuration and then for their hose load with a Vindicator nozzle attached. The tests were conducted by using a flow meter and pressure gauges to obtain the data. All lines were initially pumped at the standard flow for that particular hose length, diameter, and friction loss and nozzle pressure.

Results of the initial testing revealed several problems:

1. The TFT nozzles either delivered a nozzle pressure that was too high or too low. This was caused by the flow adjustment spring malfunctioning. Several nozzles needed to be sent out for servicing or required field maintenance. See TFT Service Bulletin for further information.

2. Several hose lines leaked severely or blew during testing. Caused by poor or missing hose gaskets or abraded hose lines.

3. The inner liners of several sections of hose had delaminated form the outer lining causing high friction loss in the hose.

4. The #1 cross-lay on E291 showed high friction loss in the piping. Inspection reveled that there were 5 90 degree elbows between the gate and the discharge outlet!

5. Many of our engines carry fixed gallonage nozzles which deliver a set flow at a set nozzle pressure. All of these worked as marked. However, if a higher flow is required, extremely high engine pressures are needed.

6. Only a small number of our engines have been mapped out for the flows of their current configuration. All MCFRS engines, engine/tankers and tankers need to have all of their discharges mapped for flows.

7. High nozzle reaction on the TFT and Elkhart lines at higher flows made it hard to near impossible for a 2 person crew to advance.

The initial test results using the Vindicator nozzles showed flow increases as much as 233% over MCFRS's current nozzles and the Vindicator nozzles provided 71 % less nozzle pressure with no significant loss in range. The higher flow rates provided by the Vindicator nozzles allows for faster knock down, increased mobility and increased firefighter safety by reducing exposure to high heat environments.

The Vindicator nozzles allow MCFRS to operate its 1 ¾" attack lines at a 200 gpm base flow at the same engine pressure as its 150 gpm base flow for its current nozzles. The 50 gpm increase in fire flow will allow our crews to be more effective in their initial attack efforts.

Montgomery County Fire Department Engine 22 Reserve

Vindicator Heavy Attack Nozzle # 1 Pre-Connect
200 feet of 1 3/4" hose

Discharge Pressure	Gallons Per Minute
160	200
230	250

Elkhart Chief 150gpm @ 50-psi # 1 Pre-Connect
200 feet of 1 3/4" hose

Discharge Pressure	Gallons Per Minute
145	150
245	200

TFT Hand-line 50-350 gpm #1 Pre-Connect
200 feet of 1 3/4" hose

Discharge Pressure	Gallons Per Minute
150	100
215	150

The information above is for the # 1 Pre-Connect
This chart should not be used for any other discharge ports.
Flows may vary with different brands or sections of hose.

Compliments of First Strike Technologies, Inc., P.O. Box 146, Algonquin, IL 60102.
Ph: 847 658-3216, WWW.1STSTRIKETECH.COM. Recommend annual revision as a minimum.

Prepared and submitted as a guide to aid in simplifying pump operations.
Immediate revision should be made for any modifications, repairs, improvements, damages, or any such changes of equipment occurring with the apparatus or its equipment.

Montgomery County Fire Department Engine 22 Reserve

Montgomery County Fire Department Engine 22 Reserve

Vindicator Heavy Attack Nozzle #2 Pre-Connect
200 feet of 1 3/4" hose

Discharge Pressure	Gallons Per Minute
150	200
210	250

Elkhart Chief 150gpm @ 50-psi #2 Pre-Connect
200 feet of 1 3/4" hose

Discharge Pressure	Gallons Per Minute
150	150

The information above is for the # 2 Pre-Connect
This chart should not be used for any other discharge ports.
Flows may vary with different brands or sections of hose.

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Montgomery County Fire Department Engine 22 Reserve

Montgomery County Fire Department Engine 22 Reserve

Vindicator Blitz Attack Nozzle # 3 Pre-Connect
250 feet of 2" hose

Discharge Pressure	Gallons Per Minute
118	190
185	250
250	300

Elkhart Chief 25-gpm @ 50-psi #3 Pre-Connect
250 feet of 2" hose

Discharge Pressure	Gallons Per Minute
118	150

The information above is for the # 3 Pre-Connect
This chart should not be used for any other discharge ports.
Flows may vary with different brands or sections of hose.

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Montgomery County Fire Department Engine 22 Reserve

Vindicator Heavy Attack Nozzle # 4 Pre-Connect
250 feet of 1 3/4" hose

Discharge Pressure	Gallons Per Minute
165	200
225	250

Ekhart Chief 150gpm @ 50-psi # 4 Pre-Connect
250 feet of 1 3/4" hose

Discharge Pressure	Gallons Per Minute
150	150

The information above is for the # 4 Pre-Connect
This chart should not be used for any other discharge ports.
Flows may vary with different brands or sections of hose.

Compliments of First Strike Technologies, Inc., P.O. Box 146, Algonquin, IL 60102.
Ph: 847 658-3216, WWW.1STSTRIKETECH.COM. Recommend annual revision as a minimum.

Prepared and submitted as a guide to aid in simplifying pump operations.
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First Strike Technologies, Inc.
Demonstration Flow Chart

Department Montgomery County Location Training Academy Date 9/12/2002

Engine # 61 Flowmeter Calibratoin with a 15/16ths Smooth Bore @ 50-psi = 184-gpm

Pre-Connect # 1

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	Elkhart Chief	1.75	200	180	140	40	80	150	60
2	VHA	1.75	200	160	130	30	35	200	95
3	VHA	1.75	200	220	170	50	45	250	125
4	VHA	1.75	200	300	250	50	55	300	195

Pre-Connect # 2

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	Elkhart Chief	1.75	200	150	140	10	80	150	60
2	VHA	1.75	200	150	130	20	35	200	95
3	VHA	1.75	200	210	180	30	50	250	130
4	VHA	1.75	200	275	235	40	55	300	180

Pre-Connect # 3 Green

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	15/16ths tip	1.75	200	175	165	10	50	185	115
2	VHA	1.75	200	150	135	15	30	200	105
3	VHA	1.75	200	220	190	30	45	250	145
4	VHA	1.75	200	270	230	40	55	300	175

Pre-Connect # 3 Red

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	Elkhart Chief	2"	250	200	175	25	55	185	120
2	VBA	2"	250	150	130	20	35	200	85
3	VBA	2"	250	220	195	25	45	250	145
4	VBA	2"	250	285	240	45	50	300	190
5	1 1/8"	2"	250	110	75	35	50	265	25
6	1 1/4"	2"	250	125	85	40	50	325	60
7	Peter Ganci	2"	250	110			25	295	85
8	Peter Ganci	2"	250	270	190	80	57	600	190

Note that the #3 Red Pre-Connect had a measured FL of 80-psi for the last test. Had this test been done from a side discharge you would find that a flow of 600-gpm could be achieved through the 2" line by pumping approximatly 190-psi.

Pre-Connect #4

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	VBA	2.5	200	100	0	0	48	300	0
2	VBA	2.5	200	120	0	0	55	350	0
3	VBA	2.5	200	130	0	0	65	400	0
4	VBA	2.5	200	205	0	0	75	450	0

Note that Preconnect FL was not recorded so the actual FL for the hose and the preconnect could not be established.

First Strike Technologies, Inc.
Demonstration Flow Chart

Department Montgomery County Location Training Academy Date 9/12/2002

Engine # 81

Flowmeter Calibratoin with a 15/16ths Smooth Bore @ 50-psi = 184-gpm

Pre-Connect # 1

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	TFT	1.75	200	130	125	5	85	150	40
2	TFT	1.75	200	170	150	20	90	200	60
3	VHA	1.75	200	110	90	20	40	200	50
4	VHA	1.75	200	180	135	45	45	250	90
5	VHA	1.75	200	210	180	30	55	300	125

Pre-Connect # 2

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	TFT	1.75	200	130	125	5	90	150	35
2	TFT	1.75	200	160	145	15	75	200	70
3	VHA	1.75	200	110	95	15	30	200	65
4	VHA	1.75	200	170	130	40	45	250	85
5	VHA	1.75	200	230	180	50	55	300	125

Pre-Connect # 4

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	TFT	2"	200	150	135	15	90	150	45
2	TFT	2"	200	200	175	25	100	200	75
3	VBA	2"	200	150	120	30	45	200	75
4	VBA	2"	200	190	155	35	50	250	105
5	VBA	2"	200	230	195	35	55	300	140

First Strike Technologies, Inc.
Demonstration Flow Chart

Department Montgomery County Location Training Academy Date 9/13/2002

Engine # 271

Flowmeter Calibratoin with a 15/16ths Smooth Bore @ 50-psi = 184-gpm

Pre-Connect # 1

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	VHA	1.75	200	150	110	40	40	200	70
2	VHA	1.75	200	205	175	30	48	250	127

Pre-Connect # 2

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	VHA	1.75	200	210	195	15	45	250	150
2	VHA	1.75	200	282	250	32	55	300	195

Pre-Connect # 3

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	TFT	2.5	20	125	125	0	100	243	25
2	TFT	2.5	20	150	140	10	100	306	40
3	VBA	2.5	200	Idle	?	?	45	280	?
4	VHA	2.5	200	90	85	5	50	300	35
5	VBA	2.5	200	130	115	15	55	350	60
6	VBA	2.5	200	160	140	20	68	400	72

Pre-Connect # 4

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	TFT	2"	20	160	150	10	110	215	40
2	TFT	2"	20	190	175	15	115	251	60
3	VBA	2"	200	Idle	?	?	45	211	?
4	VHA	2"	200	160	135	25	50	285	85
5	VBA	2"	200	245	200	45	55	365	145

First Strike Technologies, Inc.
Demonstration Flow Chart

Department Montgomery County Location Training Academy Date 9/12/2002

Engine # 291 Flowmeter Calibratoin with a 15/16ths Smooth Bore @ 50-psi = 184-gpm

Pre-Connect # 1

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	TFT	1.75	200	170	145	25	105	150	40
2	TFT	1.75	200	180	150	30	85	200	65
3	TFT	1.75	200	230	180	50	90	250	90
4	VHA	1.75	200	110	90	20	30	180	60
5	VHA	1.75	200	130	100	30	35	200	65
6	VHA	1.75	200	185	140	45	45	250	95
7	VHA	1.75	200	250	210	40	52	300	158

Pre-Connect # 2

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	TFT	1.75	200	145	135	10	92	150	43
2	TFT	1.75	200	180	160	20	90	200	70
3	TFT	1.75	200	225	205	20	95	250	110
4	VHA	1.75	200	110	95	15	32	180	63
5	VHA	1.75	200	130	110	20	35	205	75
6	VHA	1.75	200	180	155	25	45	250	110
7	VHA	1.75	200	235	205	30	55	300	150

Pre-Connect # 3

	Nozzle Type	Hose Size	Hose Length	Engine Pressure	Pre-Connect Pressure	Pre-Connect Friction Loss	Nozzle Pressure	GPM	Hose Friction Loss
1	TFT	2"	250	110	110	0	90	120	20
2	TFT	2"	250	140	130	10	78	200	52
3	TFT	2"	250	170	155	15	90	250	65
4	TFT	2"	250	230	210	20	100	300	110
5	TFT	2"	250	265	235	30	95	350	140
6	VBA	2"	250	130	115	15	35	250	80
7	VBA	2"	250	175	160	15	45	300	115
8	VBA	2"	250	220	190	30	50	350	140
9	VBA	2"	250	285	240	45	60	400	180
10	VHA	2"	250	100	85	15	36	200	49
11	VHA	2"	250	140	125	15	45	250	80
12	VHA	2"	250	190	165	25	55	300	110

MCFRS CONDUCTED TESTING

A group of MCFRS Officers and firefighters were assembled to evaluate 3 common nozzles carried on our engine companies, a 15/16” smooth bore tip, the TFT H-V nozzle, and the Elkhart Chief 4000-17 and the 3 Vindicator nozzles. The panel looked at nozzle pressure, engine pressure, discharge pressure, nozzle reaction, stream distance, and hose size and friction loss in the hose line. Flow rates ranged from 100 gpm up to a flow 350 gpm.

A 200 foot course was laid out with 25 foot intervals marked off to measure stream distance. E271 was hooked up to a hydrant via a 4½”” soft sleeve and an initial intake pressure of 70 pounds per square inch (psi) was recorded. A flow meter was attached to the #5 2 ½” discharge and calibrated using a 15/16” tip. In-line pressure gauges were used to friction loss and nozzle pressure. The nozzle was then hooked to a calibrated scale to measure reaction force.

It is widely held in the fire service that 150 gpm is the minimum acceptable flow for residential fires and 250 gpm is the minimal acceptable hand-line flow for commercial fires.

Nozzle Reaction (NR) is defined as the water discharging from a nozzle producing a reaction that is opposite to the flow of water and measured in pounds of force. Nozzle Reaction is a result of flow and nozzle pressure. An increase in either one of these factors will increase reaction force. A reaction force of 75 pounds or higher is considered too high.

Test data shows that the 15/16” tip on a 1¾” and a 2” line had an optimal range for flow and NR was between 150 and 200 gpm. Flows above 200 gpm on the 15/16” tip had engine pressures above 220 psi.

The TFT on the 1¾” and a 2” line had an optimal range for flow and NR between 150 and 200 gpm. Flows above 200gpm produced high engine pressures and high NR.

The Elkhart Chief on 1¾” hose delivered 150 gpm at 60 psi nozzle pressure and 22 pounds NR. The use of this nozzle on a 2” line defeats the purpose of using a larger line to increase fire flow because of its fixed gallonage.

The Vindicator Light Attack (VLA) had an optimal flow of 150 to 200 gpm on a 1¾” hand-line. Flows above 200 gpm produce high engine pressures. This nozzle is not designed to flow above 200 gpm. Works well with foam operations.

The Vindicator Heavy Attack (VHA) on 1¾” hose showed an optimal flow between 150 and 250 gpm. Flows above 250 gpm produced high engine pressures. The VHA attached to a 2” line showed an optimal flow between 200 and 300 gpm.

The Vindicator Blitz Attack (VBA) on 1¾” line had an optimal flow at 250 gpm. Flows below this produced a poor stream and above this produced high engine pressures. The VBA attached to a 2” line had an optimal flow between 250 and 350 gpm!

MCFRS Nozzle Test

15/16" Smoothbore tip on 200' of Niedner XL800 1 3/4" Hose

	100 GPM	150 GPM	200 GPM	250 GPM
Nozzle Pressure in PSI	10	25	45	70
Pump EP in PSI	30	80	140	225
#5 Discharge in PSI	30	80	140	225
Nozzle Reaction in LBS	16	17	41	71
Stream Distance in Feet	25	30	75	80
Friction Loss per 100' in PSI	10	27.5	47.5	77.5

Task Force Tips (TFT) H-V nozzle 200' of Niedner XL800 1 3/4" Hose

	100 GPM	150 GPM	200 GPM
Nozzle Pressure in PSI	80	100	86
Pump EP in PSI	105	155	195
#5 Discharge in PSI	105	155	195
Nozzle Reaction in LBS	21	34	42
Stream Distance in Feet	50	85	85
Friction Loss per 100' in PSI	12.5	27.5	54.5

Elkhart Chief 4000-17 nozzle 150 GPM @ 75 psi on 200' of Niedner XL 800 1 3/4" Hose

	100 GPM	150 GPM	200 GPM
Nozzle Pressure in PSI	25	60	110
Pump EP in PSI	50	120	205
#5 Discharge in PSI	50	120	205
Nozzle Reaction in LBS	34	35	64
Stream Distance in Feet	25	75	100
Friction Loss per 100' in PSI	12.5	30	47.5

Vindicator Light Attack (VLA) nozzle on 200' of Niedner XL 800 1 3/4" Hose

	100 GPM	150 GPM	200 GPM
Nozzle Pressure in PSI	45	75	105
Pump EP in PSI	70	130	210
#5 Discharge in PSI	70	130	210
Nozzle Reaction in LBS	9	22	52
Stream Distance in Feet	45	75	90
Friction Loss per 100' in PSI	12.5	27.5	52.5

MCFRS Nozzle Test

Vindicator Heavy Attack (VHA) nozzle on 200' of Niedner XL800 1 3/4" Hose

	100 GPM	150 GPM	200 GPM	250 GPM
Nozzle Pressure in PSI	15	25	35	45
Pump EP in PSI	40	90	150	220
#5 Discharge in PSI	40	90	150	220
Nozzle Reaction in LBS	11	11	25	51
Stream Distance in Feet	10	45	50	75
Friction Loss per 100' in PSI	12.5	32.5	57.5	87.5

Vindicator Blits Attack (VBA) nozzle 200' of Niedner XL800 1 3/4" Hose

	150 GPM	200 GPM	250 GPM	300 GPM
Nozzle Pressure in PSI	15	25	35	40
Pump EP in PSI	65	120	190	265
#5 Discharge in PSI	68	120	190	265
Nozzle Reaction in LBS	7	37	57	61
Stream Distance in Feet	25	30	75	80
Friction Loss per 100' in PSI	25	47.5	77.5	112.5

15/16" Smothbore tip on on 200' of Niedner 2" Hose

	150 GPM	200 GPM	250 GPM
Nozzle Pressure in PSI	30	55	95
Pump EP in PSI	60	110	190
#5 Discharge in PSI	60	110	190
Nozzle Reaction in LBS	32	51	100+
Stream Distance in Feet	60	75	100
Friction Loss per 100' in PSI	15	27.5	47.5

TFT H-V nozzle on 200' of Niedner 2" Hose

	150 GPM	200 GPM	250 GPM
Nozzle Pressure in PSI	85	95	95
Pump EP in PSI	120	175	210
#5 Discharge in PSI	120	175	210
Nozzle Reaction in LBS	48	80	100+
Stream Distance in Feet	90	110	130
Friction Loss per 100' in PSI	17.5	40	57.5

MCFRS Nozzle Test

Vindicator Heavy Attack (VHA) nozzle on 200' of Niedner 2" Hose

	100 GPM	150 GPM	200 GPM	250 GPM
Nozzle Pressure in PSI	25	35	45	60
Pump EP in PSI	50	90	140	190
#5 Discharge in PSI	50	90	140	190
Nozzle Reaction in LBS	21	32	60	83
Stream Distance in Feet	25	50	70	100
Friction Loss per 100' in PSI	12.5	27.5	47.5	65

Vindicator Blits Attack (VBA) nozzle on 200' of Niedner 2" Hose

	200 GPM	250 GPM	300 GPM	350 GPM
Nozzle Pressure in PSI	25	35	45	55
Pump EP in PSI	75	115	160	210
#5 Discharge in PSI	75	115	160	210
Nozzle Reaction in LBS	34	51	67	93
Stream Distance in Feet	40	65	110	130
Friction Loss per 100' in PSI	25	40	57.5	77.5

Friction Loss in psi for 1 3/4" Hose per 100 ft

	100 GPM	150 GPM	200 GPM
Ponn Supreme	23	34	52
Neidner XL 800 (Average FL)	14.17	32.08	56.17
Ponn Conquest	12	16	25

HEAT ABSORPTION & FIRE FLOWS

The MCFRS test group conducted heat absorption testing in the MCFRTA Burn Building. The flow for all nozzles were based the National Fire Academy Water Application Rate Formula and the departments standard 1 3/4" hand-line flow.

The gas fired burn prop was fired up and the temperature at the 8 foot level was brought as close to 800 degree F as possible. The line was then opened for *15* seconds in a straight stream pattern and an indirect fire attack was used. At the end of the time period the temperature was recorded.

NFA Fire Water Application Rate Formula

LxW*/3*= GPM

L = Length in feet
W = Width in feet
GPM = Water flow rate required to black out the fire in approximately ten seconds.

This assumes approximate standard combustible contents and heights of 10 feet per story. Adjust for % of involvement and number of stories involved.

26x 16/3= GPM
416/3=GPM
138 = GPM

The group acknowledges that the 150 gpm flow is below the 15/16" tip and VHA normal flow of 180 gpm and 200 gpm respectively.

Testing shows that the Elkhart Chief and the VHA had the best absorption rates reducing the temperature by 452 degrees F and 403 degrees F respectively.

Testing conducted by FDNY between the 15/1 6" tip and the VHA nozzle showed the VHA using the same flow as the 15/16 "tip was able to absorb more heat and 38% faster. The Vindicator reduced the final room temperature by 42% more than the 15/16" tip.

MCFRS HEAT ABSORPTION DATA

	15/16" Tip	Elkhart	TFT	VHA
Start Temp	817	772	775	811
Finish Temp	605	320	406	408
Temp Change	212	452	369	403

The test conducted was done flowing a *1* 3/4” hand-line @ 150 gpm for 15 seconds.

Temperature readings were taken at the 8 foot level in degrees F.

The burn room is 26’L x 126’ W x 9’H = 3744 cubic feet and is covered with fire tiles on the floor and ceiling.

The burn room has a propane fires Symtron burn prop.

I ¾" HOSE COMPARISON DATA

Sufficient data on the different types of hose carried by MCFRS engines did not exist. Contacting each manufacture of hose to obtain samples to conduct these would be a pain staking process. In an effort to gather this data Paul Shapiro, of Fire Flow Technology and an engineer with the Las Vegas Fire Department, was contacted to see if he had data on *1* 3/4" and 2" hose. Paul provided data on 1 *3/4"* hose that he has complied and he is in the process of working on 2" hose.

The attached data looks at several manufactures hose and breaks down the information that should be looked at before hose is purchased.

The data shows that Conquest hose manufactured by Ponn to have the lowest friction loss, high abrasion rating and passes both the kink and heat failure tests.

ANGUS

	High Combat	Fire Power	Pak-Lite
Weight per 50' section Coupled	18 lbs	19 lbs	15 lbs
Liner Type	Extruded Rubber	Extruded Rubber	Rubber w/ Adhesive Back
Burst PSI	1100 psi	1220 psi	1410 psi
Friction Loss per 100 ft @180 gpm	38 psi	45 psi	25 psi
Kink @ 100 psi	Pass - No Kink	Pass - No Kink	Fail - Minor Kink
Abrasion	1320	3800	850
Heat Failure	Pass	Pass	Fail - 50 sec

KEY

	DJ 800
Weight per 50' section Coupled	20 lbs
Liner Type	EPDM Rubber
Burst PSI	1340 psi
Friction Loss per 100 ft @180 gpm	54 psi
Kink @ 100 psi	Pass - No Kink
Abrasion	Pass
Heat Failure	

NATIONAL

	8 D	N Dura	Dura Pak
Weight per 50' section Coupled	16.5 lbs	17 lbs	17 lbs
Liner Type	SBR	SBR	TPU
Burst PSI	1300 psi	1350 psi	1350 psi
Friction Loss per 100 ft @180 gpm	64 psi	40 psi	43 psi
Kink @ 100 psi	Pass - No Kink	Pass - No Kink	Pass - No Kink
Abrasion	2100 (+)	6900	6900
Heat Failure	Pass	Pass	Pass

NEIDNER

	XL-800	Powerline
Weight per 50' section Coupled	13 lbs	23 lbs
Liner Type	Glued Rubber	Rubber
Burst PSI	1040 psi	1600 psi
Friction Loss per 100 ft @180 gpm	28 psi	45 psi
Kink @ 100 psi	Fail - Major Kink	Pass - No Kink
Abrasion	4500	3240
Heat Failure	Fail - 36 sec	Fail - 2' 30 sec

1.75” Hose Data

NORTH AMERICAN

	Dura Bilt	Dura Flow	Poly Tuff
Weight per 50' section Coupled	19 lbs	16 lbs	21 lbs
Liner Type	SBR	Polyurethane	Rubber
Burst PSI	1600 psi	1700 psi	1660 psi
Friction Loss per 100 ft @180 gpm	37 psi	32 psi	33 psi
Kink @ 100 psi	Fail - Poor Kink	Pass-Minor Kink	Fail - Poor Kink
Abrasion	1442	1100	1400
Heat Failure	Fail - 45 sec	Fail - 13.06 sec	Fail 13.5 sec

PONN

	Supreme	Conquest
Weight per 50' section Coupled	20.75 lbs	17 lbs
Liner Type	Rubber	Polyurethane
Burst PSI	1420	1510
Friction Loss per 100 ft @180 gpm	43 psi	20 psi
Kink @ 100 psi	Pass - No Kink	Pass - No Kink
Abrasion	40340	42120
Heat Failure	Pass	Pass

FEEDBACK FROM FIELD TEST

At the completion of the field test, a survey was sent out to the companies participating to gather information on the Vindicator nozzles and to compare them to the nozzles currently carried by MCFRS engines.

The surveys came back showing a positive reaction for the Vindicator nozzles. The vast majority of the personnel responding stated that each engine needs to be mapped out for its hose and nozzle set-up to assist drivers on exact flows (No matter what nozzle and hose used). All personnel should receive training on the proper use of these nozzles prior to an implementation. Personnel were impressed by the high flows and the reduced nozzle reactions. The biggest debate created by the Vindicator was the like/dislike of the pistol grip!

Other feedback received was the amount of friction loss found in E291 ‘s piping and the amount of maintenance required to keep the TFT nozzles operating properly.

The attached memorandum from Captain William Wells of Station 8/A gives a good summation of the Vindicator nozzles.

MONTGOMERY COUNTY FIRE AND RESCUE SERVICE

Douglas M. Duncan
County **Executive**

Gordon A. Aoyagi
Fire Administrator

MEMORANDUM

June 27, 2003

TO: Captain Michael Nelson

FROM Captain William Wells
Station Commander **8, A**

SUBJECT: Vindicator Nozzle

In response to your memo dated June **18th** submit the following comments regarding the vindicator nozzles that where loaned to station 8.

I have had the opportunity to use the vindicator on four major house fires. The performance of this nozzle far exceeds the performance of existing nozzles that are in use today. The safety factors associated with this nozzle are impressive from a firefighters' point of view. The knock down capabilities, ease in movement of hand lines combined with the quicker cooling effect of large amounts of water make this nozzle a firefighting tool that can not be overlooked.

I had the opportunity of using this nozzle on a basement fire In a townhouse earlier this year and was impressed with not only the knock down ability but also very little steam blow-back that would be associated with our current hand line nozzles. Visibility in the bum basement remained at acceptable levels.
The vindicator nozzle by far is easier to use, provides a safe means to extinguish an interior structure fire with less physical stress from hand line movement in combination with less heat stress because of its cooling effect. This nozzle is a very efficient and effective firefighting tool and is the future of safe interior structural firefighting.

If I can be of further assistance in this matter please call me.

SUMMARY

The Vindicator nozzles delivered and exceeded the expectations of the MCFRS.
They deliver high flows up to 350 gpm on a 2" attack line and higher flows on a 2 ½".

Low nozzle reactions and nozzle pressures. Fire streams that have excellent reach, penetration and gpm delivery.

The nozzles are rugged, require minimal maintenance; cost no more than competitor's nozzles and have a *10*+ year warranty.

The Vindicator nozzle allows our personnel to increase fire flow, reduce nozzle reaction, and provide better maneuverability of attack lines. The use of these nozzles will increase firefighter safety!

RECOMMENDATIONS

- A Vindicator Heavy Attack Nozzle should be placed on one of our 1 ¾" crosslay lines.
- A Vindicator Blitz Attack Nozzle should be placed on a 2" attack line.
- A Vindicator Blitz Attack Nozzle should be placed on the standpipe pack and these attack lines should be 2" hose.
- All MCFRS Engines, Engine/Tankers, and Tankers should have all their attack lines mapped out in a flow chart.
- All MCFRS Engines, Engine/Tankers, and Tankers should have all their flow charts updated yearly, as part of it annual pump test to identify potential pump problems.
- All Elkhart Chief Nozzles and 15/1 6" smooth bore tips should be retained in the nozzle inventory.
- All TFT nozzles should be phased out due to maintenance issues and malfunctions of pressure springs.
- Equipment inventories need to be standardized as per the Water Supply Work Group study.
- Ponn Conquest should be the standard attack line purchased by MCFRS and phased in as part of normal hose replacement.
- All engines should carry a 1 ¾", 2" and 2 ½" attack lines to meet fire flows for residential and commercial structures.
- Yearly hose testing on all hose needs to be conducted to determine its serviceability.
- All personnel shall receive training on the use of the Vindicator nozzle.
- Updated friction loss for hose and nozzle technology needs to be incorporated into the Pump Operator Training program.
- Current pump operators need to receive update training on emerging technology as it is implemented into the MCFRS.
- Establish a Research & Development (RD) Office to address emerging technology as it relates to fire and EMS equipment and apparatus.