TWO INCH ATTACK HOSE - IT WAS ALWAYS MISUNDERSTOOD!

In the 1970's the American fire service was looking to *up* its game especially in the area of structural fire attack. It was a time when many fire departments were engaged heavily with daily working fires – and many large scale fires, too. Fires were attacked aggressively by firefighters wearing styles of turnout gear not seen today. Tall rubber boots or heavy work shoes, turnout coats made of cotton or rubber, rubber or canvas gloves that did not have liner systems and helmets without impact caps or earlaps was usually worn. Hoods were non-existent. Liners in turnout coats might have been an old army field-jacket or something similar. Oh, yes, sometimes firefighters didn't wear a turnout coat – only what some felt was comfortable for the job at the time!

Looking back at those times (sometimes referred to as the "War Years or the "Battle Years"), and comparing the equipment and personal protection worn by firefighters to gear standards today, firefighters performed the impossible with what was available. Fire fighters, through their respective fraternal organizations (IE: Int'l Assoc. of Fire Fighters – (IAFF), Int'l Assoc. of Fire Chiefs (IAFC)) and other agencies were looking for safer and more effective fire control equipment, procedures and better personal protection. Research and field-testing of turnout gear and station wear was done by a joint venture of these two unions along with the NFPA and others. The effort was called "Project FIRES" and the goal was to find workable ensembles of turnouts and clothing from the study of actual conditions and physiology – yes, that's right! It was finding what could protect us and not hurt us.

Yes, back then you trained with SCBA but they were heavy and cumbersome. Thankfully our old SCBA became the focus of research which was looking for better breathing apparatus for firefighters, as part of the *ensemble*. NASA was involved and helped with this work. The old devices were bulky and hard to breathe from as they were "demand" type systems - where you had to inhale to get any air- meaning they were NOT positive pressure, and the liter flow was likely very low and not enough to keep you going! It was not uncommon at a working fire to hear low pressure alarms sporadically ringing short signals because the users' demand for air was more than the SCBA regulator could supply. Firefighters would take them off as soon as they could in many cases. Fortunately, many saw the wisdom of better turnout gear and personal protection for firefighters. Over time the firefighter protective ensemble or "envelope" has morphed into what it is today. I have said it many times before in classes and conferences that right now the American fire fighter is the 'best protected' than at any time in the history of firefighting. In fact, many senior members will say today's firefighter is maybe too protected so the wearer cannot recognize the environment they might be in.

This was also a time when some of the old 'disciplines' or ways of doing the job were taught and expected to be executed on the fire ground – like truck work and ventilation skills to complement fire attack - as it should still be.

Sadly, some American fire departments began to see firefighter layoffs, resulting in fire force reductions and other problems. It was also a time when some of the basics of firefighting started slipping away.

FIRE ATTACK & EXTINGUISHMENT MECHANISMS

"Put the fire out and everything gets better!" Andy Fredericks

While all this and more was taking place in our profession, fire attack efforts were being looked at for better water delivery. Back then we knew the fire environment was changing. One of the things looked at was the growing use of synthetics and other materials that contained hydrocarbons or similar things. Firefighters were smoke eaters and the "newer" fires weren't the same as in the past. Something was different, and it wasn't anything friendly. The realization then, was the same as now – that fires were burning hotter, faster and creating heavier, more dense toxic smoke than fires that were purely class A – wood, cotton or other ordinary combustibles.

Yes, it was realized that more water was necessary for aggressive extinguishment. Along with that came the need for less stress for firefighters moving hose lines into burning buildings. But also then as now, it was necessary to understand that each size attack hose line has a point where they are no longer effective for fire control and a bigger line and a greater flow is necessary. That point was somewhat lost over time because of people who thought automatic or other types of nozzles would allow smaller hose lines to match the flows of larger ones.

In the past, the fire service focused on three sizes of fire attack hose lines – Booster (3/4 and 1 inch) 1 ½ inch and 2 ½ inch. Each size has/had its own capabilities and limitations and for many decades it was the norm to see those lines on the job. (NOTE: Interestingly, you could go to a major fire somewhere and maybe see all three sizes stretched - and maybe abandoned, while the big guns were working. This was jokingly called "progressive firefighting" as fire departments would sometimes initially stretch small hose lines that were too small for the initial attack. After being pushed back by the fire, firefighters would stretch the next size bigger and repeat the scenario until they ran out of hose options and had to resort to master stream equipment – or maybe not! A lot of buildings were lost because of that thinking. Some of those hose line choices no doubt were predicated from the old belief that a little water goes along way when it turns to steam, expands and snuffs out the fire!!!

It all sounded good on the drill ground and in the security of the class room. Of course that type of attack is supposed to be used in a confined space or hold of a ship! The sales people made fog sound great when trying to sell you an automatic or other fog nozzle. Just remember, it takes GPM's - NOT micro-scopic droplets of water in small amounts to overpower a fire.

It was also noted in some circles that the use of fog and its confinement for structural fire attack set the cause for ventilation back decades in many fire departments.

Today, there are studies and research being conducted and we see people trying to make a science out of fire fighting. It is not! Perhaps some people are looking for recognition trying to satisfy their ego and be able to give the gospel of fire according to themselves. How very wrong because instead of working to learn / teach principles and practices they are confusing many and causing unnecessary controversy between what is right and / or wrong about fire fighting.

THE MOVEMENT BEGINS

Going back into the 1960's the FDNY started employing RAPID WATER combined with 1 ¾ inch hose and a 15/16 inch solid tip nozzle. Simply put, it was system on an engine that employed a device to dispense a friction reducing agent into pump outlets which allowed greater water flows through smaller hoses and nozzles. The goal was to get more water on the fire and minimize weight and hose management stress. Some departments followed suit and bought into the idea but over time, things like operational costs, maintenance and reduction in fire activity no longer warranted the need for it. Many things were researched and tried in the field. Some lasted some did not. But please never let it be said the fire service is stagnant and not forward looking.

As different ways of delivering more water were tried, it paved the way for many different ideas on how we could do it and what tools (Hose and nozzles) would be needed. Starting in the 70's and 80's many departments began researching ways to increase their water delivery and some of the changes were smart and well thought out.

Some departments went for changes in their fire attack systems and switched hose sizes from "small to big" and "big to small. That may sound funny or strange but briefly, what happened for example, is some departments moved away from 1 ½ inch attack hose in favor of 1 ¾ inch attack hose as their primary attack hose lines, which I think we can agree is a good move in the right direction. One and three quarter inch hose with a low pressure solid bore or constant gallon age nozzle makes a great interior attack line with good target flow and mobility. It is able to handle a good body of fire in a structure when properly handled. It has excellent use in other firefighting applications such as for rubbish, vehicles, other fires and foam hand lines Interestingly, as this hose was mainly intended for interior structural operations, it was getting used for vehicles, rubbish and other fires and then began getting stretched for large fires. It is not and has never been intended to be a heavy hand line for large scale offensive/defensive fire operations. Its stream does not have the reach or volume required in those situations. An article written by a Chicago fire officer noted how the 1 ¾ inch hose line had grown to become the "booster line" of the 90's meaning) it was used by some departments for everything and for ridiculous reasons. It is a telling tale when a fire department uses this size hose line for defensive operations at a major fire.

Another mistake or misunderstanding made by some departments back then was to keep their old low volume, high pressure nozzles and attach them to the new hose, which limited the discharge volume!

HERE COMES TWO INCH HOSE AND MORE MISUNDERSTANDING

Again, the push for more water and easier attack line management was addressed with two inch hose with 1 ½ inch couplings. I don't think anyone could argue the concept. However, it seems some fire service officers/"managers" were ready to move forward without doing some homework to see how much fire attack efficiency was to be gained with this size hose. Tragically, some departments bought into the thinking that 2 inch hose with an automatic or other type of high pressure fog nozzle would flow as much water as a 2 ½ inch attack hose line. They discarded their 2 ½ inch attack hose in favor of two inch hose. Automatic nozzles (or other regular fog nozzles) requiring a nozzle pressure of 100 psi at the nozzle were installed. Coupling nozzle pressure and friction loss in older 2 inch hose while trying to flow that volume

was in some cases dangerous. To flow in the range of 265/275 gpm's there was a friction loss of around 45 psi per 50 foot length. In doing the math, you can see an average 200 foot layout would require a pump pressure of around 280 psi to flow that much water through the hose. That's unmanageable for a firefighter to safely hold and 30 psi ABOVE annual hose test pressure! In so many instances the 2 inch hose has been under-pumped all these years to avoid those higher pressures and is probably flowing what 1 ¾ inch hose can comfortably flow!

Furthermore, another problem that came with 2 inch hose was it being stretched as an interior second or third line into a bread and butter type operation when additional lines of 1 ¾ inch hose would have been sufficient. Because of the close dimensional hose size and same size couplings it was thought by many to be "*about the same as 1 ¾ inch!*" Weight-wise and for handling. Some officers justified this practice by using the old "back up" hose line rule where a second line should be at least as big *or* the next size bigger than the first line.

Without proper training or educated officers to correct the problem, it soon became a hose line handled with two or in some cases only one firefighter inside a building fire. And of course, there is the back pressure from the higher pressure nozzles. When advancing two inch line up or down stairways, making turns or bends, it takes two to three firefighters to do it efficiently. The older jacket and hose liner material needed a bigger bend radius or it kinked especially in residential or other tight areas. One fifty foot length of two inch hose holds about 68 lbs. of water where as a one and three quarter length holds about 52 lbs. of water. Thus it was deemed unmanageable or unworkable. Minimum fire ground staffing for 1 ¾ and 2 inch attack lines should always (yes, always!) be at least 2 firefighters for each size line – depending on the situation. More stretching complexities? … then get additional help on the line.

There were also concerns voiced that replacing 2 ½ inch with 2 inch hose would lead to reduced fire ground staffing. Thus confusion on hose line selection began! By the way, that same mobility and water weight logic was used to sell the idea of two inch over two and one half inch hose. Remember again, each size hose has its limitations.

It took many years of actual flow testing and fire ground results to realize that the claims of two inch hose were misleading or false. Many fires were "lost" because of low flows. Two inch hose is an excellent attack hand line but as mentioned before, it has limitations, and should never have been thought of as a replacement for 2 ½ hose. Many of those fire departments have since switched back to 2 ½ inch for large hand line operations. Some departments have retained their 2 inch hose for use as an intermediate size attack line or for standpipe use. The key to any flow questions is answered after you put YOUR own equipment and pump pressures to a flow test on YOUR engines to see just how much water you are really discharging. A fire stream may look good, but that can be deceiving.

A LITTLE BIT ON NOZZLES

Moving to two inch hose HAS BEEN a good move for the fire service. Period.
Along with this movement, though came the push to equip these new hose lines (and one and three quarter inch hose, too) with automatic type nozzles with variable flow ranges. As automatic fog nozzles were introduced, they were presented in such a way that misled many firefighters as

to how much water was actually flowing from a nozzle. The stream may look good but the volume…
The nozzles were said to regulate themselves to pre-set nozzle pressures – usually around 100 psi. It has been witnessed all over the country – a 200 ft. stretch of hose with an automatic nozzle at the business end. Looking at the pump panel outlet pressure gauge and reading a discharge pressure of around 95 or 100 psi. What about friction loss, you ask?
There were claims and statements floating around, "If you don't use these nozzles or embrace this new technology then you're stuck in tradition and not progressive!"
What's wrong with tradition? Isn't *saving lives and property* a fire service tradition?
Or another interesting floater was "So and so fire department uses these nozzles and they're the most progressive department in the world!" Really? How do you determine that???

Much like we see happening today regarding fire service politics.
Unfortunately, local homework was not done by many fire departments and we ended up relying on a sales person or some other uninformed person who said "Look at that stream!" "Why, you're doing 250 gpm's right now." Ok, if you say so.
What was not said in many places was "Let's put this new stuff on a flow meter and see if it performs like you said it does!"

On the other side of this movement were the departments that used their old nozzles!
The trend today is to move forward with nozzles that are low pressure, high volume. Without a doubt, there has and always will be a nozzle controversy. But the reality is that these nozzles (both solid and fog) will deliver more water at lower pressures and result in less reaction force. There will always need to be good strong information and regular training for any equipment provided to firefighters otherwise they will teach themselves and create "their own" devices, and draw their own conclusions.

IT'S A NEW DAY!

Several years ago while still on the job in Cleveland, I was assigned to conduct an engine company operations class for all engines and all shifts, including battalion chiefs. In the block of instruction we flowed the three sizes of attack hand lines (1 ¾, 2, 2 ½ inch) found on engines with a flow meter, then conducted a simulated offensive fire attack pairing two engine companies on a 2 ½ hand line.

When it came to the two inch hose, it was generally found that flows were way under what was expected. Most two inch hose at that time was between 10 and fifteen years old. Higher pressure automatic nozzles were assigned to the two inch hose. The nozzles were old and not well maintained. (NOTE: If your department uses automatic or other fog nozzles a regular nozzle maintenance program is absolutely necessary. Low pressure fog and/or solid bore nozzles are worth investing in.)

Using the CFD SOP mandated set pump pressure of 125 , some older two inch hose flowed in the neighborhood of 135 gpm's. This flow is easily beaten with 1 ¾ inch hose which has less hose & water weight to deal with.

Since those "early times" hose and nozzle research has taken place and has given the fire service more information, resulting in better qualities for each. Standards that mandate certain items or functions, materials and manufacturing, testing, etc. for nozzles and hose is allowing for greater flows and manageability.

This photo illustrates some of the 2 inch hose and nozzles tested. A couple of points of consideration for hose was bend radius and resistance to kink along with potential for nozzle whip. A well-matched attack hose system needs a good, high volume nozzle valve and tip size (or high volume – low pressure fog tip).

RECENT FLOWS AND FINDINGS

There is no perfect size or weight of fire attack hose line for all fires – there isn't! There is no "One size fits all" hose line, either. Otherwise we would have found it by now. However, if we did, someone somewhere would have found something to complain about and probably would possess a degree and would have conducted a study to down play all the previous facts, figures and work accomplished.

A couple of years ago, Jerry Herbst of Elkhart Brass Co. was introducing a newer solid bore tip size aimed at better flows for 2 inch hose for the fire service. It is the one and one sixteenth inch tip. This tip size beats down the old hydraulic rules of solid tip sizes and hose diameters Since working with it back then, I have been a proponent of it. I have presented it in training and conference venues, and I tell people this is some of that "old style stuff" with the new modern approach. The bottom line is it gives greater flows with lesser resistance pressures, especially when matched with good quality hose.

Recently, I have been doing some research with a small group of firefighters from local fire departments in my area. Jeff Diederich, a lieutenant with the Bedford, Ohio fire department brought the group together, and expressed concerns of his department's initial operations from standpipes in taller buildings with low initial staffing. Another of his concerns is standardization and minimum attack flows for his department and the other fire departments they work with. Understandably, his issues and others are echoed by many departments across the country.

During the times we flowed, a plan was devised to get good data on hose, nozzles and flows so an informed decision could/can be made regarding which hose performed best with flows and manageability of two inch hose. A flow meter was attached to a side discharge of a pump. Right after the flow meter tube an inline psi gauge was also installed.

An inline gauge was installed behind an Elkhart 1 3/8 split ball valve shut off. The nozzle was pressurized to 50 psi and then we pito'ed the stream to verify the inline gauge accuracy. +/- 2psi. Below are our observations.

2" Ponn Conquest, 100ft, in 1.5 couplings.

Here are some of the results of that testing:

Tip Size	15/16th	1-1/16	1-1/8
Outlet PSI	66	85	95
Nozzle psi	50	50	50
GPM	220	280	320
Est FL/50ft	8	17 (+ / - 2psi)	23

A discussion regarding the Fl properties of 2" hose, and specifically why it can NOT replace the 2.5 hose for longer lays was had. To prove our point we used the Bedford Niedner 2" as an example - 2" Niedner xl-800, 200ft, in 1.5 couplings

Tip Size	1-1/16	1-1/8
Outlet PSI	144	170
Nozzle PSI	50	50
GPM	270	300
Est FL/50ft	24	30

200ft Niedner with 1-1/16 50 PSI NP

In June of this year I presented at the Boise Fire Symposium. FIRENUGGETS.com and the Boise Fire department, as you would expect, put together a great conference as was evidenced by the number of students and where they came from. (I urge all of you to stay up on this conference and attend this school sometime in the future!)

In our area of **Engine Operations – Fire Attack training**, there were three sections and one dealt with flows of different sizes of attack hand lines using low pressure nozzles. When the two inch was being demonstrated, the results were very much consistent as back in Ohio. (Before the conference I had the same 2 inch hose shipped to Boise and the same nozzles.) The intent was to check quality of pumps and flows of the same hose and nozzles. Here were the results:

100 feet (2- 50 ft. lengths) 2 inch hose. Couplings were 1 ½ inch thread size.

Nozzles were controlled with an Elkhart split ball valve. 1 3/8 inch waterway.

Tips sizes were : Solid Bore - **1 "; 1- 1/16"; 1- 1/8"**

Pump Discharge Pressure : Approximately 90 – 95 psi. (50 psi NP plus 20 psi FL/ 50 ft. length of hose)

Flow results: **1" – 260 gpm; 1- 1/16" – 280 gpm; 1 1/8" - 297 gpm.**

Each student rotated through, holding each size nozzle at each of the different flows. This was to have them experience the actual force and how to counter it with good nozzle mechanics. Of course working as a team with a back - up firefighter. Coincidentally, after I demonstrated the hose line flowing around 300 gpm's, a student asked me how the back pressure felt. I said, "Look, I'm 63 years old and I just held this BY MYSELF!" You however, should have someone to back you up on this line and all hose lines; if they do their job, you won't have any problem with this line – or any other one for that matter! I believe every one came away with a little more understanding about the newer hoses along with nozzles, pressures and mechanics.

WHY IS THIS HAPPENING?

As I mentioned earlier, the newer standards that apply to the materials, manufacture, testing, etc. of our hoses and nozzles are mostly what is allowing for better flows and manageability (. In the far distant past when many of the old mathematical formulas were developed, there was one kind of material for hose lining – rubber! Hose jackets were cotton or Dacron. So, the formulas were based on those materials.

Today, we have several different types of hose linings and a few of those allow greater flows because of low friction loss. Other factors are the hoses' ability to expand and carry more water. Couplings, nozzle valves, and nozzle tips have all been re-worked for better flows.
In any event, if your department wants to conduct testing/research for hoses and nozzles then you should do it AFTER you have developed a plan to find what you are looking for. For example, do you need to consider greater flows and mobility? Personnel availability and initial stretching considerations? A quick, blitz line with move-in capabilities?

A WORD ABOUT TWO INCH ATTACK LINES

This is an intermediate size line and ***should not*** be considered as a replacement for 2 ½ inch attack lines. The two inch hose is an excellent size attack line for immediate large flow from an engine water/booster tank or perhaps a tanker-pumper. It can provide for heavy knock-down and then advancement into a structure if that's what conditions call for. Just remember, it can take a tank down quickly.
It is also a hose line where its use in standpipe operations is being realized or considered more and more, either as an entire attack line or as the "lead length".

The flows we attained were under training and controlled conditions. Like any attack hose line, there needs to be set "target flows" that give a particular size line its identification and capabilities. Even though we have consistently flowed over 260 gpm's with this size line, it seems two inch hose should have a target flow of approximately 230 gpms. This figure is what our group agreed upon considering flowing pressures, manageability and looking at the 1.75 and 2.5 inch target flows. In any event, each fire department should test and flow their own equipment as results will vary from department to department.

DON'T EXPECT to see absolute accurate numbers! In the past, some old "Drillmasters" would pull out an old hydraulic formula and quiz you on it to see if you knew exactly what you were pumping! That was *pre-flow meter era* and, what we in the job now realize is that we are looking at approximates - "target flows" are the minimum gpm's that *a* particular hose line should be flowing, but we work to beat that.

By the way – this proves that fire fighting is not a science – it never has been, and never will be. Unfortunately, those who do not understand principles and practices will try to change the job for themselves.

Low pressure, high volume nozzles are being looked at and are winning favor in fire departments across the country. They work well with all size hose lines. They are a must for two inch hose. Old rules of hydraulics stated that a solid bore tip should not exceed 50% of the hose diameter. That is not true any more. We have successfully shown that bigger tips are applicable. Interestingly, I ask firefighters to look at the waterways of 1 ½ inch hose couplings and nozzle valves – they are 1 3/8 inches. I then ask them to consider a deck gun with 1 3/8 inch tip @ 80 psi and to consider its volume – which is around 500 gpms's. We're not looking for anything near that amount but it shows that this line can provide a high flow for us. All we have to do is our homework!