ANALYZING THE HIGHRISE HANDLINE

The intention of this text is to show various hose and nozzle combinations that can be used as a highrise handline in a multi story structure fire under specific fire protection system conditions. It is these conditions, which can and do vary from building to building, ranging from poor and inadequate pressures unable to sustain required flows from handlines to workable pressures able to support handlines.

It should be noted that from the beginning, the pressure rating of fire protection systems was based the given that the handline being used from the standpipe would be 100' of 2-1/2" hose using a 1-1/8" smooth bore nozzle at 50 psi nozzle pressure. This equates to a 265 GPM flow, thus the 65 psi standpipe residual pressure. In 1993 the NFPA code changed requiring the standpipe residual pressure to be 100 psi. I am not sure if this number reflects a certain size handline but the bottom line is that 35 psi more is now available to deliver more water. It's important to know that this new code is not retroactive so the 65 psi systems are still out there. .,

And of course the size of the fire problem itself will also factor in to the flow requirements needed from the handline. Several things can factor in that could create a large GPM demanding fire. The time need to actually get water on the fire is delayed because of the logistics of getting people to the fire floor itself. This coupled with the fact that large open floor plans together with the modern more combustible fuels used in today's products and the possibility of wind driven fires all contribute to a big fire.

Developing the required flow through the stream producing nozzle is crucial to the overall success of any fire attack. Producing a fire stream requires a positive pressure to deliver the water, which is why we have pumps on our engine companies. The pump has to be able to develop enough pressure to overcome pressure losses in the hose evolution being used. For the most part this is not a problem. The only pressure limitations on an operation are the maximum allowed pressures of the hose and water delivery equipment, which is set by the manufacturers themselves.

What about developing flows inside a structure utilizing its building fire protection system for a part of the water delivery evolution? This type of operation, because of the restrictions in the building system itself, can

significantly increase the required pressures needed just to get to the handline evolution to create a sufficient fire stream. These restrictions can include elevation loss, plumbing friction loss, low system pressures, pressure regulating devices, pressure reducing valves, and pressure restricting devices. This is whether the system is supplied directly from a municipal or property water system or indirectly from city water to an in-house pump and then through the standpipe system. Because of these restriction issues the trend is to use one type of handline, the 2-1/2" with a 1-1/8" smooth bore tip. This option, because of its low operating pressure characteristics, assures that the handline will handle any and all fire and system situations to the fullest potential. However because of the hose handling requirements needed to deploy the heavy and bulky line, it is vital that the crews be properly trained in handling the line in a highrise environment.

There are two things that can be done to offset low system pressures. First, fire departments must be able to take over a system with pumping apparatus when applicable and supply the system with a maximum allowed pressure per NFPA codes. Let's take a look at system pressure requirements. All systems have to have a hydrostatic test done for the system to be certified. The code states that a minimum pressure of 200 psi be obtained for systems with system pressures up to 150 psi. For systems over 150 psi the system shall be tested to 50 psi above system pressure. Here is an example. The Fitzgerald hotel in Las Vegas is a 36 story building and has a system pressure of 250 psi per NFPA. This is a pre 93 building with a 65 psi standpipe residual pressure. The system was hydrostatically certified at 300 psi again per NFPA. What this pressure range allows us to do is add 50 psi to the system pressure to possibly assist in increasing the standpipe residual pressure.

Another interesting fact about system pressure requirements comes from the UL codes. They require a 5 to 1 pressure safety margin in all material used in the construction of the plumbed system itself.

With all this being said an FD pump operation can be setup to support a highrise operation using the guidelines of the hydrostatic test pressures to possibly achieve higher system pressures.

The second thing that can be done to offset low system pressures, and what will be discussed in depth in this article, is the design of the highrise handline. The highrise handline needs to be as easy as possible to deploy and flow adequate water in a usable stream.

FD pumping apparatus can increase the pressure in the systems sometimes significantly

The key to moving adequate water in a high-rise/low pressure system is to have a handline that offers the required water in an effective firefighting stream with the least amount of pressure loss, in other words, low pressure nozzles and hose with low friction loss characteristics. Secondary to this, the hose should be able to be deployed and used as efficiently as possible.

The low pressure nozzles can be either smooth bore or combination nozzles. An optimal nozzle pressure of 50 psi works well, but, a slightly lower or slightly higher nozzle pressure may also work. Just remember that the lower pressure equates to a lower flow and reach.

The truth of the matter is that a 2-1/2" handline will work best in delivering the most water in any highrise scenario with low or high pressure systems and with big or small fires. You can't go wrong with this choice. The trade off is the hose handling.

Many fire departments across the country only use the 2-1/2" handline but there are some that utilize smaller lines as well. The Los Angeles Fire Department(a highly respected department who has had their share of highrise fires) uses a highrise attack line made up of lightweight 2"

hose with a combination nozzle and have been very successfully with that combination. Of course they also have the option of bringing up 2-1/2" if needed.

The bottom line is, once company officers reach the fire floor with their arsenal (small and large handlines)a decision can be made on which weapon to use based on the system, fire problem, and their experience. Hopefully the flow tests in this article will give some options.

This article is going to show other options under specific conditions which may be usable. It is up to each department to make their decision on what to use.

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A series of flow tests were conducted to analyze several types of high-rise hose pack combinations. The tests involved 1-3/4" (1.75), 1.88", 2",and 2-1/2" lines, all 150' long. Smooth bore nozzles, sizes 15/16" 1", 1-1/8", 1-1/4", 1-3/8'and 1-1/2" were used as well as a specialty type nozzle called the Vindicator (it's been called a large bore tip) because of their low pressure operation characteristics and the ability to flush debris.

There are those that think that combination nozzles are not good for highrise applications because of the potential for debris from the standpipe system to clog the nozzle up. There are departments however that have successfully fought highrise fires with combination nozzles therefore this test will include one. It is a fixed gallonage, 150 GPM at 50 psi nozzle pressure combination nozzle used in a break apart nozzle in conjunction with a 15/16" tip. Remember the purpose of this article is to show several different choices. Your department will make the choice on what works best.

All tests were done ranging from a worst case scenario situation being low system pressure to a fairly high pressure simulating either a newer system with a higher system pressure or a building system taken over by FD apparatus. The standpipe pressures used in the tests ranged from 30 psi to 150 psi.

To insure the accuracy of these tests calibrated inline and pitot pressure gauges were used to measure the standpipe, nozzle base, and exit or nozzle pressures. A calibrated flow meter was used to measure the flow of the combination and Vindicator nozzles since they can't be pitoted for flow readings.

An assortment of gauges as well as a flow meter assured test accuracy

The hose used for the tests represented the best suited for highrise firefighting because of their pressure reducing characteristics. The following is a list of hose used in the tests with their corresponding weight per 50' of coupled hose.

1-3/4"(1.88) Combat Ready made by Key Fire Hose	18 lbs.
2" High-Rise made by Angus	19 lbs.
2-1/2" Magnum 800 made by Key Fire Hose	23 lbs.

You will note that the 1-3/4" hose is actually a little larger than that measuring out at 1.88". For some reason the fire hose industry has been

allowed some leniency as it relates to the actual inside diameter of 1-3/4" hose. Some manufacturers have increased the size while still calling it 1-3/4" hose. This is not necessarily a bad thing. This larger than 1-3/4" hose has allowed for more flow because of less friction loss and virtually weighs the same or less than standard 1-3/4" hose uncharged. It is for this reason that this specific type of 1-3/4" hose which is actually 1.88" was evaluated for highrise use..

Finally, to insure complete accuracy of the tests, all hose was measured to see if the hose was actually the correct measurements. A common problem with fire hose is that they are not always the true measurements that are in the specs. In our case the hose was supposed to be in 50" sections. The 2-1/2" was indeed 50 footers. All others were various lengths. The good news is the shortest section was measured out at 48' so the tests were not affected at all.

FLOW TEST 1.88" HOSE

NOZZLE OR BASE PRESSURES AND GPM AT THE FOLLOWING

OUTLET PRESSURES

NOZZLE	30	40	50	60	70	80	90	100	120	150
15/16"	12 90	16 104	22 122	28 138	32 148	36 157	40 165	48 181	60 202	76 228
1"	12 103	16 119	22 139	26 151	32 168	36 178	40 188	46 202	58 226	74 256
1-1/8"	10 119	12 130	16 150	20 168	24 184	28 199	32 213	36 226	46 255	58 286
1-1/4"	10 147	12 161	16 186	18 197	20 208	24 227	26 237	28 246	36 279	42 301
VIND. B	14 80	20 105	24 125	26 140	28 165	30 180	32 190	34 205	40 240	48 270
TFT METRO	16 60	22 80	24 105	32 120	38 130	44 135	50 155	56 160	68 175	82 185

FLOW TEST 2" HOSE

NOZZLE OR BASE PRESSURE AND GPM AT THE FOLLOWING

OUTLET PRESSURES

NOZZLE	30	40	50	60	70	80	90	100	120	150
15/16"	14 98	18 111	24 128	30 143	36 157	40 165	46 177	50 185	62 206	86 242
1"	14 111	16 119	20 133	26 151	30 163	36 178	40 188	48 206	56 222	76 259
1-1/8"	10 119	12 130	16 150	20 168	24 184	26 192	30 206	36 226	46 255	58 286
1-1/4"	8 131	10 147	12 161	16 186	18 197	22 218	24 227	28 246	36 279	42 301
VIND. B	14 110	18 132	20 162	24 178	26 206	28 215	32 228	34 248	40 288	48 302
TFT METRO	18 100	22 119	28 140	36 159	40 169	44 182	50 185	56 202	68 227	84 200

FLOW TEST 2.5" HOSE

NOZZLE OR BASE PRESSURE AND GPM AT THE FOLLOWING

OUTLET PRESSURES

NOZZLE	30	40	50	60	70	80	90	100	120	150
1-1/8"	18 160	22 176	32 213	40 238	46 255	52 271	60 291	66 303	80 336	100 376
1-1/4"	14 174	22 218	28 246	34 271	42 301	48 322	52 335	60 360	76 402	86 430
1-3/8"	14 210	18 238	26 286	30 308	34 328	40 355	44 373	50 397	60 435	76 490
1-1/2"	10 211	16 267	20 299	24 327	30 336	32 378	42 433	46 453	50 473	64 535
VIND. B	22 150	30 200	36 254	42 257	50 305	62 313	66 337	68 340	70 450	100 511

Nozzle Pressures

The flow tests revealed that most streams had at least a minimum interior attack flow(note I said minimum), however almost half lacked sufficient reach and velocity to be very effective. A 30 psi nozzle pressure was considered to be the minimum to create a minimum workable stream. The cut off point for the 30 psi NP averaged around the 60 to 70 psi standpipe pressure. Keep in mind that pressures under 30 psi are not recommended but could possibly work if needed as a last resort. Just remember safety comes first.

A common denominator in all of these tests was the fact that the tips that allowed higher flows also took higher standpipe pressures to create the minimum 30 psi nozzle pressures. The one exception to this rule was the Vindicator used with the 2-1/2" line. It's 30 psi nozzle pressure started at 40 psi standpipe pressure.

1.88" and 2" Hose

The tests showed that the 2" hose was slightly higher in flow than the 1.88" hose. However, both size's were considered equal in performance characteristics in a side by side evaluation.

Again the minimum 30 psi nozzle and base pressures seem to kick in around the 60 to 70 psi standpipe pressure range
and the flows at that range started at about 150 GPM maxing out at 300 GPM at the top standpipe pressure of 150 psi.

2-1/2" Hose

In the event of a low system pressure or large volume fire scenario that would require large flows to extinguish, there needs to be a hose evolution to deliver the required stream. Many departments utilize 2-1/2" for these situations. The following flow tests showed the capabilities of a 2-1/2" handline using Keys Magnum 800 hose 150' long in the low pressure range, 30 to 100 psi as well as the higher 100 to 150 range that you expect to see in newer systems and systems was properly pumped by FD apparatus. The following nozzle combinations used were:

*2-1/2” nozzle with a 1-3/8” waterway in conjunction with 1-1/8” and 1-1/4" smooth bore tips

*2-1/2" nozzle with a 2" waterway used in conjunction with 1-3/8" and 1-1/2" smooth bore tips and the Vindicator nozzle

You should not be surprised to see the flows increase significantly with the 2-1/2" for obvious reasons. This is why it is a very popular size to be used in a highrise application. Again because of the size of the hose the higher nozzle pressures developed on average of around 20 psi sooner than the smaller diameter hose. But remember the trade off is heavier hose.

Final thoughts and recommendations

An important point to remember is that many building fire protection systems have the ability to allow fire department pumping apparatus to increase the system pressures, sometimes significantly. What does this mean? Yes, the low end pressure range flows in the tests were marginal at best, but a properly run fire department pump operation into a building system can sometimes bring the bottom end numbers up to the 100 psi range, if not more. The best suited hose and nozzle combination for the highrise pack is also equally important. To neglect either one of these components could reduce the efficiency of the operation significantly. They both work together. I say bring both up and decide. If nothing else the small diameter hose pack can be used for overhaul.

When deciding which handline to use in a highrise fire, consider the following.

If the fire is that of a large magnitude and/or the building system is either known to have low pressures or found to have low pressures upon FD evaluation, or if it was unable to be determined, the 2-1/2" handline should be deployed.. I think it's important to bring up small and large hose packs and make the decision based on the situation at hand. If the system pressures and the fire problem will allow, make it easy on the troops by using the small handline. If instead the system pressures are too low, the fire problem is big, or if you are just not sure of either, use the 2-1/2" line.

I encourage fire departments to do similar tests. Our tests were done with specific makes of hose and nozzles. Your tests should involve any equipment that you feel should be evaluated.