Review of 51mm Hose in High Rise incidents.

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This paper briefly discusses the usage of 51mm hose within UK FRS and its relevance to high rise firefighting:

There exists various national guidance notices to UK-FRS advising the usage /adoption/consideration of 51mm hose lines in relation to high rise firefighting (1,2,3). These documents look into flow rates with standard dry/wet riser technologies and (to some extent) pre-empt the newer BS9990 dry/wet risers.

As part of a range of tests and evaluations of replacement hose and branches… In 2005 I carried out a set of flow tests on various trial lengths of TYCO 'Premium' lay flat 51mm hose.

The results are charted in appendix 1.

There are 3 operationally relevant aspects of 51mm hose that needs to be considered:

1. Flow rate / Frictional loss

2. Manual handling when charged (water weight and flexibility)

3. Manual handling when uncharged (weight)

It is important to note that '70mm' hose (which is a conventional name used across most UK FRS) is in fact 64mm internal diameter hose

1 Flow rate / frictional loss

The ODPM research project carried out in 2004 looked at branch and hose design in relation to pressure and flow characteristics and its impact on high rise firefighting. Although some of the views expressed are anecdotal the research did carry out some more scientific, controlled flow tests on 45, 51 and 70mm hose: In its conclusion statements:

"9.3 The pressure drop across 69m of 45mm hose is so significantly large, that at low pressures, the majority of the branches assessed were not able to achieve the performance requirement to adequately undertake techniques that are taught for compartment firefighting.

9.4 When firefighting in tall buildings fitted with dry rising mains, with some firefighting branches there will be an elevation beyond which there is inadequate pressure to undertake compartment firefighting techniques. This elevation will depend upon the charging pressure used for the rising main, size and length of hose used for the attack line, the flow and the specific performance of the firefighting branch used. Account also needs to be taken of kinking in the hose line at low pressures and the effect this has upon the pressure and flow available at the firefighting branch. For the same firefighting branch, where 45mm hose is used, this elevation will be significantly less than that where 70mm hose is used. If 51mm hose was used a firefighting attack could be mounted at higher elevations than could be achieved with 45mm hose currently used by most fire and rescue services."

This research relates to the flow needed for the various designs of AUTOMATIC HAND CONTROL BRANCHES that the research project had on trial. It does not relate to smoothbore branches.

The tests carried out in 2005 painted a slightly different view of 51mm flow rates:

These tests were carried out under the supervision of the FRS Services Water officer and were conducted using 2 different base pumps and measurements taken with an 'in-line' digital, calibrated, local water authority flow and pressure meter.

45mm, 51mm and 70mm hose of the same length (+/- 5%) were tested. The 45m and 70mm hose were standard 'off-the-appliance' Angus Duraline hose. The 51mm was new, TYCO 'Premium' lay flat hose

The flow capabilities of the TYCO 51mm hose were consistently similar to standard 45mm hose. **It is believed that the TYCO hose flow tests were impeded by <u>unsuitable couplings</u> fitted to each end.** These were BS336 standard instantaneous couplings designed for 45mm hose use, thus having an internal diameter of 38mm:

Deriving from: πr^2 the internal cross-sectional areas would be:

70mm (64) 3.1414 x 32 x 32 = 3217 mm^2

51mm 3.1414 x 25.5 x 25.5 = 2042 mm^2

45mm 3.1414 x 22.5 x 22.5 = 1590 mm^2

Restriction at coupling

38mm 3.1414 x 19 x 19 = 1134 mm^2

It can be seen that this coupling will act as a 'constrictor plate' in a 51mm hose line **<u>reducing</u>** its cross-sectional area by approx 45%.

There is extensive research and debate about required flow rates, fire load, high energy wind driven fires…etc.. There are many variables that are difficult to build into any formulaic definitive answer. But it is generally acknowledged that fires in high rise have a tendency to be become 'higher release rate' fires and as such, a higher flow rate should assist in its control. It seems logical that we should endeavour to provide fire fighters with the best possible flow rates, There also exists a perceived requirement for smoothbore <u>and</u> low-pressure/high-flow spray branches to deal with high rise, high release rate fires.

<u>Frictional loss</u>

Five simple rules of frictional loss

- At any given velocity friction loss decreases with the increase in diameter
- Friction loss increases directly with the square of the velocity
- Friction loss varies directly with the length of the hose
- Friction loss increases with the interior roughness of the hose.
- For all practical purposes, friction loss is independent of pressure.

Figures recently produced(4) for hose-branch flow characteristics have shown that smooth bore nozzles (for example a Galena 30mm open-bore) can greatly increase flow rates at low pressures. With a higher flow comes increased dynamic frictional loss. In high flow condition, 45mm hose can have twice the frictional losses of 51mm hose. Typically, connecting up to 3 lengths of 45mm together will have a cumulatively detrimental effect. This may impact on the throw of a smooth bore branch.

2 Manual Handling (When charged)

Deriving from: length (23m) x πr^2 the water content in Litres

70mm (64mm) 23000 x 3.1414 x 32 x 32 = 7399100ml = 74l = 74 Kg

51mm 23000 x 3.1414 x 25.5 x 25.5 = 4698487ml= 47l = 47Kg

45mm 23000 x 3.1414 x 22.5 x 22.5 = 36579919ml =36l = 36Kg

The problems pertaining to the weight and inflexibility of charged 70 mm hose lines when used in corridors and flats is well known to firefighters. It places serious restrictions on its use and suitability for internal high rise firefighting. This was reinforced when at a current training event (exercise Finely, Arlington House, Margate 2009) crews were deliberately instructed to deploy lines made up of 2 lengths of 70mm hose. This caused delay, fatigue and seriously shortened BA duration times.

Standard issue 45mm hose is conventionally deployed as a larger attack line for internal firefighting (superseding high pressure hose reels) and is the hose commonly used in current Marine firefighting. There is a perception that Marine fire fighting training is the only training where lay flay hose management is considered. Fire fighter BA teams should be trained and confident in handling or manipulating a charged 45mm hose line without undue concern. Transition to 51mm hose would have negligible inpact.

The 51mm hose will add approximately 10KG to the water weight of a charged hose line. The fire fighters in the trial have trained with (and indeed, used operationally) the TYCO 51mm hose and they report no concerns over its usage within compartments, corridor and flats. Most remark that it is very similar to using 45mm hose (anecdotally)

3 Manual handling (Uncharged)

One of the most notable properties of the TYCO hose was its weight. This is an important consideration in high rise deployment. Large quantities of equipment may have to be carried up staircases, if lifts are risk assesses as unusable. Any weight reduction is advantageous.

Using a base line of the 60m requirement (as furthest travel distance from a dry riser outlet BS 5306 /BS9990) a hose line consisting of 3 lengths would be require to safely deploy on any unknown floor layout. Current Durline hose (45mm x 23m) weighs 9.1 Kg. The TYCO hose (51mm x 23m) weighs 6Kg.

Using TYCO hose would relate to a 9.3KG weight saving in each high rise loadbag.

It is important to note that other hose manufactures produce lightweight hose that is suitable for internal structural fire fighting. Compliance with BS 6391 must also be a consideration.

CONCLUSIONS:

National research has shown that there are definite 'flow rate' advantages to using 51mm hose and in local trial and exercises, firefighters reported that using 51mm hose was very similar to using 45mm hose (as far as the physical aspect of manual handling a charged length)

51 mm hose may be beneficial with many current operational branches, especially spray/fog and automatic branches.

The use of lightweight hose has a notable, beneficial physiological effect on firefighters carrying equipment in high rise stairwells.

No serious disadvantages can be found in replacing a proportion of FRS 45mm hose with lightweight 51mm hose. Provisionally 3 lengths on each appliance.

Further work on costing and durability may be required. 51mm hose has been stowed as a replacement to 45mm hose on both Scania (Emergence one) and Dennis(Sabre) appliances without modification.

Further trail and research into correctly specified, lightweight 51mm hose should be perused. Ultimately consideration should be given to the use of smooth bore branches and low-pressure/hi-flow spray branches flowing through lightweight hose lines.

SOURCES

1. GRA 3.2 High Rise Firefighting 2008
2. ODPM Fire Research Technical Report 3/2005 and 4/2005
3. CLG Fire and Rescue circular 71-2006
4. Paul Grimwood TB2/2010 Chatham Queys

APPENDIX 1 51 mm TYCO Hose trial

Flow testing of hose to assess comparative performance of 51mm Hose

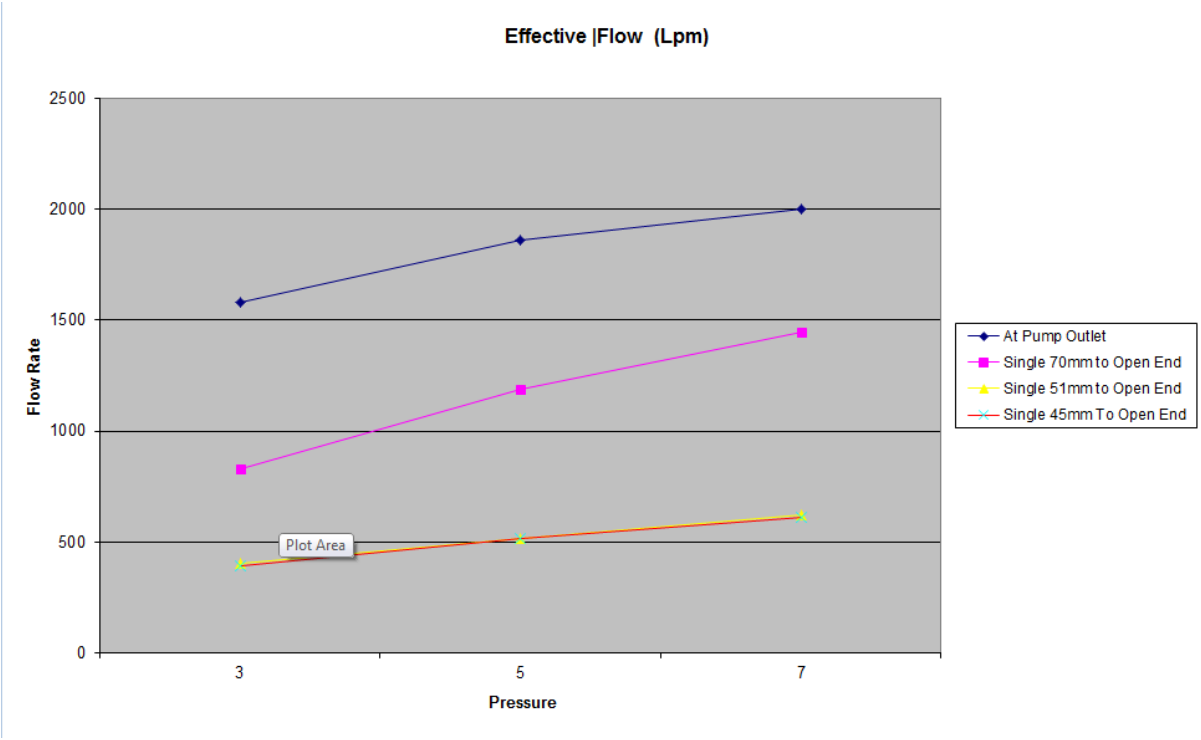
Flow rates tested at pump delivery using calibrated Water Board, digital flown meter with built in Pressure Gauge (Pressure gauge accuracy verified with additional gauge, **Pump gauge reading 40-50% inaccurate!**)

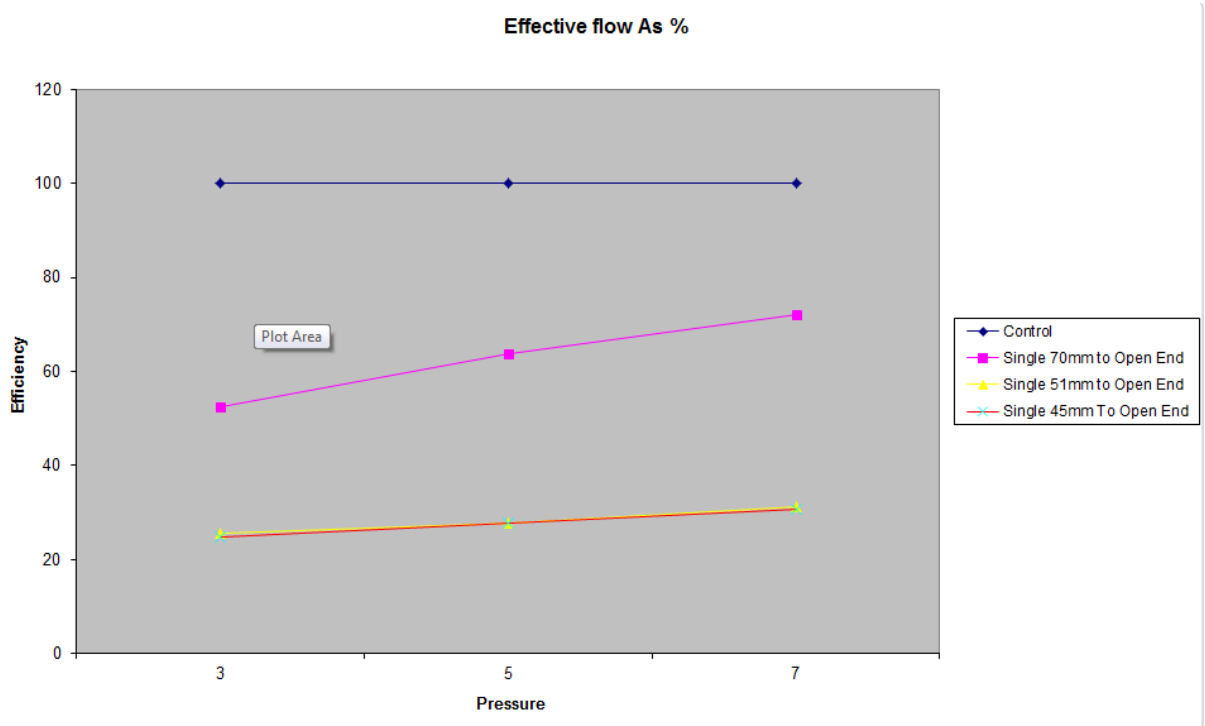
Hose Flow DATA		3	5	7
	At Pump Outlet	**1579**	**1861**	**2000**
	Single 70mm to Open End	**830**	**1187**	**1444**
	Single 51mm to Open End	**403**	**514**	**624**
	Single 45mm To Open End	**391**	**514**	**612**

Comparative Effects

	Bar	3	5	7
Control Figures	At Pump Outlet	**1579**	**1861**	**2000**

	Bar	3	5	7
As Percentage: Effective flow efficiency efficiency	Control	**100**	**100**	**100**
	Single 70mm to Open End	**52.56491**	**63.782912**	**72.2**
	Single 51mm to Open End	**25.52248**	**27.619559**	**31.2**
	Single 45mm To Open End	**24.76251**	**27.619559**	**30.6**


Effective |Flow (Lpm)
2500
2000
1500
1000
500
0
Flow Rate
Plot Area
3
5
7
Pressure
At Pump Outlet
Single 70mm to Open End
Single 51mm to Open End
Single 45mm To Open End


Effective flow As %
120
100
80
60
40
20
0
Efficiency
Plot Area
3
5
7
Pressure
Control
Single 70mm to Open End
Single 51mm to Open End
Single 45mm To Open End