FOAM EQUIPMENT AND HAND CONTROLLED BRANCHES

6th September 2005

During the training sessions that we have carried out with crews regarding the World Series pump, it has become apparent that as a service we are not aware of the true figures and their effects on flow rates when it comes to frictional loss through our hoses. It is mistakenly believed that we add 0.2 bar per length of hose, be it 45mm or 70mm irrespective of any given flow rates.

The figure 0.2 bars was originally quoted in the manual of firemanship as an approximate guide on the fireground when using 70mm non-percolating hose with a given flow rate of 500 l/min. But this figure seems to have been adopted into the service as a fireground figure for frictional loss, regardless of the diameter or overall length of hoselines.
0.1bar must still be added for every meter the branch is above the pump and deducted for every meter it is below the pump.

The following gives the formula and correct calculations that should be applied (it must be remembered that our 45mm & 70mm hose do not have full flow couplings).

<u>Key for formula below</u>

P = Pressure loss in bars
f = Degree of internal roughness of a particular hose or pipe is referred to as its friction factor (f) or co efficient of friction.
l = Length of hose in metres
L = flow rate in Litres per minute
d = hose diameter in mm

Formula: $$P_f = \frac{9000\ flL^2}{d^5}$$

The first calculation is using 500 l/min (figure taken from SIS tech 1/026) with a Delta branch H500-65f in jet position using 45mm hose optimum inlet pressure 6-7 bar.

$$\frac{9000 \times 0.005 \times 25 \times 500 \times 500}{45 \times 45 \times 45 \times 45 \times 45}$$

=**<u>1.524</u>** bar to be added per length.

The second calculation, same branch & flow rate using 70mm hose optimum inlet pressure 6-7 bar.

$$\frac{9000 \times 0.005 \times 25 \times 500 \times 500}{70 \times 70 \times 70 \times 70 \times 70}$$

=**<u>0.167</u>** bar to be added per length.

The third calculation is using the DM600 on a jet optimum inlet pressure 10 bar, 900 l/min using 45mm hose.

$$\frac{9000 \times 0.005 \times 25 \times 900 \times 900}{45 \times 45 \times 45 \times 45 \times 45}$$

= **<u>4.94</u>** bar to be added per length.

(We are not saying that we would try to use 45mm hose if a flow rate of 900 l/min was required and this can clearly be seen to be impracticable if more than one length is required)

The fourth calculation is using the DM600 on jet position, optimum inlet pressure 10 bar using 70mm hose.

$$\frac{9000 \times 0.005 \times 25 \times 900 \times 900}{70 \times 70 \times 70 \times 70 \times 70}$$

= **<u>0.54</u>** bar to be added per length

We also believe that the Delta H500-65F branches do not deliver the correct flow rates at the given optimum inlet pressures laid down in Tech 1/026.

We carried out flow tests using a flow meter (see appendix fig 1) and the results are as follows: -

We used four H500-65F branches (all fully open in jet position)
Branch 1 @ 7 bar = 290 l/min
Branch 2 @ 7 bar = 290 l/min
Branch 3 @ 7 bar = 280-290 l/min
Branch 4 @ 7 bar = 320-330 l/min

At 9 bar we reached 450 l/min
At 11 bar we reached 500 l/min
We used two DM600 branches (fully open on jet position)
Branch 1 @ 10 bar = 910 l/min
Branch 2 @ 10 bar = 930 l/min.

Using our test results, and assuming 190 (scania) as having a tank capacity of 1300 – 1350 litres, we placed a Delta H500-65f in No 1 delivery and then ran the pump giving inlet pressures at the branch of 7 bar (290 l/min) and then 9 bars (450 l/min). We timed the water usage after ¼, ½, and then ¾; (the final ¼ of the tank could not be timed due to the piston primers cutting in). On both occasions the given flow rates and tank level corresponded, so we believe this gives a fair (but not scientific) gauge to the results found.

On many occasions flow rates and loss of pressure due to frictional loss may not impact on firefighting operations. (Note: ignoring the height factor if the pump pressure is reduced by 50% the flow rate will decrease by approx 30%). But when flow rates and inlet pressure are of paramount importance i.e. tackling compartment fires, gas cooling, foam equipment etc then it can be seen that the pump operator must take many factors into account, i.e. optimum inlet pressure of branch / correct friction loss per length for the flow rates required.

As it's flow rates and not pressure that extinguishes fires, and with modern firefighting techniques, more emphasis needs to be put on flow rates through hose lines and not just a fixed branch pressure with no regard to length or diameter of hoselines.

We then used the flow meter to test the Delta inline inductor (Tech 1/035 gives a different flow rate of 450 l/min). The tech note states that the inductor requires an inlet pressure of 10 bar, which will give 6-7 bar branch pressure. But as previously shown this does not take into account any frictional loss per length and 10 bar at inlet would give 6-7 bar **AT OUTLET** of inductor.

Our test results are as follows: (using equip from 190 & 191).

<u>Test 1</u>

Flow meter in No 1 delivery, inductor into flow meter and branch into inductor (see appendix fig 2).

B190 @ 10 bar at pump / 10 bar at flow meter = 230/240 l/min
B191 @ 10 bar at pump / 10 bar at flow meter = 230/240 l/min

We took the pressure up to 15 bar (low-pressure side of the pump must not exceed 17 bar) but could not increase the flow rate above 280 l/min.

<u>Test 2</u>

One line of 45mm del hose in straight line from No1 del into inline inductor, flow meter into outlet of inductor and branch with foam attachment into flow meter (see appendix figs 3 & 4).

Pump @ 11-11.5 bars, flow meter reading 6 bars flow rate = 250 l/min
Pump @ 17 bar (MAX) , flow meter reading 7.5 bars flow rate = 300 l/min.

Test 3

Inductor into No 1 delivery, flow meter in outlet of inductor and branch in outlet of flow meter (see appendix fig 5).

Pump @ 10 bar, reading on flow meter 6 bar = 240 l/min
Pump @ 12 bar, reading on flow meter 7 bar = 270 l/min
Pump @ 17 bar, reading on flow meter 8 bar = 310 l/min

These tests show a dramatic difference in flow rates and these have a major affect on the use of this foam equipment and its application rates and the figures quoted in Tech 1/035. The tech note also states that 45mm hose should be used, but it can be seen from the figures on frictional loss that 70mm hose would be more practicable, especially as the pressure on the low pressure side of the pump should not exceed 17 bar and our del hose is only tested to 10 bars. It should also be remembered that any frictional loss added to the delivery side of the inductor needs to include the 35% reduction across the inductor, i.e. 1.5 bar per length for 500 l/min would be approx 2 bar per length.

We are aware that the formula for calculating frictional loss is not the most accurate and does not account for the hose expanding under pressure, but conversely the hose expands in length. Also kinking, snaking and laying hose over obstacles etc. will also have an effect on frictional loss. But we feel our tests, although basic, do give a fair indication and show the need to reassess the operational /practical use of our firefighting equipment and its use to meet modern firefighting techniques; be it application rates for foam to water application rates / droplet size at a given flow rate and branch pressure etc.

Again we are aware that our tests are not scientific, and in fact we may be proved wrong, but we feel our tests and practical experience seems to bear out our concerns and the health and safety implications.

M Arrowsmith
Blue Watch Welwyn Garden City