



PUMPING WITH FLOW METERS

This purpose of this document is to give staff an understanding of the reasons for fitting Flow meters to all Nottinghamshire front line appliances and also to explain the advantages from an operational perspective.

Background

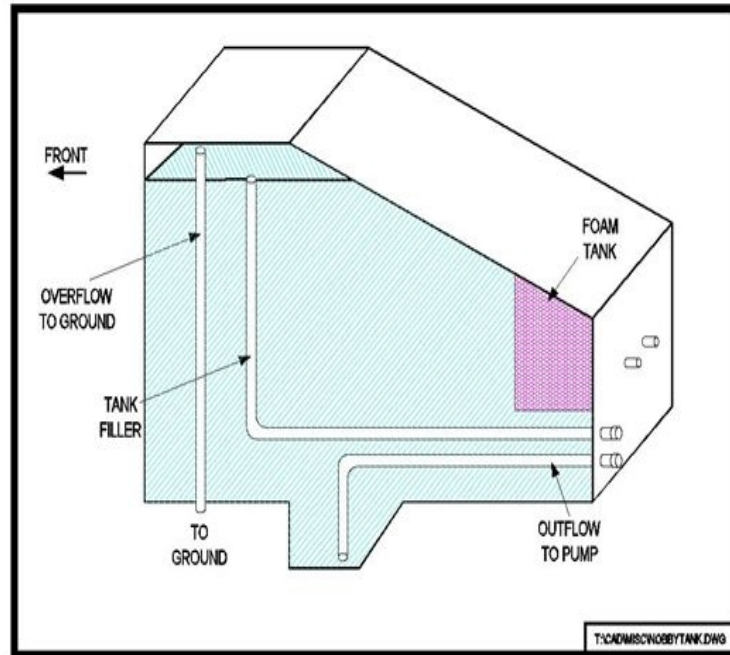
Like most Fire and Rescue services, Nottinghamshire embarked on a replacement programme of all front line appliances with Scania CP28 cabs supplied by JDC. The vehicles were fitted with Godiva World Series 2010 Major Pumps that could be supplied from an 1800 litre water tank carried on the chassis, or any external pressure fed supply or open water source.

The design of the water system meant that the pumps could be fed from any pressure supply going through the tank filler. This method is the safest way to feed pumps as it protects fire fighters from any surges in mains pressure or indeed from any pressure increase when changing from tank supply to hydrant.

This is not recognised as Safety Critical by some other Services yet on page 73 of the current Fire service manual it states that: “at least one fire fighter has died and several injured due to surges in mains pressures”. I have visited several Fire Services over the past few years and we have two distinct methods of supplying pressure fed water to pumps.

Some have the supply connected directly to the pump eye using radial collecting heads, whilst others favour the feed going through the tank filler as a far safer operating system. The main argument for not using the tank fill system is one of vortexing. This is a common problem when pumping, but is easily negated with proper training and a good understanding of how a pump works when supplied from any on board tank, and provided the training is to a suitable standard then safety is maintained to a high degree.

However, an even bigger improvement to fire fighter safety comes when using moulded body shells incorporating integral water tanks. These tanks can be fitted with sumps allowing water to be drawn upwards into the tank to pump feed pipe. This makes it impossible for any vortex to enter the pump as the laws of physics prevent the occurrence.



Following the move to Emergency One in 2008, the decision was taken to utilise a moulded body with integral water tank. Coupled with this was a fully flow metered water system and automatic tank filler valve along with the E1 pump control system. The flow meters used are the TSI electro magnetic type using LCD gauges for incoming and outgoing low pressure feeds and LED displays for both high-pressure hose reel displays. However, since the vehicles have been on the run for some time the decision was taken to change the high pressure LED gauge displays for LCD as the LCD is easier to calibrate.

Operation

All the flow meters fitted to Nott's appliances record the flow of water and display this flow rate in litres/minute.

The system is designed so that a flow meter fitted to the tank filler records all water entering the tank, this flow being displayed on a unique "flow in" LED display. Each delivery has its own flow meter and LCD gauge, and there is a further LED which displays the total flow of any combination of meters on the outgoing side of the pump.

Pump operators now have a simple system whereby if "flow in" is greater than "flow out" then the safety of all concerned is at a premium.



Testing

There are numerous advantages to flow metered systems both from a fleet management perspective as well as an operational or fireground viewpoint. However, in order that we provided the best system for our fire fighters it was obvious that we would have to start with an evaluation of all the hose and branches carried on front line appliances.

We approached TSI and took delivery of a combined pressure/flow meter in order to carry out our own research.

The first tests involved the high-pressure hose reels.

Using the TSI meter we flowed both 60mtr and 90mtr reels at 25 bars. This was the standard pressure of all our operational hose reels at that time. What we found was that the 60mtr reels gave between 90 and 100 litres/min of flow at 7.5 bars branch pressure and the 90mtr reels were between 70 and 80 litre/min.

We then increased the pump pressure to 30bars and the results were surprising. The 60mtr reels now flowed 130 litres/min and the 90mtr reels 105 to 110 litres/min with a branch pressure of 7 bars on the 90mtr reels.

Following these results we then set out to find a suitable hose reel branch capable of delivering 120 litres/min @7 bars pressure. The result was the purchase of the Akron Assault 4802 branch rated at 130 litres/min @ 7 bars that the manufacturers produced to this specification. With a pre-set pump RPM of 2250 these branches deliver 120litres/minute at a branch pressure of 7.0 bars on 90mtr 19mm bore reels which is a 30% increase in flow from the pressures that we had always operated our pumps at. Results of these tests have been circulated to other fire and Rescue Services.

The next matter was to assess our High Rise premises protocols and in particular the achievable flow rates when working at height using dry risers.

Working on the 14th floor of a suitable premise we used a TSI combination meter at the branch and a portable flow meter at the pump.

We then flowed both 38mm hose and 45mm hose with the current branches used in High Rise compartment fires and also a Delta Attack 400 that Delta had made to our request for a branch that could flow 400litres/min @4 bars branch pressure.

Again the results were astounding. We were now able to give fire fighters a larger volume of water at a manageable pressure and this needs to be considered by every Fire Service in the country when faced with this type of fire.

With a pressure system, all that is known is the pump pressure. All the various pieces of research over the years suggests that a 4 to 5 bar jet should be available for crews to tackle the fire, but it is guesswork as to how much water is at the branch because of all the unknown factors; condition of the internal surface of the riser, pressure loss due to turbulence at the delivery, frictional pressure loss, loss of pressure due to height etc. A further unknown quantity is what the branch can deliver. Some branches can deliver 600 litres/min at 4 bars yet others may only deliver 200 but if no flow meter is fitted then how does any fire fighter or OIC know whether there is enough water at the branch to protect the lives of the crews?

Other branch testing with the flow/pressure meter proved that we had several branches under flowing. The Akron 1723 Turbojet branch has been a long time favourite with Nott's crews and when tested we found that several branches were only flowing around 500 litres/min and not 750 as the branch is designed to flow. This had the effect of pump operators increasing the pump speed to gain the correct flow, but in so doing the pressure was also vastly increased with the obvious manual handling issues resulting.

After completing all the relevant tests we were then in a position to deliver a complete package to operational crews combining suitably calibrated branches for use with TSI high and low pressure flow meters. It was also apparent that quality training would need to be provided to all operational staff.

Apart from the operational crews we also ensured that ALL primary cover officers received suitable training on the capabilities of Appliances fitted with flow meters and the advantages they afforded.

It was also evident that refresher training would need to be introduced on an annual basis to keep competency levels high.

Advantages

The operational advantages of pumping with a flow-metered system are numerous and these are listed below.

The available quantity of water for fire fighting can now be displayed for the pump operator as can the total flow out of the pump. This means that operators can see exactly when they would overrun the supply.

Using partial deliveries allows for each delivery to have its own unique flow. With a pressure system all jets are at the same pressure, thus if 3bar is delivered when working off a ladder then all other deliveries are at 3bars.

Because the flow at the branch is displayed at the pump there is no longer a need to calculate pressure losses. In a high building the flow at the branch is known by the pump operator at the ground and can be fully controlled.

The risk of injury due to pressure surge is negated because the flow meter allows the operator to deliver the correct flow at a controlled pressure with a partial delivery.

Branches have the optimum flow and pressure that results in easier to handle branches with less jet reaction.

Conclusion

Fire-fighters lives are better protected by the use of flow meters. However the importance of quality training cannot be overstated. The general standard of pump operating has dropped over the last few years but the use of flow meters makes it much simpler to understand and to operate appliances on the fire ground with the obvious health and safety benefits.

CM Chas Clark
Fleet Trainer
Nottinghamshire Fire and Rescue Service.

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