GO WITH THE FLOW

1st February 2008

Since writing my last reports in 2005 I feel that nothing has changed within the service regarding firefighting equipment, training, and after recently attending a B.A.R. it is clear to me that we as a service are still falling short with our knowledge of flowrates, frictional loss, firefighting equipment and firefighting techniques. I do not claim to be an expert in any of the above but I feel I know enough to raise some questions and in some small way help us all to enhance our knowledge and understanding of these subjects.

Since completing the training package for the World Series Pump, I have continued to give many training sessions to watches around the service (at their request), during which it has become clear that there is still a lack of understanding as to the need to correctly flow our hoselines. Many of these crews still mistakenly believe that they should add 0.2 bar per length regardless of the flowrate required or diameter of hose in use, and on most occasions when using the Delta H500-65f they would set the pump at 6 - 7 bar (worryingly some would set the pump at an even lower pressure) regardless of the number of lengths of hose in the line or without taking into account the height above the pump that the branch is being got to work (they also believe at 6 - 7 bar they are flowing 500 l/min. because this is what it still states in the SIS Tech 1/026). If instead of using the fireground formula we use Angus Fire's own hose calculator for frictional loss through Duraline hose it will mean we have to factor in higher figures for losses through our hoselines. We could also consider flowmeters built into the deliveries, Hale Products have been experimenting with this on their pumps but they have not persevered with it because they are not sure that there is a demand for them and after speaking with them it became clear that no one had ever explained to them the advantages to us operationally of having them on the delivery side of the pump. We should also look into branches/combination nozzles with built in flow/pressure gauges and adjustable flowrates. Electro magnetic flowmeters should be considered over the paddle wheel type as I believe they are more accurate, there are other manufacturers that produce these types of flowmeters and having flowmeters fitted to each delivery is definitely the way forward (they are a must have!) especially as the accuracy of pump gauges cannot be totally relied upon.

To begin with we need to educate ourselves to achieve a greater understanding of dealing with fire at its different stages. A fire in its *growth-phase* will require a higher flowrate than a fire that has progressed beyond 'steady-state' combustion into a *decay-phase* of burning, and a direct attack on a fuel-phase will be different to an attack on a gaseous-phase fire. We may choose a direct attack, indirect attack or 3D water fog for fire suppression of the above but what ever method we choose our attack lines must be correctly flowed.

When we used to do our "Hot Fire" training we used hosereels and the fires encountered were only approximately 1.5 MW burns (a realistic room fire will present a heat release rate of 5 MW, an apartment 15 MW and a large office 50 MW). Today our primary attack hoselines are 45mm hose due to the low flowrates associated with 19mm hosereel tubing. When dealing with real compartment fires and even greater heat release rates due to the fire loading in the compartments, maintaining adequate flowrates is the most important thing (even above optimum droplet size). As said previously, we have crews that are not achieving branch inlet pressures of 6 -7 bar (there is also a loss of pressure over the branch) therefore resulting in potentially seriously low flowrates. If the branch operator were to attempt a 3D water fog attack the pressure loss would result in a

drop in the flowrate and incorrect droplet size (which may lead to excessive amounts of steam being generated), we also need to be aware of the fact that steam generation increases (vapour expansion) with the change in temperature in the compartment e.g. at 200 ˚C = 2060, at 600˚C = 3900. We could reach a situation where the lay flat hoselines are down to flowrates close to 19mm hosereels but at low pressure. So this may result in the branch being flowed below the *critical flow rate* (absolute minimum) of 200 l/min for a compartment fire up to 70m².

There are now many experts that believe with today's modern fire loads we will need to achieve flowrates of 500 l/min or above. In the USA firefighters are not allowed by law to enter fires with less than 380 l/min at the nozzle, (in New York the first primary attack line must have a minimum flowrate of 680 l/min), and in France its 500l/min.

If we apply the above to High-rise firefighting, and as stated in my previous reports, we will be seriously under flowing our hoselines, particularly if the Delta H500-65f branch is taken aloft. Following the submission of the "Branches Report" by the 'task and finish' project group I would like to bring your attention to numbers 7, 8, 9, and 10 in the list of recommendations.

Number 7 states "The service investigates further the availability and actual performance of main line branches incorporating a smooth bore nozzle into a jet/spray branch."

Number 8 states "Any jet/spray combination branch is capable of producing a 'solid' cone over a range of angles."

Number 9 states "Consideration that a solid stream nozzle ('A'-type) as part of a hand controlled branch capable of operating at 2-3 bar should form part of any high rise pack."

Number 10 states "Training would need to be provided for a different fire fighting technique that would need to be employed with this equipment."

As a member of that project group I would strongly urge the service to adopt these recommendations A.S.A.P.

I still believe that at this moment in time and with the equipment presently available to us in the service, that the Delta mainline DM600 should be the **only** hand controlled branch that is taken aloft at a High-rise incident (see the findings in my previous reports).

Also the firefighting technique of directing a straight stream (or solid stream) into the overhead needs to considered. Although some of our current branch techniques may be the most effective method when dealing with most compartment fires and where the fog pattern is applied in a controlled fashion (brief bursts) it is proven to be more efficient than the straight stream, when it comes to dealing with a High-rise fire be it residential or office buildings, high flowrates are what is required. There are a number of advantages of the solid streams produced by smooth-bore nozzles (they would give us the capability to achieve manageable flowrates of 600 l/min). Not only are the branches used at lower operating pressures reducing nozzle reaction, the solid streams in some circumstances are less susceptible to premature vaporisation than fog stream. Solid streams are also better able to penetrate superheated atmospheres. This, combined with the fact that their physical properties give them far superior reach, means that solid streams are much more apt to reach the seat of the fire (they are also more effective in buildings with high ceilings).

With a smaller percentage of the steam vaporising (depending on the temperature of the ceiling in the compartment), the excess steam generation inherent in an under flowed/pressure or wrongly applied fog application is not present. Less steam generation means less disruption of the thermal balance of the fire compartment. Maintaining the thermal balance relatively intact preserves a condition of differentiated heat strata. Most of the heat remains in the upper levels of the fire compartment while

the floor remains relatively tenable. Visibility is less negatively affected, and the solid stream does not push products of combustion towards victims, firefighters, or uninvolved areas of the building.

This is in direct opposition to the conditions possibly created by introducing a fog stream into the fire compartment, particularly if using a H500-65f branch at low pressure because when we face a fast developing fire, the application of fog bursts into the overhead serves little purpose if (a) the stream velocity and (b) the flowrate content, are inadequate. Where a fire is in transition from a 1MW fire to a 5MW fire then to overcome this rapid growth-rate of the fire we must have adequate pressure at the nozzle tip (7bar), which provides high velocity, which breaks the droplets down into an effective fog pattern. With effective droplet sizing and correct application the steam is lessened with the fog pattern. Using insufficient pressures the fog stream readily vaporises, voluminous amounts of deadly, superheated steam are driven down to the floor. This severely increases the hostility of the environment in which crews operate and victims lay awaiting rescue. The use of smooth-bore nozzles in certain circumstances will lead to a safer a more effective and efficient means of attack at Highrise and possibly some Lowrise fires. The key to using a solid stream is rapid, vigorous nozzle movement to direct the stream off the ceiling and upper walls (this is still a controlled application technique). This will cause the stream to break up into large, heavy drops of water that will rain down onto the burning solid fuels. As these large chunks of water begin their journey downwards towards the seat of the fire, they simultaneously cool the upper area of the fire compartment. The upper level of the compartment is the birthplace of rapid fire progress phenomena, such as backdraught and flashover. The large, heavy drops of water created by smooth-bore nozzle movement have a much lower surface-to-mass ratio than fine droplets produced by a fog nozzle, thus they are much less prone to premature vaporisation. This makes the solid stream more efficient in some circumstances for extinguishment because its large droplets of water cool the upper area of the fire compartment and then are still able to pass down through the superheated strata to the seat of the fire-the burning solid fuels where the fuel flame interface is located. Thus, the superheated upper portion of the compartment, containing massive quantities of unburned fuels, is quelled and the further distillation of flammable vapours and particulates at the fuel-flame interface is quelled in the lower level of the compartment.

This technique is not new and is practiced and promoted by experts and some fire services (including armed forces) throughout the world today, in America for example. Yes it may involve a larger volume of water being applied into a compartment and some will argue there will be more water damage, but this must always come second to crew safety and correctly taught and practiced, water damage can still be kept to a minimum. There will also be those that will argue that the straight stream is not as effective in the 'hot cans' as a fog attack but these are not realistic fires, this technique has its place and can be easily taught and understood, yes there are some issues with it as a technique but fully understood and correctly applied at the right time and place it can be an additional tool in our arsenal. The ODPM and our own trials have shown that we may be able to deal with a fire in a High-rise buildings (up to certain floors and fire loading) using the Delta mainline DM600 employing branch techniques already taught within the service. But as can be seen from the above a smooth-bore nozzle should be considered for High-rise fires as soon as possible and the straight stream into the overhead technique explored to give us an additional means of attack which will ensure we have the versatility to adapt our firefighting techniques to suit the varying conditions and the different stages of a fire we may encounter at each specific job. I feel the DM600 can be used in the interim at High-rise fires but only up to a limited height because of the low riser outlet pressures encountered. We should still consider the introduction of 51 mm lay flat hose (with the correct size couplings) for these and other incidents because of the advantages it has over 45mm hose when it comes to frictional loss and the manual handling advantages it has over 70mm hose. We need to have fire plans that are specific to each individual High-rise building and to test and have the results recorded for the potential flowrates available from all hydrants available to the crews at an incident (in

fact we should go back to testing and recording for all risks be it High or Low-rise or any other type of building). The fire plan and equipment i.e. hose size and length should be geared towards the individual risks and problems that may be encountered, this may seem impracticable but in reality this should be easy to achieve as most of this can be carried out at station level and in fact would prove to be an invaluable training aid to crews on the ground. We need to educate our crews as to the correct riser inlet pressures required this is because during the pump training sessions when asked crews have given me figures ranging from 4bar – 15bar. We also need to plan and train for a failure (whether it's accidental or due to vandalism) of the rising main and to have procedures fully practiced and in place.

The container fires we encountered during our training exercises were not a true reflection of the conditions we may face in a real compartment fire and as I stated earlier the fire loading may be greater than those encountered in the cans. The types of compartments, their construction, ceiling heights, their layouts and size will require the crews to read and adapt their method of attack to suit the conditions encountered. I feel the attacks made in the hot cans may give crews a false sense of security, and we are in danger of firefighters believing "one cap fits all". I am in no way just trying to knock our training, but we must realise its limitations and the restraints placed upon our instructors by the facilities available and Health & Safety. We need to realise our training must progress and adapt and that there is no substitute for realistic carbonaceous burns. We need to explore all techniques and branches that are out there to ensure that we have the knowledge and tools in our arsenal to deal with and adapt to, any situation we may encounter.

I stated earlier that there is a possibility that crews are entering compartment fires using seriously low flowrates and I would like the service to consider the following. If when dealing with some fires in Low-rise buildings we were to use the DM600 branch (instead of H500) in the primary attack hoseline and the traditional nozzle technique and/or the straight stream into the overhead technique was employed (although it is not a smooth bore nozzle), it may in some circumstances be more effective and safer than using the smaller branch under flowed. Yes we could ensure that the smaller branch is correctly flowed (and has the correct nozzle tip pressure), but because of the higher pump pressures required, the hoselines become hard and difficult to manoeuvre particularly when the branch is shut. The DM600 at any low-rise fire would provide higher flowrates at lower inlet pressures, for example at 4 bar the branch will flow approximately 440l/min. Yes this would result in the pump operator having to factor in a higher figure for frictional loss, in the above example it would be approx. 1.6 bar per length of 45mm hose, this means the pump operator needs to set the pump at 8.8 bar (flowing). If we break with tradition and exchange the first two lengths of 45mm hose for two lengths of 70mm hose (frictional loss for 440 l/min through one length of 70mm = 0.2 bar) the pump needs to be set at 6 bar (flowing) resulting in a softer hoseline and it being more manageable for the branch team. The nozzle reaction force when advancing or retreating a flowing branch would be 198.5N this is well within the acceptable limits for a team of two. The DM 600 would ensure that when lay flat hoselines are in use flowrates are well above the *critical flowrate* (absolute minimum) required. It should be borne in mind that it is hydraulically less efficient to go from 45 - 70mm hose because as water passes from the 45mm hose through the restricted instantaneous couplings and then on through into the 70mm hose there is turbulence created (this applies to any hose diameter above 64mm) and a consequential reduction in pressure. Hence we should always consider using 70mm and reducing down to 45mm (or 51mm) for any lengths where there is a manual handling issue.

At 3 bar with the same hose configuration it will flow approx.300 l/min with 0.1bar loss per length of 70mm and 0.8 bar per length of 45mm requiring the pump to be set at 4 bar when flowing and there will be a nozzle reaction force of 117N.

At 5 bar it would flow approx. 570l/min with 0.3 bar loss per length of 70mm and 2.6 bar per length of 45mm requiring the pump to be set at 8.2 bar and when flowing there will be a nozzle reaction force of 287.5N.

All of the above reaction forces being within the acceptable limits of a two person team operating a flowing hoseline.

The SIS also states, "The water supply is shut off with the handle in the 'forward' position and allows a full flow when the handle is in the 'back' position", many crews are unaware that they can vary the flowrate by setting the stirrup handle in its different positions. This makes the DM600 more versatile allowing flowrates to be varied to suit the situation encountered. Although the intermediate positions are not easily distinguishable, there are possibly branches available that allow flowrates to be adjusted more easily. Yes the H500 can be used in the same way, but as stated the branch on full flow may be at dangerously low flowrates.

I suggest the above for the interim period only (especially as we have a limited water supply in our tanks, I will cover this issue later on in this report) as I would like to strongly urge the service to consider that if hosereels are ever to be used that we ensure that 25mm bore hosereel tubing is used so as to have the highpressure capabilities and increased flowrates (which the World Series pump gives us) for a higher velocity stream/fog stream primary attack hoseline. And with the DM600 (but we should research the suitability of other combination nozzles that may be available) in the secondary hoseline (covering jet), this will give us the versatility to deal with a compartment fire in both the fuel-surface and gaseous-phases. This may also help prevent us from having to try to play catch up by which time it may be too late. It will also ensure our covering jet, whether it is supporting a primary attack hosereel or 45mm hoseline, is sufficiently flowed. Yes this will result in the need for training of the crews and pump operators but this should not be a barrier. We must educate to improve the safety of our crews, and increase our efficiency when dealing with these types of incidents. If we decide as a service that hosereels are not the way forward, then we need to ensure our lay flat hoselines and branches whether they are primary or secondary attack lines have the capability to provide much higher flowrates from the outset (this is most definitely the way forward!).This would certainly help ensure that we don't need to try and play catch up when it's probably too late.

We may have to adapt the stowage of our hosereels to fit the larger tubing but this can be done, we will not be the first service to do this. We should also consider shorter lengths of 70mm hose (flaked or Dutch-rolled) in areas with High-rise risks to lessen the frictional losses up to the branch length and enable the shorter lengths to be laid from a riser outlet on a lower floor to help eliminate much of the kinking and snaking of the hose as tends to happen now. And as stated earlier crews should be encouraged that where possible, they should use 70mm in hoselines (including when using foam equipment) which will help ensure frictional loss and pump pressure is kept to a minimum. I believe this practice should be explored by the service and its benefits exploited and I can only see there being advantages of having this as a policy where practicable.

I would also like to draw your attention to the fact that we are encuring additional costs in pump maintenance and repairs which is mainly due to pump operator errors due to lack of training. I have spoken with Brian Middleton and asked him to provide you with a break down of these costs. Since completing the training package for the World Series pump (which I still believe is the wrong way to deliver such an important and practical subject) I continually have stations (wholetime and retained) contact me for advice, guidance and requests for practical training sessions. Whenever possible I try to accommodate but I feel this is training through the back door and on every occasion I ask the crews to let the service know of the shortfall in their training needs, but I am not sure this is happening. I am more than willing to help and advise but I feel we need a

proper structured pump operator courses to bring our knowledge up to a higher standard, we need pump charts sited in pump bays and pump operators to be issued with handbooks. With the launch of Hale Products new pump 'the Prima', it may help to remove some of the issues associated with the World Series pump, only time will tell, but at present the majority of pumps in use in the service today are World Series. The recruits don't get to see (use) theses pumps till on station and find the pump totally alien to them because the differences in the pumps in the service have not been explained to them. On many occasions it's the newest member of a watch that contacts me for information because they have been tasked with giving a lecture on the pump to their watch.

The pump is one of our most useful tools and certainly one of the most often used, but the pump and pump training seems to be the thing that is most neglected. I have certainly seen during numerous training sessions the enthusiasm and the thirst for knowledge by many crews with reference to the above. But I also see the frustration of these firefighters when they feel they are under trained in pump operating, this becomes even more evident when individuals quiz me after having had a bad pumping experience operationally. The service currently carries out DCT assessments on station, and the drivers are set a written exam. Some of the questions asked would be more suitably directed at mechanics, and there seems to be a slant towards the service expecting a driver/pump operator to know more about the mechanics of the engine, without any emphasis being placed on their technical knowledge of the pump, or their practical pump operating.

I would also like to ask the service to consider going back to 1800 litre tanks. I believe we switched to smaller tanks because there was a weight issue with previous appliances, I feel that this may not be an issue with the Scania's. This will give us all the obvious advantages of a larger tank and give the pump operator more time to supplement the supply, particularly as at the moment when we are down to the last quarter (approx.) of the tank and any real volume of water is being delivered, air is drawn into the pump (despite anti-vortex plates being fitted) from the tank. This causes an interruption to the water supply/jet, thus resulting in the piston primers constantly cutting in. This increase in tank size would be safer and more advantageous particularly if we correctly flow our primary attack hoselines (25mm HP lines or ideally high flow lay flat hoselines).

Our World Series pumps are 2010's, and can deliver between 3000 – 3500 l/min approx, a 3010 pump can deliver between 4000 – 4500 l/min approx. from a pressure fed supply, the only difference between these two pumps apart from the output is the size of the suction tube (100mm/140mm). Being a High Volume Pump service and given the fact that the H.V.P.'s 150mm hose can be coupled directly on to the suction tubes of our pumps via a Stortz to round thread adapter (at the moment we have Stortz to 100mm round thread adapters) if we had a number of the 3010 pumps within the service (possibly one at each two pump station) this would give us a greater pumping capability for firefighting or water removal within the county (this is also true if we disregard their use with the H.V.P.'s). The larger suction tubes can be done as a retro- fit or fitted as standard to new pumps (they would need a Stortz to 140 mm/5½" round thread adapter), but this would mean an initial cost in purchasing larger suction hose (yes we could use adapters to go down from 140 -100 mm suction but this would defeat the object). There are also larger pumps available e.g. 4010 and so on, but these are actually larger pumps all-round with a bigger volute and impeller etc, but they could still be considered. We could save ourselves some money if we stop fitting collecting heads to the hydrant to tank inlet (an 'A' type adaptor can be used instead) the reason for this is the service has not chosen to use Automatic Tank Fill controls (see my reports ref. the World Series Pump 2003) therefore the hydrant to tank valve is only used to pass tank to tank or to fill up from a hydrant (see Godiva World Series Pump training package).

We are still under flowing our foam equipment and the SIS Tech 1/035 still states that the foam equipment is designed to be used with 45mm hose, but as can be seen from the

above and my previous reports this is not best practice. Using 45mm hose and pump pressures stated in the SIS would result in us not meeting the required application rates. We are not able to attain flowrates stated in the SIS through the Delta inline inductor (see my previous reports for more information) and this throws out all the figures given in the SIS.

I would ask the service to research and explore the use of Compressed Air Foam Systems (C.A.F.S.). They may help overcome many of the issues we have associated with High–rise firefighting and it may be a more efficient way of dealing with many types of fires we encounter. There are a number of systems out there and I believe there are presently some tests and trials going on to assess their suitability for dealing with fires in High-rise buildings. The initial cost of these systems may be expensive but if the tests prove positive they may be cost effective in the long run and help improve firefighter's safety and efficiency.

I would like to ask the service to consider if it is at all possible, to hold a day in the very near future in which we have an open forum/debate into firefighting techniques, flowrates and firefighting equipment, and to extend an invite to attend to our colleagues from all fireservices, manufacturers (branches, pumps and hose), the Fireservice College, the Fire Brigades Union and independent experts in all these fields. Yes there will be differences of opinion and debates as to who is or what makes someone an expert or as to what technique or piece of equipment is correct for a certain situation, but there is already enough evidence from real fires, studies and reports from experts around the world to help us all reach a common ground. We need to encourage and educate manufactures to design and produce equipment that meets the needs of the modern fireservice, instead of us relying on equipment and practices because "We've always done it like that!" or "We've always used that!" We need equipment that meets our needs, and to lead the way and to work with them when it comes to its design and specifications i.e. lay flat hose with full flow couplings what ever the diameter of hose. Our modern firefighting equipment should be suited to what we require, not what they think we require or have required in the past. Some of these lessons have been learnt following the loss of firefighter's lives and some from close calls at incidents from which we can all learn. We owe it to them, those serving today and to the next generation of firefighters to share and learn as much as possible to help prevent these tragedies from happening in the future. History has shown it's our tragic losses that determine our future practices. We have a chance today to alter the future hopefully without any further losses. I believe that this day would help us as a service and everyone nationally to spread the word and to gain the knowledge and skills that will enable us to better arm ourselves with the correct equipment ensuring our crews remain safe and proficient for what ever they may face. With the support of the service, I would be willing to organise and coordinate the above as I feel passionate about this subject and determined to help us all learn and adapt for the challenges the fireservice may face today.

I am not nor do I claim to be an expert in any of the above and many of the things in this and any of my previous reports reflects and relies on other people's knowledge, research and hard work for which I can claim no credit, but I do strongly believe we can all learn and improve our skills.

This report is no way meant to offend, or contradict any safe practices, but I feel its time for us to broaden our knowledge and skills and engage with others when it comes to all of the above.

Ff Martin Arrowsmith
Blue Watch.
Welwyn Garden City.