

# WATER UK – CFOA – LGA

22 January 2008

## Fire side briefing paper

### 1. Introduction

1.1 This briefing paper examines some of the current water supply issues facing fire and rescue services (FRSs) and suggests some improvements for the future.

### 2. The current situation

2.1 The 3<sup>rd</sup> Edition of the National Guidance Document on the Provision of Water for Fire fighting (The Guidance) was published in January 2007. The Guidance outlines the need for the Water Companies and the FRSs to co-operate effectively to ensure that both can meet their respective statutory obligations in the most economic, efficient and effective manner possible.

2.2 The guidance states that both parties have an obligation to the public and their customers to ensure that they discharge their obligations effectively and efficiently and one of its recommendations is that Water Companies and FRSs should review the content of their policies regarding inspection, testing and abandonment of hydrants by jointly testing the validity of continuing historic practice against their current obligations and common objectives.

2.3 The fundamental issue in achieving the efficiencies envisaged in the Guidance is to move to a transparent and robust risk based method of matching the risk with an adequate supply of water for fire fighting. The procedure used to determine the quantity of water required must include a method for calculating the flow required in litres per minute (LPM) and also the distance any supply can be from the risk.

2.4 There also needs to be a realisation that there must be a limit to the amount of water that can be extracted from the water supply infrastructure and as such there is a finite amount of water that can be supplied from any hydrant, even on the larger mains. It is therefore true to say that some very large fires cannot be extinguished, all that can be achieved is to stop the fire spreading to adjoining structures whilst it burns itself out. This fact needs to be borne in mind when determining the amount of water required to fight fires in large buildings. When dealing with large buildings in built up areas there comes a point when the quantity of water required simply cannot be supplied by any means. This is not true for special risks such as refineries etc.. where the site operator can provide additional infrastructure to supply the need.

2.5 Under the Fire and Rescue Services Act 2004 and the previous legislation, all FRSs have, and have had, a duty to take all reasonable measures for securing that an adequate supply of water will be available for use in the event of fire.

2.6 Historically the supply of water for fire fighting has been achieved through the provision of hydrants. The hydrants were commonly spaced at intervals of 90 to 180 metres in built up areas, but in remote areas there could be much longer distances between them. The definition of an adequate supply has been, and remains, ill defined.

2.7 There have been many changes to the equipment and tactics in use by the FRSs since most hydrants were installed. Fifty years ago fire appliances were using low-pressure pumps, basic branches/nozzles and many only carried 225 litres of water. This meant that water was often used inefficiently and as such was used very fast making quick access to a hydrant vital. Modern appliances are equipped with high pressure pumps and sophisticated branches/nozzles which are capable of applying water to a fire very efficiently, this ensures that the maximum extinguishing effect is achieved with the minimum quantity of water. Modern appliances also carry 1800 litres of water. The tactics used by fire fighters have been adapted over the years in light of lessons learnt and research into fire behaviour. The current combination of improved tactics, efficient fire fighting equipment and eight times as much water on the appliances means most fires can be extinguished without the need for a hydrant. We are now equipping fire appliances with compressed air foam systems,

which will make the use of water for fire fighting even more efficient. It is estimated that only 5% of fires actually require the use of a hydrant during the fire fighting phase, however it must be remembered that hydrants are also used for filling fire appliance tanks after the fire. This change in circumstances must be factored into our planning for the future or we will fail to achieve the efficiencies which are available.

Having made the previous statement there is growing concern about the flow rates available to firefighters inside burning buildings. A firefighter needs to have a hose line/reel that can provide an adequate flow should the fire escalate whilst they are in the risk area. So it is not acceptable to commit if the hose line/reel is only able to deal with the existing fire, there needs to be an amount in reserve to enable safe egress. There appears to be a growing consensus that the minimum flow rate should be 200 LPM. This has a direct impact on the provision of hydrants as there is obviously a need to supply the pump with sufficient water to keep the firefighters supplied with at least 200 LPM whilst they are in the risk area. This means an 1800 L tank will only keep firefighters supplied for approximately 9 minutes. Therefore additional supplies (additional appliances or hydrant run in) need to be available within approximately 9 minutes.

- 2.8 There is a balance of risk, cost and benefit to society in the continuing provision and maintenance of a hydrant on a distribution system. The FRSs trade off the benefit of being able to have access to water in the event of a fire against the ongoing costs of providing and maintaining the hydrant. The Water Companies carry the risks of leakage, contamination and interruption/discoloration of supplies. It follows that it must be in both parties interest to restrict the number of hydrants to that which is actually necessary to ensure an adequate supply of water for fire fighting.
- 2.9 The current situation is that there is a probably an over provision of hydrants in most built up areas due to the fact that they were provided some time ago and have become increasingly redundant as changes to tactics mentioned previously have made the use of water at fire more efficient and effective. It is also probably true that there are areas which have an under provision of water, notably those containing large un-compartmented buildings, where the water supply infrastructure is simply not able to supply the quantity of water that would be required to extinguish a fire.
- 2.10 It is probably true to say that the flow that is actually available in most of the UK, is what can be provided by the water supply infrastructure rather than what the FRSs may actually need.

### **3. Hydrant flow rates**

- 3.1 The Guidance [6] provides advice on the flow that should be provided for different classes of risk, but the advice in the document is somewhat vague and inconsistent. It gives flows for some types of building whilst giving flows and distance to the nearest hydrant for others [6] p 37.
- 3.2 Why does a primary school require a hydrant within 70 metres when, for an industrial area of over three hectares, there is no mention of any distance other than to say that a certain flow should be available somewhere on the site?
- 3.3 The other concern is that the guidance given for the provision of water is based on type of buildings and is not based on the fire load energy density (FLED). Therefore the guidance does not differentiate between high, medium and low risk occupancies.
- 3.4 Before we can move to a truly risk based approach we need to establish a robust and transparent method of calculating the flow that would be required for any particular risk and for determining the acceptable distance that the supply can be from the risk.
- 3.5 As a result of the lack of robust and transparent advice in the Guidance [6] a review of literature was conducted. A search was conducted for any research papers that investigated methods used for calculating water requirements for fire fighting. The following research papers covering the subject were found, Davies

[1] Torvi [2], Barnett [3] and Grimwood [4]. From the search it is clear that there is very little published research into veracity of the various methods for calculating water for fire fighting available. It is also the case that most of the existing methods for calculating water requirements were challenged in the papers reviewed.

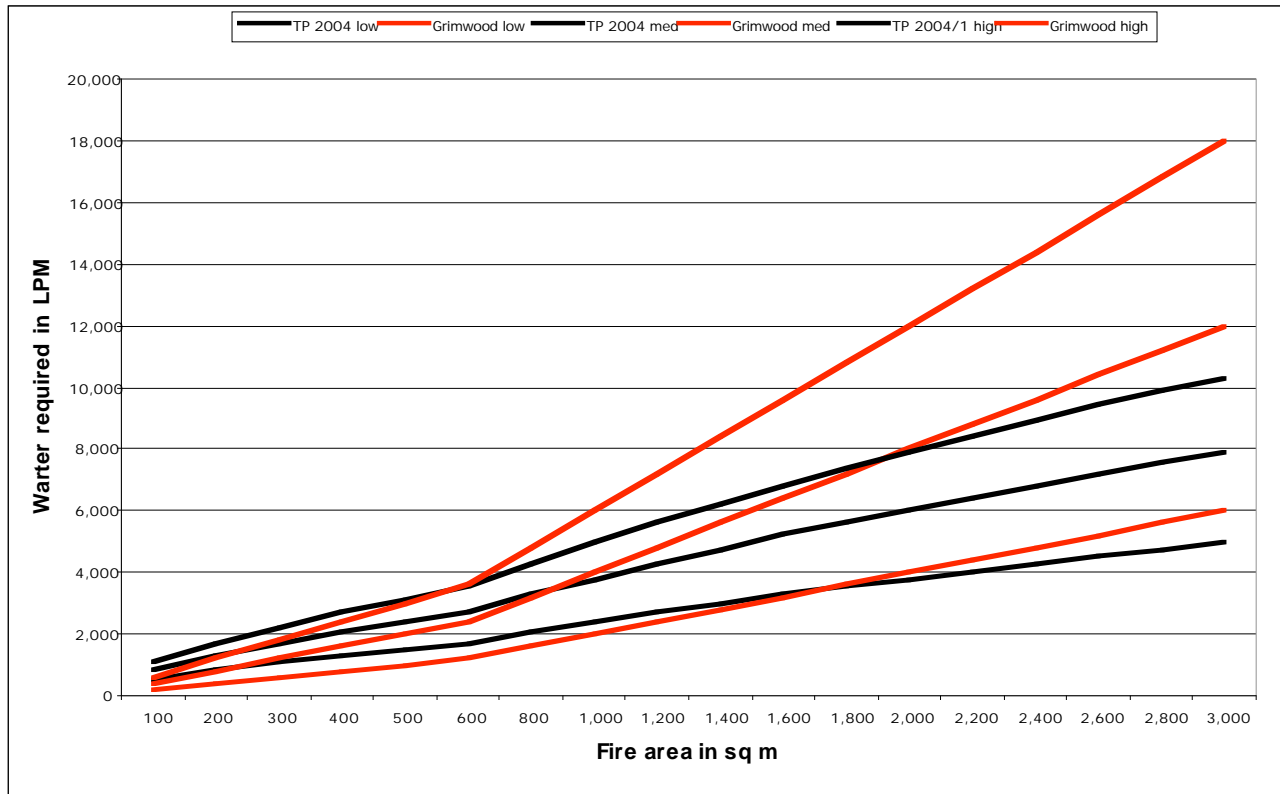
- 3.6 Davis [1] sought to create a linkage between building type, expected maximum fire size and required fire fighting water supply. He proposed that a fire engineering approach is required so that the expected fire within a given building can be predicted and correlated to an acceptable fire fighting water supply [1] p 23. Davis concluded that as of 2000, there was no supportable method available and that additional work was required [1] p 79. He also proposed that the work done by Barnett [5] was the most relevant. [1] p 83.
- 3.7 Torvi et al [2] reviewed five methods for calculating water for fire fighting in 2002 and came to the conclusion that all were flawed in some way and if used to calculate water requirements for the same fire would produce markedly different results for the amount of water required. He then went on to explain a new software application that has been developed to calculate fire fighting water supply. The software package is complex and would be suitable for fire engineers designing large complex building, but the method appears not to be suitable for non-specialists dealing with day-to-day management of fire water requirements over large areas. There would also be the need to have the software to use the method.
- 3.8 Barnett [3] reviewed the five methods reviewed by Torvi [2] and went on to review a further six other methods. Barnett concluded that the most convincing method for calculating flow was SFPE (NZ) Technical Publication TP 2004/1 [5] – see Barnett [3] p 8. TP 2004/1 [5] is based on calculating the heat produced for a given size of fire and then calculating the water required to cool the burning fuel to the point that the fire will be extinguished. The fact the water is not applied at 100% efficiency and that some of the heat from the fire will escape and therefore not need to be cooled are factored into the method. The method also allows for some flow for cooling exposures and thus factors in a degree of safety. The method has been used to produce a table [5] p 14 which gives the water required for a certain area of fire, thus it is relatively easy to predict the size of a fire that might need to be extinguished and to then use the table to predict how much water is required. The table is further refined by giving a choice of (FLED) for each area of fire so it is possible to predict the water requirements for low, medium and high FLED. He also stated that the Grimwood and Sardqvist methods produced figures that were in the same ballpark as TP 2004/1 [3] p 7. The fact that there is a relatively simple table to use to determine the water required makes this method suitable for use by non-specialists dealing with day-to-day management of fire water requirements over large areas.
- 3.9 Grimwood [4] covers many aspects of fire fighting one of which is water requirements. Grimwood has created a basic formula for calculating water requirements for fires from 50 M<sup>2</sup> to 600M<sup>2</sup>, which would cover the vast majority of fire attended by any FRS in the UK. Where LPM = a x 2 or a x 4 or a x 6 where a = area of fire in sq m and 2 is for low risk, 4 is for medium, and 6 for high risk [4] p 30. These three classifications can be compared with the three classifications in TP 2004/1 Grimwood's formula is very simple and is suitable for use by operational personnel on the fireground. Grimwood goes on to support TP 2004/1 and states that in his opinion it is the most accurate method available [4] p 8. The graph below shows a comparison between TP 2004/1 and Grimwood for the flow required according to fire area in sq m for the three different classifications of FLED and it can be seen they correspond very well up to around 1000 sq m after which the Grimwood formula produces a much higher requirement than TP 2004/1
- 3.10 The review of the literature has revealed that there are two principal approaches for calculating water requirements, one is based on empirical research into water usage at previous fires and the other is based on fire engineering first principles.
- 3.11 Three of the papers all made reference to the fact that the problem with empirical research is that it is very difficult to establish how much water was actually used at any particular incident with any degree of accuracy and it also difficult to link the water usage with the effectiveness of the fire fighting operation. It may be true to state that 1000 LPM was used at a very large fire, but if that flow completely failed

to extinguish the fire it is not much use for calculating flows for other similar incidents. The three papers all state that the methods based on empirical evidence are not a proven method of calculating flow requirements. The papers determined that any method used to calculate water flow requirements should be based on fire engineering first principles as this makes it possible to calculate the flow required for any given predicted fire.

Grimwood does not support this (above) statement entirely as his research of 120 fires was based solely on empirical evidence obtained by himself at close quarters to the fire operations. He states that the resulting methodology was not applicable above 600m<sup>2</sup> of fire involvement. He states that for design purposes, the 'fire engineering first principle' methods produce over-estimates, whereas the empirical research produces actual flows used at real fires and are able to measure, to some extent, the degree of success achieved. For example, he estimated that at 2 litres/m<sup>2</sup> approximately 50% of the fires could only be extinguished during the decay stages. (From personal correspondence with Grimwood)

- 3.12 The papers all concluded that any prediction of the water required to extinguish a fire should be based on fire engineering first principles and in the case of Grimwood also correlate to empirical studies to validate the results. This is acceptable for work done by individuals trained in fire engineering who are competent in applying the science to the building in question. However, there are few such individuals in the UK and there is a need for many non-specialist individuals to make decisions on water supply matters on a regular basis. These individuals need a method that is based on first principles so that it is transparent and robust, but also is suitable for use by non-specialists such as fire and water officers responsible for water supplies in their respective services. TP 2004/1 is the method that has the most support from the papers reviewed and it is suitable for use by non-specialists as such it would appear to be the best choice for planning water supplies. Grimwood's method is the most suitable for use on the fire ground for compartments up to 1000 sq m.
- 3.13 The table in TP 2004/1 [5] can be used to calculate the flow required for individual buildings when required. However, it would be overly onerous to risk assess every single building in an area, an acceptable way forward would be to survey an area and then select a building that represents the most common or average building in the area. The water supply for the area could then be based on that building and this should supply an adequate supply in the event of fire in any of the buildings. Any high risk buildings should be treated individually.

3.14 The graph shows the correlation between TP 2004/1 and Grimwood for the three classifications of FLED.



#### 4 Hydrant spacing

- 4.1 The next step is to determine how close to the risk the water supply needs to be and what the distance between successive hydrants should be.
- 4.2 Current opinion is that some 95% of fires are extinguished without using hydrants, so obviously, only 5% of fires are extinguished using hydrants. This can be further refined by realising that the 5% will be in larger buildings in commercial and industrial areas.
- 4.3 When considering hydrant spacing it makes sense to differentiate between those areas where hydrants are likely to be used and those where they are not.
- 4.4 The Building Regulations [7] stipulate that any premises with a compartment of more than 280M<sup>2</sup> needs to have an existing hydrant within 100 metres or if not then one must be provided within 90 metres [7] p 107 The Regulations go on to state that if no piped water supply is available, or if the flow from the hydrant is insufficient, then other water supplies must be provided. Bearing this (regulatory guidance) in mind it seems that, as a general principle, the hydrant spacing for hydrants covering buildings with compartments of more than 280M<sup>2</sup> should be 180 metres thus ensuring that the maximum distance to a hydrant will be 90 metres. This would cover most of the commercial and industrial risks in the UK. There is also a need to recognise that the flow required to fight the fire needs to be achieved, it is not adequate to simply state that a hydrant needs to be available within the set distance. That hydrant must supply an adequate supply of water and if not other arrangements need to be put in place.
- 4.5 Other areas will present a much lower likelihood of using a hydrant and therefore the spacing can be increased. It is suggested that the spacing be doubled to 360 metres making the maximum distance to a hydrant 180 metres. Delivery hose is generally 25 metres in length so this means approximately 8 lengths will be required to supply water to the fire. Alternatively water can be shuttled using fire appliances. Shuttling is likely to be acceptable as most fires in these areas will be extinguished using appliance tanks and the only water required will be to refill tanks to provide an element of reserve water for safety.

4.6 This two spacing mentioned should be satisfactory for use in covering areas of buildings of similar risk and this will avoid the need to risk assess every single building. However any high risk premises should be treated individually.

## 5 Next steps

5.1 The contents of this briefing paper should be the basis for further discussions between Water UK, CFOA/LGA with a view to moving towards providing a genuinely risk based supply of water for fire fighting.

5.2 It must also be recognised that FRSs will need to reduce their hydrant stock if they are to achieve the efficiencies that are expected of them. If the FRSs are required to pay to reduce their hydrant stock then it is not going to happen.

## 6 References

- [1] Davis – Fire Fighting Water: A Review of Fire Fighting Water Requirements: A New Zealand Perspective –March 2000/3 – Canterbury University
- [2] Torvi et al – FIERA system Water Requirements Model – July 2002 – National Research Council of Canada
- [3] Barnett – SFPE(NZ) Technical Publication TP 2007/1 – 2007
- [4] Grimwood – Fire Fighting Flow Rate – Jan 2005 – [www.firetactics.com](http://www.firetactics.com)
- [5] Barnett – SFPE(NZ) TP 2004/1 – 2004
- [6] Water UK/LGA – National guidance document on the provision of water for fire fighting – Jan 2007
- [7] CLG - The Building Regulations Volume 2 – Buildings Other Than Dwellinghouses – Approved Document B – Into effect 2007

Additional information

[www.fire-flows.com](http://www.fire-flows.com)

Dorset Fire and rescue Service – Interim Guidance Note 34/2006

## 7 Further information

Pete Barrow  
Equipment and Logistics Manger  
Dorset Fire and Rescue Service  
67 Bridport Rd  
Dorchester  
Dorset  
DT1 2NQ

01305 251050  
07767826502