The Effectiveness of Fire Hydrants

Stephen Moore – Fire Service College, Moreton in Marsh

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TITLE:  
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ABSTRACT:  
There is a legal requirement for fire authorities in the United Kingdom to provide adequate water for fire-fighting purposes. Whilst this supply can be drawn from many sources, the provision of fire hydrants fitted to the water authorities domestic water supply mains system is by far the most common method. Research by Catton (1988) and Fowler (2001) has indicated that the quantity of hydrants installed and the cost of maintenance and testing have led brigades to consider if they are responsible for too many hydrants.

The research was designed to determine the current value of fire hydrants to the service and the effect future developments, such as residential sprinklers and compressed air foam systems (CAFS) may have. This will have an impact on the extent and location of hydrant provision, legal responsibilities, firefighting tactics and future research and development.

INTRODUCTION:  
The use of water, by fire brigades throughout the world, has its roots set deeply in history. The provision of that supply has varied dependent on its availability and industrial and social developments. In the U.K this provision is generally by underground pipe-work installed and maintained by water companies. Though this network is provided solely for the provision of good quality drinking water to the community, it has also proved irresistible to fire brigades as a convenient means of addressing their legal obligations to provide fire-fighting water.

The Fire Services Act 1947 puts a legal duty on fire authorities to provide adequate water supplies for fire-fighting purposes. UK brigades responded to this by fitting fire hydrants to the drinking water supply network. In the absence of specific guidance, until 1998, authorities determined their own policies and standards in terms of provision. The fundamental principle was based on the spacing of hydrants and the variation of said distances dependent on the perceived risk in the area. In general terms the greater the risk the closer the hydrants.

As a result the U.K. fire services have a huge number of hydrants. The scale of provision is now so high that it has a significant impact on brigades’ resources, particularly in terms of the annual testing regime. Consequently, a number of brigades are adopting the strategy of extending the periods between tests or ceasing them altogether. Some are modifying the test itself to make it less time-consuming.

Previous research by Catton (1988) indicates that brigades are of the opinion that they have too many hydrants and would like to reduce them. There is little evidence of a national strategy to achieve a reduction, or what progress there has been in meeting this goal. New technologies and equipment may further reduce the fire service’s dependence on fire hydrants as the current provision of hydrants is based on outdated fire-fighting tactics and equipment.
RESEARCH METHODOLOGY:

The research methodology was of a hybrid type, consisting of quantitative research by questionnaire and qualitative research by semi-structured interviews. The research philosophy was in the positivism tradition with the emphasis on objective measurement. The key features of which Easterby-Smith et al. (1991, p.27) emphasise as, “focussing on facts to formulate hypotheses and then test them. To take large samples and that the observer is independent”.

A questionnaire was sent to each chief officer of the 58 U.K. fire brigades for the attention of their Water Officer. The survey employed both categorical and quantifiable methods of data collection. There were four principle areas of information sought: the number and disposition of fire hydrants; the financial costs to the brigade; the frequency of use of hydrants at fires; the methods used by brigades to ensure that the hydrant provision met their legal obligation to provide an adequate supply of water for firefighting. It was possible to also determine the number of hydrants and therefore assess the extent of the provision nationally. Their location in terms of risk category area was requested, together with information of how many new hydrants have been installed in the last five years and how many have been abandoned thus determining any change pattern.

The financial cost per annum of installation, repair, abandonment and testing to the brigade was requested along with information on how hydrants are tested by personnel. The frequency of operational use of hydrants, in terms of the numbers used and their location was also collected to identify the business critical hydrants.

Following every fire incident that results in damage of financial loss, the fire service completes a fire damage report form, (FDR1), containing information regarding the incident. By collecting quantitative statistical data from Fire Statistics and Research Section of the Office of the Deputy Prime Minister using the FDR1 information, the use of hydrants under the following headings was ascertained:

- Geographical area
- Brigade Area
- Risk category
- Type of premises involved
- Type of fire

This provided information on how and where hydrants are used, the types of incidents and the risk category areas. It was intended to use this to identify any variations between metropolitan and county brigades and whether their use in urban areas is more prevalent because of availability whereas rural areas have to be covered by alternative appliance design.

Qualitative semi-structured interviews took place within county and metropolitan brigades with operational fire crews. The focus was to research the use of hydrants in normal firefighting operations to assess the value of hydrants at Fire Damage Report 3 (FDR3 - small fires) incidents and FDR1 type incidents such as car fires, domestic properties, commercial and industrial sites, in order to determine whether they form an essential supply source.

International visits to Hong Kong Fire Service and Western Australia Fire Service took place to identify alternative strategies of hydrant installation and maintenance.
FINDINGS:

There are approximately 1,259,000 fire hydrants installed in the U.K. Data from the CACFOA Benchmarking Report indicates there are 24 hydrants per 1000 head of population. Based on a population of 58,000,000 this would indicate a UK hydrant provision of 1,392,000. This is a 9.5% variance between the two figures.

Research indicated that 7,892 hydrants had been abandoned over the previous five years and that 8,083 new hydrants had been installed. This represents a 0.02% increase over the previous five years. One point of note is that of the 7,892 hydrants abandoned over the period 4,621 were as a result of the work of just three brigades, the remaining brigades being responsible for 3,271.

The total annual expenditure allocated to hydrant maintenance budgets in the U.K Fire Service is approximately £7,800,000 per annum in the year 2000/01. This figure compares favourably by comparison to the data collated in the CACFOA Benchmarking Report (2000). It states that the average cost of hydrant maintenance is 0.46% of fire service budgets. The 2000/01 annual budget for the UK Fire Service was £1.6 billion. 0.46% of £1.6 billion is £7,360,000. The difference of £440,000 constitutes a 5.9% variance.

The use of fire hydrants at FDR1 fires was found to be low. Fire crews suggested that “the rate of use was low”, discussion led to a range of between 10% to 30%. With regard to FDR3 incidents the result of discussion elicited a rate of between 0% and 5%. This was typical of all responses regardless of station location or crew type.

Supporting evidence from the Statistical Office of the Office of the Deputy Prime Minister figures indicated a frequency of use of fire hydrants to be in the order of 491 uses at 218,429 FDR1 incidents (2000). This equates to hydrant use at 0.22% of FDR1 incidents. A secondary validation exercise with two brigades indicated that rather than the OPDM Statistics Office return of 0.22% that the frequency of hydrant use at FDR1 type incidents is more likely to be in the order of 5.4% of the total.

Fire crews indicated that their preference is for the hydrant plate to indicate flow rate rather than mains size. Crews were asked if they would like to have a guaranteed minimum flow rate from a hydrant. Without exception all crews expressed a view that they would. When asked what that flow should be the range varied from “enough for a working jet” to “enough for the risk area being covered”. When pressed to quantify the rate of flow for a working jet a consensus of approximately 480 litres per minute was reached. Work by Grimwood (2000, p.32) indicates that 450 l/min is the minimum flow rate requirement for compartment firefighting in the UK.

Brigade water officers were then asked if, in their professional opinion, the provision of fire hydrants in residential areas is essential to the extinguishments of domestic property fires. Of the responses received, 44% stated that they felt it was, whilst 56% stated they were not. The use of hydrants at domestic properties was investigated by asking at what percentage of domestic property fires do crews use fire hydrants. When the issue was discussed after disregarding tank replenishment there was a divergence of opinion. The range was from 10% up to 80%. The significant point is that the wholetime city and town crew felt the figure was 10% whilst the retained and rural crews all put the figure at nearer 80%. Supplementary questioning concerned whether the provision of fire hydrants in residential...
areas was essential to the extinguishment of domestic property fires. The wholetime crews suggesting they were not essential whilst the retained rural crews were of the opinion that they were due to increased travel time.

Changes over time regarding flow rates was investigated by asking crews whether they have improved, stayed the same or deteriorated over the last five years. 70% said they have stayed the same and 30% stated they had deteriorated. There was no significant variation between crew types. Both rural and city crews had experienced flow reduction from hydrants over the last five years. When asked as to why they believed it was the case the common response was that “water companies were using it as a tactic to reduce water leakage from the water mains system by reducing the supply pressure”.

Crews were asked if they thought that in the future they were likely to be using more, less or about the same amount of water for firefighting as they do currently. All crews felt that they would be using less. The main reasons for this were the introduction of high-pressure hose reels, domestic sprinklers and compressed air foam systems (CAFS). Opinion was that this would continue as further technological developments took place. Training procedures that had been adopted such as flashover and back-draught training together with compartment entry drill had emphasised the minimum use of water. In particular, how the more efficient application of water has a significant effect on reducing the knock down times of fires. The work done by Davies (2000) on shielded fire indicates a 35% reduction in water usage when using CAF. These studies also indicated that re-ignition is less likely with CAF and this further reduces the quantity of water used.

The Residential Sprinkler Association discusses the reduction in firefighting water supply requirement further on its web site http://www.firesprinklers.org.uk/life-safety-sprinklers. It states that,

A life safety sprinkler is designed to use just enough water to control the fire.
Typically a life safety sprinkler head discharges 45-45 litres of water a minute compared to a fireman’s (sic) hose at perhaps 1000+ litres a minute.

It goes on to suggest that, “In general a sprinkler system will use between 1/100th and 1/1000th of the water used by the brigade”.

Hong Kong:

The cost of installation and maintenance of fire hydrants is not borne by the Hong Kong Fire Service. Plans for new or redeveloped property is submitted to the Fire Service for comment and approval. The cost of installation to meet the required standard is borne by the developer. The Hong Kong Water Supply Department is required to maintain the fire hydrant stock to the approved standard at all times. If any failing or defect is noted, the details are passed to them for action at their expense.

The duty and subsequent cost of standard testing fire hydrants does fall to the Fire Service. The standard testing frequency for all hydrants is six monthly with actual flow testing being carried out on a less frequent basis. Hydrants are universally spaced at two hundred metre intervals on both sides of the carriageway. The two rows of hydrants are positioned in an offset pattern thereby ensuring a hydrant is no more than one hundred metres from the next one on the other side of the street.
The flow rates required are:

<table>
<thead>
<tr>
<th>Type of Hydrant</th>
<th>Minimum Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestal</td>
<td>2,250 l/min</td>
</tr>
<tr>
<td>High Draw</td>
<td>4,500 l/min</td>
</tr>
</tbody>
</table>

The key issue is that every hydrant has an agreed performance standard. Fire-fighters have a pre-determined expectation from the hydrant supply and with that knowledge they can employ fire-fighting tactics based on known resource availability. It is important to fire crews to have confidence that the hydrant supply will give an accepted minimum flow-rate. The actual flow is a matter of agreement with all parties.

**Perth, Western Australia:**

Under current Australian legislation the provision of adequate fire hydrants to the standard prescribed by the Fire Authority falls to the land developer. This permits the Fire Service to specify the location and number of hydrants it deems appropriate to provide adequate water for firefighting. However, the costs of testing, servicing and repairs of hydrants following acceptance fall to the fire service. At this point any over provision at the planning stage makes itself felt as the year on year maintenance costs start to build up. Perth sees the testing, maintenance and repair burden of fire hydrants to be a significant barrier to their ability to provide the services to the community.

There are some 35,000 hydrants in the metropolitan area, each requiring an average of 12 minutes to service by the attending fire crew. This results in a figure of approximately 28,000 working hours per annum on hydrant servicing alone. Perth have developed, with their water provider, a maintenance free fire hydrant. Cost comparisons are significant in that current hydrant and box replacements costs are Aus $ 1,700 compared to the new plastic hydrant and box cost of Aus $800. This represents a 53% cost reduction in installation and repair costs. The future synopsis indicates that as a result the 28,000 hours servicing and testing workload will be reduced to approximately 25% or 7,000 hours.
RECOMMENDATIONS:

- HMFSI should consider the issue of fire hydrant provision as a key area for investigation during the 2003 round of fire service inspections.

- Land developers should bear the legal requirement to carry the cost of new hydrant installation, where any new installations are considered appropriate, to meet the standard set in the Water UK document. The Local Government Association (LGA) should work with central government to progress this issue with immediate effect.

- To ensure the good management of fire hydrants far more information should be maintained on a routine basis by Brigade Water Officers. Records indicating the frequency of use of hydrants, both annually as a total and by individual hydrants, should be kept. The frequency of their use at specific fire types such as domestic properties, commercial and industrial sites and risk category area will improve decision-making regarding future provision. Chief Fire Officers (CFOs) should consider instigating the collection of this information as of April 2003.

- Water flow meters should be fitted to some fire service appliances. This would assist in the compilation of accurate data and the development of a risk based approach to fire-fighting water provision. This information should be passed on routinely to the appropriate water authority. Through CACFOA trial brigades should be identified to carry out this work on behalf of the service. Work should commence during 2004.

- The provision of fire hydrants in residential areas should be investigated to determine whether or not they are now essential. Impact assessments on all new equipment and training developments must be carried out to determine their effect on the quantity of fire fighting water required. It is imperative that when any such cost benefit, such as hydrant reduction is identified, that such savings are fully realised. The evidence of this report indicates they are not essential in urban two storey residential areas. However, provision in rural areas should continue to be on a risk-assessed basis. Individual CFOs should assess this on a brigade basis utilising the information gained from record keeping recommended in this report. Brigades should be in a position to carry out this work in 2004.

- The Water Act (1991) and the LGA Water UK (2002) document need not be amended in order to place the water companies under a legal obligation to guarantee a minimum flow from a fire hydrant. To ensure fire crews will have some confidence in hydrant provision, the UK fire services must agree a nationally acceptable performance standard. The recommended standard should be 480 lit/min. Guidance to this effect should be issued by CACFOA immediately.

- When hydrants are fitted to water mains which cannot deliver this requirement, they should be abandoned. Brigades should not fit new hydrants to any water mains which cannot meet this flow requirement and should identify alternative strategies for water provision. Indicative evidence is that hydrants should not be fitted to water mains of less than 100mm diameter. This will address the “comfort zone” issue of the provision of a large number of hydrants even though flow may be poor. This will also assist in reducing the number of hydrants but also improving the value and
quality of those remaining. CACFOA should issue guidance to this effect immediately.

- The UK fire service should commence a legal challenge to confirm who is liable for the cost of abandonment of hydrants. This is seen as a significant cost barrier to hydrant reduction schemes and the Water Industries Act (1991) is not explicit as to where the cost will lie. This confusion needs clarifying as a matter of urgency. The LGA should work with all UK brigades to source joint financial support to progress this issue. The legal challenge is a key element to these recommendations and should commence prior to April 2004.

- Fire services must work closely with their water authorities in order to maintain accurate flow rate information of their hydrants. To ensure this fire services should request flow rate information from their water providers concerning all water mains on which fire hydrants are fitted. This should be carried out on an annual basis in order to reassess the adequacy of provision and to confirm all hydrants meet the minimum performance standard. Fire brigade water officers should make contact with their appropriate water providers to gain this information immediately. CACFOA should issue guidance on the appropriate methodology, timeframe and required information.

- Hydrants markings should cease to be indicated by mains diameter and should be replaced by indication of the minimum flow rate guaranteed by the water company in litres/min. As stated previously the minimum should be 480 lit/min. The Office of the Deputy Prime Minister – Fire Policy Unit should issue guidance to CFOs to this effect with an appropriate timeframe. It is considered that all such changes must be carried out within five years.

- The UK fire service should monitor the work of FESA and the provision of maintenance free plastic fire hydrants. When substantive evidence of results are published the UK fire service should review it closely and adopt all areas of benefit. CACFOA should observe the trials closely and assess their value to UK brigades. CACFOA should produce a report of their findings within the next three years.
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