FIRE SERVICE EMERGENCY COVER
UK OPERATIONAL DEPLOYMENT PROJECT

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1. ABSTRACT

1.1 This extensive project has explored a rationale of risk-based deployments that match resource intervention to outcomes. The initial themes have been translated into working procedures and evaluated. The project is now at the stage of review prior to possible implementation UK-wide.

1.2 The underpinning process reviews risk at individual and societal levels within conventional models of tolerability. Toolkits have been introduced to facilitate risk assessments in premises (dwellings and other buildings) and at operational incidents (non-fire emergencies and major events). The foundation for resource allocations is fire service intervention expectations developed from a worst-case planning scenario. Cost calculations are integral to allow cost benefit analysis to be considered.

1.3 The assessed risk can be matched, using computer software, to planning templates to help define scenarios and allocate resources. The allocation model factors travel, appliance availability, workload and resource effectiveness to allow cost benefit analysis.

1.4 The project evaluation, referred to as Pathfinder trials, have examined the hypothesis, planning assumptions, methodology, and tested the software across a range of demographic distributions. The outcomes highlight both transitional difficulties and the robustness of the project work. Decisions will be taken very soon as to likely implementation.

2. BACKGROUND

2.1 In the UK the current national standards of fire service emergency cover trace back to a 1936 report[1] that recommended 3 standards of general response. These related to urban areas, smaller towns and rural areas with typical responses of 5 minutes, 10-12 minutes and 15-20 minutes respectively. At the end of the Second World War these standards were refined[2] so that 6 risk category groups were formulated with respected standards of attendance for the first, second, third and fourth pumping appliances. Those standards held true until 1958[3] when, following a further review, the categories were reduced to 4 levels of response with an additional 'special risk' category. Those standards have maintained until 1985[4] when a further review did some minor modifications. Significantly in 1995 the body responsible for financial management in the UK, the Audit Commission, considered fire cover as part of a wider review. Their report[5] essentially promoted the concept that "prevention was better than cure", together with the suggestion that there should be a radical shift in the emphasis of how future categorisation is carried out.

3. PRESENT INITIATIVE

3.1 The fire service, again through the Central Fire Brigades Advisory Council (CFBAC), reviewed these issues and, following an extensive report[6] it was agreed that there should be a developed and evaluated risk assessment model, which could be used successfully by the UK fire service for planning fire cover. That risk assessment approach, it was identified, should also be applied to non-fire emergencies with no greater difficulties or cost than the current system. The new approach envisaged related to both individual and societal risk. Also taken into account was to be the risk of property, and a relationship between the risk of death and response time.

4. RISK ASSESSMENT APPROACH

4.1 The foundation of this risk assessment approach was that risk to life should be categorised into three broad regions: intolerable, where the risk is unacceptable either to the individual or societal demands and requires reduction; tolerable, where the risk is acceptable but should be reduced to that as low as reasonably practicable; and negligible, where there was no great risk presented. The upper limit - tolerability - would not be set higher than the current highest level of risk that society was able to tolerate and the lower level, where risk was below one in a million, was regarded as 'negligible'. It was within the region of tolerable risk that action should be taken using the 'as low as reasonably practical' (ALARP) principle, already well established in UK safety cultures. This effectively means achieving a change if it can be managed cost effectively. Consideration was also given to the high proportion of non-fire emergency calls that the fire service has received and the need to take those into account so as to reduce the significant risk of non-availability of the fire service resources and likely risk to life.

4.2 Working in this way fire cover would be based upon risk assessment and at a level of risk which society was prepared to tolerate. The task of the service was then to ensure that that level was not exceeded and secondly to drive down the risk where it could do so cost effectively. To manage these arrangements it was seen that fire safety would have to take a greater precedence in the whole process. Consideration was therefore given to a number of overseas countries where fire safety had been implemented as a process of managing risk. In addition detailed work would need to be carried out, it was recognised, on response options so that the weight and type of response, and time to respond could be managed as part of the overall flexible response option.

4.3 A final but important part of the work was the need to include the costings into the project so that the risk map for a particular area could be measured in a cost effective way to help balance the various options that might arise. This in turn would allow for the planning of emergency cover using three elements of: assessing the risk; reducing the risk through fire safety measures; and the finally providing firefighting options for that risk which had to remain.

5. PROJECT MANAGEMENT

5.1 Against the background of the 'Out of the Line of Fire' report the CFBAC agreed to establish a series of formal project management schemes that would take forward previously explained risk concepts. In addition, to enable this to happen, a series of trials and practical working arrangements were implemented which are referred to as 'Pathfinder Trials'. The work has now advanced significantly and options are to be considered by the CFBAC in the very near future as to how to take forward the outcomes of the 'Pathfinder Trials'. A simple model was developed to illustrate how the planning process would be undertaken by brigades. Effectively this requires risk assessment of the area and the identification of risk groups and through the operational response planning process, the allocation of resources via a modularised arrangement to vehicles. This in turn allows emergency cover modelling to allocate those vehicles and resources to stations, either at existing historical locations or, where practical, using optimisation options to new locations.

6. RISK ZONES

6.1 The work has been extensively undertaken by consultants[7] who identified that there should be five basic risks - individual, which is the risk to individual members of the public and measured in terms of the frequency of fatality for individuals in any area; societal, which is the risk of death to large numbers of people in one incident (this would be estimated in terms of the probability of the incident occurring to a specified number of fatalities); property risk, which is estimated in the terms of the probability of loss in a specific cash value; heritage risk, where the risk to nation's heritage goes beyond replacement value for property; and finally

environmental risk, which is the risk of damage to the environment from the incident. All these proposed new standards work against the three levels already mentioned of intolerable, tolerable and negligible risk, with tolerability using the ALARP concept.

7. DWELLING SOCIETAL RISK TOOLKITS

7.1 Life risk in dwellings was identified as the primary concern, as well as societal risk in large buildings, such as hotels and care establishments. It was generally identified that the loss of more than six individuals was likely to create the need for a societal consideration. In order to carry out these assessments the consultants developed a series of toolkits, which were aimed at particular properties, such as dwellings. The 'other buildings' toolkit was a far more defined set of processes where societal risk dominated and therefore was not constructed by the overlayering of individual risk and criteria. Conversely dwelling fires are usually based around the individual hazards that are present and also benefit from considerable data, which has been gathered from fire damage reports[8] over many years. This has also enabled the simple model to be developed of the relationship between life risk and attendance time.

8. RESPONSE MODEL

8.1 This approach to risk allows medians to be drawn which offer zones of response to risk relationships, effectively if areas of risk are generated within the high zone it simply illustrates that the fastest response will still be too slow to reduce risk to tolerable levels. Under such cases it becomes necessary to seek other fire safety measures, which will help reduce those risks. Conversely if risks fall within the low region then no further action is necessary, the risk being approach as negligible. The consequence of this model is that attention is drawn to the median frequency of fire, which is the area where death rate can be managed using the ALARP principles. A change in attendance time may therefore improve the reduction in risk in such an area as would further action taken through fire safety.

9. MAJOR INCIDENT AND SPECIAL SERVICE TOOLKITS

9.1 Apart from these two major toolkits dealing with dwellings and other buildings, two other toolkits were developed to manage major incidents, which relate primarily on statistics drawn from national data, and information, which is reliant on the responses to non-fire emergencies (referred to in the UK as special services), again gathered from reporting processes.

10. SOFTWARE

10.1 Considerable software development has been made to support the toolkits. BRATS (which is the Brigade Risk Assessment Toolkit System) is computer software which is initiated through a geographical information system database relating to information gathered on a geographic area. This software enables the determination of risk levels within a brigade area. To support resource allocation BRAVE (Brigade Resource Allocation to VEhicles) software has been developed. This concentrates resources through resource modules and there identifies the vehicles that have to contend to provide the appropriate resources. To enable options to be developed BROS (Brigade Response Option System) software helps carry through worst case planning scenarios (WCPS), the worst cases selected by a brigade to which fire cover is being planned and reflects a reasonable vision for that area. It is therefore not the worst case, which can be managed but is based on a planning scenario and may not be identical between brigades. However variations in the worst-case planning scenario from the national normal standard would have to be justified.

10.2 As explained the overall approach is to manage risk through response and using the modules of resources that need to travel together to any incident before any work can be undertaken. The planning scenarios, which are generic in nature, are fed into the database, so providing the range of planning scenarios. The toolkits that help drive the procedures necessary are based on statistical evidence.

11. PATHFINDER TRIALS

11.1 The brigades involved in the Pathfinder Trials have used the BRATS arrangement to a 1:50,000 scale map data. This has enabled them to construct around enumeration districts drawn from the UK's 1992 Population Census to review population data. Enumeration Districts typically hold 300 to 500 people in England and Wales and 100 in Scotland. Brigade incidents are plotted to gain historical data on the GIS systems using 6-figure geocode. The BRATS process embodies the four risk assessment toolkits that have so far been developed. Looking at each Enumeration District with these toolkits, for example, would enable a particular layer of risk to be developed. Progressively these risk layers can then be added until, on a geographic basis, an overall assessment of the area can be derived. Similar arrangements exist for other buildings, but as already previously described; in these cases there is a generic assessment of risk, rather than the layering approach developed as each part of this process.

12. FLEXIBLE OPERATIONAL RESPONSE

12.1 The generation of the BROS programme is to present a series of scenarios which enables each task to be undertaken against a particular incident time. By identifying tasks in this way it is possible to examine the individual resource requirements both in terms of people and equipment, together with the vehicles that might be required to take those resources in a modular sense to the incident. The BRAVE programme enables these decisions to be reached. This tool provides, on the basis of experience, a number of options in terms of allocation and combinations of modules to particular vehicles. The programme then revisits each of the risk areas identified in the worst case planning scenarios so identifying the likely vehicle and equipment needs together with personnel. This in turn would allow allocation of vehicles to individual stations, both on an historical basis, where they currently exist, or to find other new locations where this was preferred. Approached in this way operational resource planning can be extremely flexible and modifications can be made to the various scenarios to cater for local variations.

13. FIRE SAFETY

13.1 Fire safety, as mentioned, is also a key area of risk assessment. It has been necessary to consider fire prevention activity alongside community (fire) safety, the current approach used in the UK, together with issues arising from the fire protection arrangements which relate to advice and enforcement as applied within workplaces in the buildings. This in turn allows a mechanism to be put in place to help support fire cover and operational deployments. Work to date has been relatively modest in the area of forming safety assessments, particularly in the trade-off between fire protection systems and their impact on the mitigation of risk. The work that has been ongoing in terms of fire safety engineering is a critical factor in this entire area and further development is anticipated.

14. APPLICATION

14.1 It will be seen that the new approach is highly reliant upon data inputs and software management. The process uses a basic geographic information system to which is added the collective requirements of risk assessment planes produced on the various templates used, together with risk information. Using BRATS software risk assessment can then be undertaken and applied within the GIS arrangements. BROS and BRAVE then help with resource requirement identification, so producing a complex and useful pattern. Adding to this the evaluation is the vehicle allocation to stations, which can produce using road data systems, optimum locations for fire stations. This enables options for relocation from historical positions for fire stations.

14.2 A further software package uses brigade assessments of resource demand, taken from the GIS and the worst case planning scenario, of vehicle and attendance requirements using information to cater for vehicle travel, variations and frequencies of incidences and durations, incident rate changes during the day, estimation of

vehicles moving from outside the area and the estimated demands that might be placed on vehicles due to the risk within the area. Historic data can be used to build up part of this package so clearly establishing workload patterns. The software used in terms of planning is OSCAR, the Ordnance Survey Road Centreline Data, software produced as part of the UK graphical mapping system.

14.3 The final software arrangements relate to the cost effectiveness of the overall process. Here consideration makes use of the relationship between attendance time and probable losses for each of the identified and determined performance requirements for each hazard. The software therefore helps attribute a contribution that each performance can make.

15. ATTENDANCE TIME

15.1 The relationship between fire growth and attendance time is well established and has already been identified in the outline to this paper as a model to which activity may be ascribed. In particular dwelling fires, where the substantial number of deaths occurs, have clearly indicated that attendance within 5 minutes is likely to have the most significant effect in terms of rescue and escape. In a similar way, when looking at major incidents, attendance time is likely to impact upon the survival times of casualties and mitigation impact, that is the rate at which the incident might escalate. It will also be necessary, due to location, to identify the sort of responses that may be possible given that an incident may occur within a remote area. The societal risk that is attached to other buildings relies on a different series of values and is based around the likely incidence of large fires. In many cases time between ignition and growth is minimal - 5 to 10 minutes - and it is incredibly difficult to predict exactly the likely impact on people who may need rescue in large numbers. Certainly beyond 20 minutes rescue becomes more difficult and people who have remained within the fire compartment beyond this period are most unlikely to survive.

15.2 The response times in any particular risk area will therefore be determined upon the requirement to reduce the individual risk in dwellings to as low as reasonably practical, but in other buildings and at major incidents generic assessments, built around the planning process of worst-case scenarios, will be used.

16. PATHFINDER TRIAL OUTCOMES

16.1 Moving these packages forward into operational deployments has become part of the Pathfinder Trials, which seek to develop deployment strategies using the information gathered from the various toolkit and risk analyses. It has to be recognised, of course, that emergency cover will not start from a fresh piece of paper in most cases. The planning process inevitably involves the legacy of fire station locations and operational allocations currently made. However, using the software packages it is possible to develop optimum locations and so introduce forward planning over a transitional period which would allow the release of current sites and the purchases of new sites, particularly where this was seen to be a cost effective and risk reduction improvement.

16.2 The worst case planning scenarios also help define, because of their modular approach the likely requirements of equipment and personnel. This in turn can drive approaches around vehicle design, both in terms of equipment to be carried and personnel numbers to be conveyed. The two packages therefore combine to provide an optimum process of vehicle and location identification. It is also necessary to feed into this process the workload that is currently undertaken, since if vehicles deployments are used in a wide range of activities their availability for key emergency cover will diminish.

16.3 This is important in the UK where there is a predominance of false alarms that can have a profound effect on vehicle availability. Whilst activity management efforts are underway to reduce this unwanted workload the existing process will need

to consider the multi-tasking arrangements of vehicles and personnel. Software has been developed to help identify these likely changes, both during the day and night hours.

16.4 The risk assessment approach includes cost benefit analysis, so enabling property risk to be assessed against the basis of fire service intervention. This enables objective decisions to be reached in terms of the amount of resources that could be deployed and their value in achieving a significant reduction in loss.

16.5 Concerns such as these are important in other buildings and heritage property, as well as in life saving factors for dwellings. Optimising the deployments becomes a key part of approaching evaluation through arrival times and workload effects. Added to these are the calculations of losses, both life and monetary, together with the resource input costs, which have to be considered to formulate the cost benefit analysis. Work has progressed in the UK to take these issues further forward so that now there is a whole process that is seen as at a significant stage in offering tools and planning options to introduce a working system of risk assessed operational deployments.

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[1] Report of the Departmental Committee on Fire Brigade Services (1936) (Riverdale) (Cmnd 5224)

[2] Report of the Departmental Committee on the Post-War Fire Services (1944)

[3] Report of Joint Committee to consider report of Technical Working Party of Chief Fire Officers (1958), Central Fire Brigades Advisory Councils, Home Office, London

[4] Report of the Joint Committee on Standards of Fire Cover (1985) Central Fire Brigades Advisory councils, Home Office, London

[5] National Report 'In the Line of Fire' Value for Money in the Fire Service (1995), Audit Commission, London, HMSO.

[6] 'Out of the Line of Fire' (1998) Modernising the Standards of Fire Cover - Report of the Joint Committee on the Audit Commission Report to the Central Fire Brigades Advisory Councils, Fire and Emergency Planning Directorate, Home Office - The Stationery Office.

[7] ENTEC Consultancy, 17 Angel Gate, City Road, London EC1V 2PT.

[8] FDR1 is the standard UK property fire report

BIOGRAPHICAL NOTE

Dennis Davis was appointed in 1999 as HM Chief Inspector of Fire Services for Scotland. Previously the Chief Fire Officer of Cheshire (1986-1999) he has 37 years' fire service expereince. He is a past President of both the UK fire chief's association CACFOA and the interntional body the Institution of Fire Engineers, of which he is currently Chairman of the Management Committee. Personally committed in fire engineering development, he held established degree level in fire engineering in the UK and the IFE Engineering Council Division.