# The Fire Cover Review

**Report of the Task Group to the**
**Central Fire Brigades Advisory Councils**

**October 2002**

# Volume 2 – Technical Papers

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## HISTORY OF THE DEVELOPMENT OF THE STANDARDS OF FIRE COVER

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# 1 BEFORE 1958

The formulation of national standards of fire cover, for specified types of area, was undertaken by the Riverdale Committee in 1936. The Committee recommended that certain minimum requirements should be laid down for typical classes of area:

- Congested urban areas;
- Smaller towns with mainly residential property, more widely spaced and few, if any, important risks; and
- Mainly rural areas with scattered villages and hamlets and remote homesteads.

The Committee suggested that at least one mobile appliance should reach a fire in any part of these areas in not more than 5 minutes, 10-12 minutes and 15-20 minutes respectively.

Attendance Time was defined as the time between when the operator had sufficient information to mobilise resources, and when the designated resources arrived at the given address.

During 1938/39, further work was undertaken by the Home Departments in consultation with the Central Fire Brigade Advisory Councils on the first attendance requirements in particular localities. However, it was not until 1944 that a Departmental Committee formulated risk categories and standards of cover which could be applied to the whole country. The 1944 Committee recommended six broad categories of risk and first attendance, as shown in Figure A 1. This took into account the minimum requirements laid down by the Riverdale Committee, and the pre-war practice of the London Fire Brigade and other large pre-war professional fire brigades where a pre-arranged attendance had been normal.

| Risk Category | Attendance Times of Appliances | | | |
|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th |
| A | | | | |
| B | 5 | 5 | 8 | 8+ |
| C | 5 | 5 | 8 | |
| D | 8 | 8 | | |
| E | 10 | | | |
| F | 20 | | | |

***Figure A 1: The Risk Categories Defined in 1944***

# 2 REPORT OF THE 1958 JOINT COMMITTEE

## 2.1 BACKGROUND

In 1955, the Central Fire Brigades Advisory Councils set up a Joint Committee to consider a report by the Technical Working Party of Chief Fire Officers on the 1944 standards and the problems which had arisen in applying them. The Committee reported to the Advisory Councils in 1958, and the minimum standards which it recommended are those in force today.

## 2.2 CATEGORISATION OF RISK

The Committee recommended two changes in the six risk categories which then existed:

1. Category A should cease to exist as a separate category and there should instead be pre-determined attendances (PDAs) to particular risks in what were then 'A' risk areas. The Committee felt that the fire risk which justified cover over and above that appropriate to 'B' risk usually formed only a very small and self-contained part of the area, and could be treated quite adequately as an isolated risk requiring a PDA.

2. Categories D and C should be amalgamated and the standards applying to 'E' risk should apply to the new category (the National Association of Fire Officers and the Fire Brigades Union dissenting). A majority of the Committee were persuaded that, in practice, there was rarely any difference in the times of first attendance at 'D' and 'E' risk incidents, and that the combination of the two would be an administrative convenience resulting in no significant decrease in the standards of fire cover provided. The Committee nevertheless accepted that some parts of the new combined areas would have risks higher than the average.

In 1974, the Joint Committee on Fire Brigade Operations of the Central Fire Brigades Advisory Councils devised a points formula to assist fire authorities with assessing the risk categories of their areas. The formula was devised for use by fire authorities when interpreting the prose descriptions of risk categories set out in1958.

## 2.3 FIRST ATTENDANCE – SPEED AND WEIGHT OF ATTACK

The Committee decided that, following the revisions to the risk categories, no changes were required to the number of appliances and the attendance times required. This was determined using a formula devised in 1939 based on street mileage, weighted by the assessed fire risk and size of population, and was used to calculate the total number of appliances to be allocated to each borough or urban district.

## 2.4 STANDARDS OF CREWING

The Committee also reviewed the 1944 guidance on standards of crewing. They were generally content with the requirement that there should be 5 crew on the first appliance to arrive, and 4 on second or subsequent appliances, but were unable to agree on the percentage of times on which this should be met. The Home Departments ultimately advised that the standards should be met on 75% of occasions.

# 3 REPORT OF THE 1985 JOINT COMMITTEE

In 1981, the Central Fire Brigades Advisory Councils set up a Joint Committee to review the standards. They recommended:

- Some re-wording of the prose descriptions of the risk categories, and renaming 'High Risk' as 'Special Risk'. They advised that proper risk assessment must necessarily have close regard for local circumstances, and that identification of relevant local factors and analysis of their significance in terms of risks were matters for the professional judgement of Chief Fire Officers.
- There should be no change to the existing minimum standards on weight of first attendances or attendance times.

Figure A 2 shows the standards as they were then agreed.

| Risk Category | Attendance Time of Appliances | | |
|---|---|---|---|
| | 1st | 2nd | 3rd |
| Special Risk | Pre-Determined Attendance | | |
| A | 5 | 5 | 8 |
| B | 5 | 8 | |
| C | 8-10 | | |
| D | 20 | | |

***Figure A 2: The Risk Categories Defined in 1985***

A discussion of the software developed by the Home Office for modelling these standards in fire brigades can be found in Technical Paper K, References 9 and 10.

# 4 THE 1995 AUDIT COMMISSION REPORT – 'IN THE LINE OF FIRE'

In 1995, the Audit Commission, in its report *In the Line of Fire* (Technical Paper K, Reference 16), praised the fire service for its performance but observed that, in the view of the Commission, its achievements were constrained by many of the frameworks within which it traditionally worked. The standards of fire cover were one such constraint. In particular, the standards of fire cover recommended a minimum response to a particular kind of area, without regard for a number of relevant issues. For example, reference only to the built environment was an unreliable means of assessing risk to life and property. Whilst the built environment did not change throughout the 24 hour day, its occupancy did, and with it the fire risk.

Furthermore, the standards failed to make allowance for the substantial investment in fire safety measures in public buildings and places of public assembly that had been made in recent years. The result was that emergency response to modern buildings, having high levels of fire protection, was the same as that given to old buildings having poor levels of fire protection.

There were other concerns, in so far as the standards specified how the fire service should respond, but not what it should achieve. In theory, at least, the fire service could satisfactorily meet all the standards of fire cover whilst routinely failing to prevent large losses of life and property.

Also, by recommending a minimum response that should be made, innovation was stifled and there was little scope under the standards of fire cover for anticipating the type of incident that was likely to occur. This encouraged over-response, in order that all eventualities would be covered. This was particularly true when planning for the transportation of firefighting personnel, since the standards prescribed attendance in terms of first line appliances carrying crews of a specified size. At large incidents, arrival of the first few appliances would frequently provide all the equipment necessary. The remaining appliances would be used purely as a means of transport for personnel.

The Audit Commission argued that there was scope for radical change, which could result in the saving of lives, suffering and property. The report recommended:

- There should be a shift of emphasis from firefighting (cure) to fire safety (prevention). They argued that fire cover should be related more closely to risk, and that fire prevention work would reduce calls for firefighting,

- Future risk categorisation should be based on empirical evidence and there should be more local flexibility, and

- There should be a re-assessment of the response standards, again giving more local flexibility.

# 5 THE JOINT COMMITTEE ON THE AUDIT COMMISSION REPORT

The Central Fire Brigade Advisory Councils responded to the Audit Commission's report by setting up the Joint Committee on the Audit Commission Report (JCACR).

The JCACR's aim was:

> To provide a demonstrable basis for striking an optimal balance between, on the one hand, expected levels of public and firefighter life, property and environmental risk, and, on the other, the level, type and deployment of fire safety, firefighting and special service resources for normal and exceptional fire and other emergency incidents.

The governing principles for the JCACR were that:

- public protection from fire must be maintained and, if possible, enhanced

- the safety of firefighters must not be compromised

- the primary focus of fire cover should more directly address the risk to life, and

- recommendations should be cost-effective and consistent with the principles of best value for public money

It should be noted that the JCACR acknowledged the resource implications of special services for the fire service. Whilst the Fire Services Act permits brigades to use their resources for activities other than firefighting, current fire cover planning does not take into account the increasing demands being placed on brigades in extricating casualties or rescuing people from non-fire incidents, and in responding to chemical incidents. Any new system of FSEC planning should enable brigades to take these into account, should they wish to do so[1].

The risk assessment process which emerged from the JCACR required brigades directly to assess the life risks in their area, rather than indirectly assessing risk from the types of property in the area as is done by the present standards. The process then permitted brigades to make allowance for many factors previously not considered. In particular, brigades would use real risk figures where statistics are available, and they would take fire safety measures into account where they existed.

There was the presumption that brigades would use fire safety measures to drive down the risk where it was within their power to do so. The attendance time for an incident would be determined by the risk remaining after allowance had been made for the effect of the fire safety measures, and they have proved to work.

The response planning process was based upon the concept of the worst case planning scenario. Brigades would specify the worst scenario for which they would plan a routine response for emergency cover purposes in a particular area. From this they would determine the resources necessary for successful intervention, and would aim to deliver those resources within the attendance time. The response would no longer be made up of one or more standard fire appliances. It would be up to brigades to decide how the required resources would be delivered to the incident.

These proposals were evaluated in Pilot Trials in three brigades: Lothian & Borders (Technical Paper K, Reference 28), West Midlands and Kent. The results were sufficiently favourable to justify proceeding to larger scale trials (Technical Paper K, References 1, 3, 5, 6 and 33). The JCACR recommended that the concepts that the Committee had endorsed should be developed further to the point where they could be implemented operationally by brigades. This further development would be done in collaboration with a number of brigades in what were to be known as ‘Pathfinder projects’. Originally, these trials were to be overseen by a Task Group of the Joint Strategic Committee on Safety and Standards, but overall responsibility for the Fire Cover Review Task Group now rests with the main Councils.

[1] It is for this reason that the term ‘Fire Service Emergency Cover’ has been introduced in the present (2002) review, instead of simply ‘Fire Cover’.

# 6 FIRE SERVICE EMERGENCY COVER DEFINED

Fire authorities are required, under the terms of the Fire Services Act 1947, to provide protection to life and property from the hazards of fire, and to provide humanitarian service. There is some debate over what humanitarian service actually should comprise, but because of the 'humanitarian requirement', and the training, equipment, and rapid response time of the fire service, there has been significant growth in non-fire emergency response by the fire service over recent years. In some brigades there are now more non-fire calls than fire calls. However, there are variations in views in some fire authorities about their responsibility for undertaking non-fire related work, and often attendance at non-life threatening incidents where extrications or rescues are required, is justified on the basis of potential risk from fire.

Whatever the niceties, the reality is that there is a large and growing demand for non-fire emergency service, or 'Special Service', as it is known. In practice, responding to Special Services imposes a significant demand on brigade resources where life or property is at risk. Provision is made in the fire Standard Spending Assessment (SSA) formula for England for calls to road traffic, rail and air accidents, spills and leaks. This recognises that there is a potential risk of fire with such incidents, even though for record purposes they have traditionally been classified as special services. Fire authorities are not directly funded to undertake other Special Services but some provision is made via SSA for the discretionary work that is undertaken. The JCACR recognised the need to consider Special Services as part of the provision of fire cover. It was decided, therefore, that in developing a system of risk-based fire cover, a means of estimating cover requirements for special service calls should be included.

Cover is intended to provide resources for the response to those emergencies, essentially of an unpredictable nature in terms of what when and where, which require a rapid response if there is to be a quantifiable benefit from responding at all. This is not the same as providing a response where there is appreciable warning, and fire brigade personnel and equipment are being used as an extension of the Local Authority's resources for dealing with a protracted incident.

There are two elements to fire service emergency cover:

- the hazard and its associated risk in terms of potential loss of life and property; and
- the resources required to deal with these hazards and their disposition around the brigade area.

**Definition**

> **Fire service emergency cover is the resource provided continuously by a fire brigade to respond to any incident which is reasonably likely to occur, in order to keep the risk within tolerable bounds.**

Implicit within this definition are several assumptions:

- Fire brigades cannot plan to respond fully to every incident which can be conceived. Brigade planning needs to be based on incidents that are reasonably likely to occur. There may be some low probability incidents where it will not be possible to deliver sufficient resources as quickly as desirable. In these circumstances, brigades must plan to work with the resources available and to supplement these when and where possible.
- It is not possible to remove the risk entirely. There will always be loss of life and property in fires. It is necessary to reduce the risk to levels which are considered tolerable. The criteria for tolerability need to be specified for brigades, and these have yet to be determined.
- Cover arrangements do not apply to *protracted* reasonably foreseeable emergencies, for example, the need to provide routine long term pumping capacity when flooding regularly occurs at certain locations.

## 7 ABCD AND REMOTE RURAL RISK CATEGORIES

At present, brigades do not directly quantify the risks in their areas. Prose descriptions of typical areas illustrate the likely risk category (See Table A 1) and these can be supplemented using the formula, mentioned earlier.

| Category | Prose Description |
|---|---|
| A | Normally to be found in the largest cities or towns of the country. For an area to be classified as A risk, it should be of substantial size and should contain a predominating concentration of properties presenting a high risk of life loss or damage to property in the event of fire. Examples of such areas might include:<br>(i) Main shopping and business centres, with department stores, shopping malls and multi-storey hotels, and office properties.<br>(ii) Concentrations of theatres, cinemas, clubs, dance-halls and other entertainment centres.<br>(iii) Concentrations of high-risk industrial or commercial property. |
| B | Normally to be found in the largest cities or towns of the not falling within category A risk. For an area to be as B risk, it should contain continuously built-up areas of substantial size with a predominating concentration of property presenting a substantial risk of life loss or damage to property in the event of fire. Examples of such areas might include:<br>(i) Shopping and business centres, predominately of multi-storey properties, offering some degree of concentration.<br>(ii) Concentrations of hotels and leisure facilities such as occur in the larger holiday resorts.<br>(iii) Concentrations of older multi-storey property offering substantial amounts of residential accommodation.<br>(iv) Industrial or trading estates containing some higher-risk occupancies. |
| C | Normally to be found in the suburbs of the larger towns and built-up areas of smaller towns. For an area to be classified as C risk, it should contain built-up areas of substantial size where the risk of life loss or damage to property in the event of fire is usually low, although in certain areas the risk of death or injury may be relatively high. Concentrations of property may vary, but will generally be of limited extent. Examples of such areas might include:<br>(i) Developments of generally post-war housing, including terraced and multi-storey dwellings, deck-access housing and blocks of flats.<br>(ii) Areas of older, generally pre-war, detached or terraced multi-storey dwellings, with a predominance of property converted for multiple occupation.<br>(iii) Areas of suburban terraces, semi-detached and detached residential properties.<br>(iv) Mixed low-risk industrial and residential areas.<br>(v) Industrial or commercial areas of smaller houses where there are few high-risk occupancies |
| D | Include all areas other than those classed as Remote Rural (RR), not falling within Categories A, B or C. |
| RR | Areas may be classified as Remote Rural if they are isolated from any centres of population and contain few buildings. |
| Special Risks | These are small areas, whether comprising single buildings or complexes, which need a first attendance over and above that appropriate to the risk, which predominates in the surrounding area. These might include residential premises of substantial size, tower blocks, major high-risk industrial plants and airports. |

***Table A 1: Current Risk Categories***

# 8 TERMS OF REFERENCE OF THE FIRE COVER REVIEW TASK GROUP

At the first meeting of the Task Group on 24 June, 1998, the following terms of reference and objectives were agreed:

> Taking into account the safety of firefighters, community fire safety and legislative matters, to develop a risk-based approach to the provision of rescue and emergency cover, as outlined by the JCACR in its report *Out of the Line of Fire* (Technical Paper K, Reference 22), into a fully defined system capable of operational use for fire, rescue and emergency cover, and to evaluate its running-costs and performance through the implementation of Pathfinder Projects in selected brigades by:
>
> - developing further the tools required by participating brigades for risk assessment, response assessment and resource allocation;
> - identifying the information requirements of the risk-based approach and the sources of the required data;
> - assessing the financial implications of the approach if applied nationally,
> - reporting on progress to the Joint Strategic Committee on Safety and Standards at various stages of the work; and
> - preparing a written report on the findings and recommendations of the Task Group for the Central Fire Brigades Advisory Councils.

The purpose of the trials was to demonstrate, in areas of selected brigades, that the risk-based approach was capable of practical implementation and to compare their results with those obtained from the present standards of fire cover. The trials were structured as two phases of work initially. The first phase was to develop the methodology and assess its likely performance in terms of the level of protection it would provide and the costs. The second phase was subject to the outcome of the first phase. Its purpose was to implement FSEC operationally on a trial basis in the Pathfinder brigades.

Shortly after commencing the first phase, it was decided to abandon the second phase, as it was considered that it would be impossible to ensure that public and firefighter safety were not compromised. There were also concerns as to:

- whether operational trials of such a magnitude would be too small to yield statistical results
- whether it was realistic to attempt to implement any proposed changes in only part of a brigade, and
- whether any proposed changes could be implemented without going through a protracted Section 19 consultation process

It was therefore decided to assess the methodology on the basis of computer modelling. The Home Office had developed a fire cover model, which was used by over 20 fire brigades to plan their fire cover under the present standards. It was decided that the development of a similar model should be explored, but one which reflected the risk-based approach which was proposed, and which could also accommodate the use of flexible response.

The benefit of a modelling approach would be that it would potentially enable not one, but a series of possibilities to be examined in the time available, and without any risk to either the general public or firefighters. The drawback would be the issue of credibility, since none of the potential solutions would actually have been tried in practice.

However, in view of the potential problems associated with attempting to carry out practical trials, the modelling approach appeared to be the only way forward, and it is the one which was adopted.

# TECHNICAL PAPER B

## RISK ASSESSMENT AND THE IMPACT OF FIRE SAFETY

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# 1 DEFINITION OF RISK

Whilst in English usage "risk" can simply mean "probability", for the purposes of risk assessment, risk is also defined as meaning, "the product of probability and consequence".

| Risk = Probability x Consequence |
|---|

A benefit of representing risk in this way is that it can take into account events which have a low probability but a high consequence. Events of this kind are often of concern.
When promoting overall fire safety, brigades can reduce risk by:

- promoting fire precautions, including fire prevention (i.e. reducing the probability of exposure to the hazard), and/or
- providing firefighting intervention (i.e. reducing the consequence of exposure to the hazard)

In some circumstances it is not possible to provide fire cover through firefighting intervention, and in others firefighting intervention alone is not sufficient to reduce risk to tolerable levels. However, the 'probability x consequence' relationship shows how risk can still potentially be reduced in such cases by reducing the probability of fire by promoting fire prevention/precautions.

## 1.1 TYPES OF RISK

### 1.1.1 The Two Basic Types

In planning their response, the Fire Service take account of two fundamental risks - risk to life and risk to property. For the purposes of this work, these have been further broken down as described in the following sections.

### 1.1.2 Life Risks

Three types of life risk need to be considered:

Individual Life Risk - This is the probability that an individual will be killed or injured in an incident.

Societal Life Risk - This is the probability that a specified number of people will be killed or injured in an incident.

Firefighter Life Risk - This is the probability that a firefighter will be killed or injured in dealing with an incident.

### 1.1.3 Property Risks

Four types of property risk need to be considered:

Property Risk - This is the loss likely to occur at an incident due to damage to property.

Heritage Risk - This is additional loss likely to occur at an incident due to that property no longer being available. This may occur because the property is of historical significance, or because it has national economic impact in terms of loss of income.

Environmental Risk - This is the additional loss likely to occur at an incident due to pollution of the environment.

Business Continuity Risk - This takes account of businesses which are sole suppliers of goods in the UK.

# 2 RISK ASSESSMENT

## 2.1 INTRODUCTION

The Audit Commission Report (Technical Paper K, Reference 16) highlighted several areas of concern with the current risk categorisation process, suggesting that in particular, it:

- was essentially property based
- took no account of fire safety measures in buildings
- did not vary with time e.g. time of day, season.

These and other issues have been addressed by the Fire Service Emergency Cover (FSEC) process and a series of toolkits developed to assess the main risks relating to fire service work.

For the purposes of Pathfinder trials, the risk assessment was split into four 'toolkits' each of which represented significant aspects of the work of the fire service. These are discussed in more detail below.

## 2.2 RISK AREAS AND GROUPS

Risk areas are defined for all the toolkits for the brigade area. A risk area is a homogenous risk and should require the same response throughout. For example, a risk area for dwellings might be a housing estate where the types of houses and occupants are the same and so this risk is similar throughout.

Risk groups are groups of areas which are considered jointly for statistical purposes. The areas can be geographically separate and should contain only areas with similar risk, but they can have different response requirements. For example, three housing estates with similar risk might be considered jointly to make a group although each has different sorts of houses. Risk groups make it possible to aggregate incidents from all the constituent areas into statistically sound populations, which can be risk assessed on the basis of historical incidents or building populations.

## 2.3 CENSUS ENUMERATION DISTRICTS

Census Enumeration Districts (EDs) are areas of similar types of housing and residents which are defined by the 1991 census. Each ED usually contains about 500 residents in England & Wales and 300 residents in Scotland.

Risk assessment was carried out for all toolkits based upon census Enumeration Districts (EDs). A common area was needed for the modelling phase and EDs had several advantages:

- they were readily available in a standard format which everyone was familiar with
- they provided extra information on the population in an area which often assisted with risk assessment
- they provide continuous coverage of the UK

There were also some disadvantages, such as:

- using EDs for toolkits which did not readily relate to resident population, such as Road Traffic Accidents
- the larger size of EDs in rural areas meant that the risk assessment might be coarse (although this may be improved with the 2001 census which will have smaller EDs)

## 2.4 TOOLKITS

### 2.4.1 General

Risk assessment for the FSEC process has been divided into four toolkits, each providing guidance on how to determine the level of risk for a specific range of hazards:

- Dwellings – covering single occupancy dwellings
- Special Services – covering all special services including Road Traffic Accidents (RTAs), extrications, chemical incidents
- Other Buildings – covering all commercial buildings and some high occupancy residential buildings such as tower blocks
- Major Incidents – covering major incidents such as bombs and floods.

A toolkit for heathland and woodland fires (Technical Paper K, Reference 29) was also developed, although it was not implemented in the FSEC software.

### 2.4.2 Dwellings Toolkit

This toolkit assesses the individual risk to life from fire in dwellings. The risk assessment is carried out using local brigade incident and census data. Small local areas are too small to be able to use past incident data as a guide to risk – a population as small as 500 people (the usual size of a census Enumeration District (ED)) is unlikely to experience a fire more than once every hundred years even for high risk areas, so historical incident cannot reliably be used to estimate risk at this local level. Therefore to assist in the risk assessment census data is used to highlight areas where the socio-demographics suggest that high rates of fire might be experienced.

Once areas and groups have been defined, the number of incidents and residents in a group is used to derive a rate of fire per household and a rate of casualty per person. These rates are then compared against nationally agreed bands for 'Very High', 'High', 'Medium' and 'Low' risk.

This approach has the advantages that:

- local information is used for the risk assessment and yet national rates are still applied, and so subjectivity is minimised
- local information on risk can be used to target fire safety initiatives

The assessment of risk in dwellings is carried out for every ED in the brigade area and therefore dwellings risk assessment provides a continuous plane of risk which underpins all other planes.

The full toolkit can be found at Technical Paper K, Reference 4.

### 2.4.3 Special Services Toolkit

This toolkit assesses the individual risk to life for special services. The risk assessment for special services involves a simple count of the number of special service incidents which occurred.

Special Services has been divided into nine categories: Road Traffic Accidents, Extrications, Hazardous Chemicals, Line Rescues, Ladder Rescues, Water Rescues, Lockin/out, Lift Releases and Other. These categories were chosen to differentiate between the types of equipment which were likely to be needed – hazardous chemical incidents were likely to require chemical protection equipment whilst lift releases would require winding equipment. Additionally, individual incidents have been divided into three categories of severity:

A Imminent Life Risk, where a fast response by the brigade may make the difference between life and death for example a seriously injured person trapped in a car,
B Serious Life Risk where a slower response by the brigade would be acceptable, for example a person trapped in a lift, and
C Other, where a response by the brigade may be discretionary/chargeable, for example, pumping of water.

The brigade area is divided into areas of risk, for each type of special service. A region might have motorways which are Road Traffic Accident risk areas and canals which are Water Rescue risk areas. Similar areas, such as disconnected motorways, can be grouped together if the risk is considered to be similar. The number and severity of each type of incident in these areas and groups is calculated.

The full toolkit can be found at Technical Paper K, Reference 31.

### 2.4.4 Other Buildings Toolkit

This toolkit assesses the societal risk to life and risk to property, environment, heritage, business and firefighters in a wide range of buildings, where societal or property risk may occur. Societal risk is generally assumed to be possible in buildings with twenty or more occupants. The current list of occupancy types is:

| | |
|---|---|
| Hospitals | Public buildings |
| Care homes | Licensed premises |
| Houses in Multiple Occupation (bedsits) | Schools |
| High rise flats | Shops |
| Hostels | Other premises open to the public |
| Hotels | Factories and warehouses |
| Houses converted to flats | Offices |
| Other sleeping accommodation | Other workplaces |
| Further education | |

***Table B1 Other Buildings Occupancy Types***

These occupancy types were based on the occupancies used by the Fire Damage Report 1 form (FDR1), although in some cases several categories from the FDR1 have been amalgamated for statistical robustness.

A national assessment of the risk in these buildings found that there were too few fires in buildings of this sort to be able to assess risk locally using past incident records. Instead, average fire rates for certain occupancies were derived nationally and these, used in conjunction with local site assessments, are used to obtain an estimate of local risk.

This means that risk assessment of Other Buildings involves site surveys of a representative sample of the buildings in an area. A survey form has been developed to record the results of site surveys making use of either prose descriptions or a points scoring system. Both methods take account of factors such as the fire safety measures, the type of people, the variation in the number of people in the building by time of day and any unusual risks in the buildings.

As for the other toolkits, the brigade area is divided into areas and groups of Other Buildings. A typical area may include some shops, factories, hotels and houses in multiple occupation. The total numbers of each occupancy of buildings is used in conjunction with the results of the site assessments, to provide a total amount of societal risk.

Societal risk is measured as the total risk in a given area rather than a risk per head of population. This means that the larger the area the more risk there is likely to be. To address this potential problem a standard sized area was needed so that comparisons between areas could be fair. A standard sized area which could be traversed within 5 minutes was chosen as this was the smallest which could reasonably be modelled. These areas were called Other Buildings Time Generated Risk Calculation Areas as their size can vary with time of day because of potential variations in road speeds. The risk in each of these standard sized areas can then be compared against nationally set risk criteria.

The full toolkit can be found at Technical Paper K, Reference 14 and explanation of revisions which were made during Pathfinder trials can be found in Technical Paper K, Reference 24.

### 2.4.5 Major Incidents

This toolkit primarily assesses the societal risk to life from major incidents. Major incidents were divided into seven categories: bombing, flooding, major vehicle crashes, aircraft crashes, shipping, hazardous chemicals and rail crashes.

The full toolkit can be found at Technical Paper K, Reference 18.

# 3 INDEPENDENT REVIEW OF RISK ASSESSMENT METHODS

## 3.1 INTRODUCTION

The development of the risk assessment methods that underpin the FSEC system was undertaken mainly by one consultancy company, Entec UK Ltd. Consequently, it was considered prudent that their work should undergo an independent review and validation.

FRD commissioned risk assessment consultants, Mott MacDonald, to independently review and validate:

- the risk assessment methods, toolkits and other documentation produced by Entec UK Ltd,
- changes and enhancements made by the Fire Research Division (FRD) during the Pathfinder trial to the Other Buildings risk assessment methodology.

Further details are given in the following sections.

## 3.2 REVIEW OF RISK ASSESSMENT METHODS, TOOLKITS AND DOCUMENTATION

Mott MacDonald were asked to study all 20 of the Entec UK Ltd reports, including the four risk assessment toolkits (Dwellings, Special Services, Other Buildings and Major Incidents), that constituted the “paper-based” description of the risk assessment methods. In particular, the consultants were asked to:

- assess the criticality of any weakness/omissions in the methods used in each toolkit,
- assess the criticality of any weakness/omissions in the overall approach for determining fire service emergency cover,
- confirm that the risk criteria and principles had been correctly implemented in each toolkit,
- assess the soundness of any application of professional judgement,

- determine whether the proposed methods agreed with the generally accepted views on the tolerability of risks to individuals and society,
- assess the practicality of the implementation of the risk-based method and whether the overall approach was sound and valid.

This review commenced during December 1999 and was completed during November 2000. In the conclusions of their report (Technical Paper K, Reference 36), Mott MacDonald stated that they generally accepted the methods and data underpinning the paper based risk assessment toolkits. They found that the risk assessment approach was more rational than the existing system and they considered that it should lead to better FSEC with expenditure being better focussed on life safety issues. However, there were some issues raised during their study that, although not judged to be of such significance that the methods, objectives or criteria would be invalidated, they could have a significant effect on the results of the process. The main recommendations of their report, which took these issues into account, are listed below and concerned:

a. Enabling brigades to accurately record all judgements made during the process.
b. National monitoring, review and development of the system once it had been implemented.
c. Addition of a review and monitoring phase in the Other Buildings toolkit.
d. Reviewing the relationship between brigade response times and fatality rates for other buildings.
e. Accounting for variations in risk through the day for all toolkits.
f. Accounting for seasonal variations in risk.
g. Continuously reviewing and updating data both locally and nationally.
h. Reviewing the scaling factor for other buildings heritage loss.
i. Accounting for incidents that occur over boundaries.
j. Accounting for the effects on fire cover of simultaneous calls.
k. Determining whether there was a bias in the system towards Other Buildings risk.
l. The possibility of pockets of high risk remaining after applying the system.

Mott MacDonald only reviewed the Entec UK Ltd risk assessment documents and not the software implementation of the system. However, three of the above recommendations (e, i and j) could be implemented using the software developed for the Pathfinder trial. Of the remaining nine recommendations, three (b, d, and g) will become the subject of continuous review by ODPM once the system has been implemented and six (a, c, f, h, k and l) will require the update of documentation, software and processes prior to implementation.

A detailed list of the recommendations can be found in the appendices of the Mott MacDonald report of this review (Technical Paper K, Reference 36).

### 3.3 REVIEW OF CHANGES MADE TO THE OTHER BUILDINGS RISK ASSESSMENT METHODS

FRD developed and modified the Other Buildings risk assessment process proposed by Entec UK Ltd, and previously reviewed by Mott MacDonald above, in order to implement it during the Pathfinder trial. FRD produced a report (Technical Paper K, Reference 40) that described the implemented version of the process and Mott MacDonald were asked to review and validate it. In particular, the consultants were asked to:

- compare and contrast the process originally proposed with that in the current process,
- identify any mistakes, omissions or weaknesses in the current process and assess their importance and
- discuss whether the approach and concepts in the current process appear to be appropriate, consistent and logical.

This review commenced during December 2001 and was completed during January 2002. Mott MacDonald concluded at the end of this study that no changes had been made to the Other Buildings risk assessment methods, since their previous review, that would invalidate the basis for resource planning. They raised several issues that might have had an impact on the results of the risk assessment but, in the majority of cases, the effect would have been small. Further details can be found in Technical Paper K, Reference 41.

## 4 THE IMPACT OF FIRE SAFETY

The Audit Commission had recommended that the fire service should focus more on fire safety (prevention) at the expense of firefighting intervention (cure). The JCACR acknowledged this view (although it had been unable to investigate to any great extent how the marriage of fire safety and firefighting intervention provided under fire cover arrangements could be engineered).

The Task Group experienced similar difficulties as well, because of the time and effort that was required to develop the risk-based approach to fire cover. However, it was realised in the course of the work, that fire cover and fire safety were better regarded as complementary approaches to achieving public safety, not as alternative means of reducing overall risk to the public from fire and other hazards. Viewed in this way, any given level of public safety could be achieved by an appropriate mix of fire safety measures and emergency intervention (i.e. emergency cover). Individual safety tactics should be chosen in the light of local circumstances and cost benefit.

With the development of methods for quantitatively assessing the performance of various fire safety tactics, it will be possible in the future to develop fire safety strategies comprising a mix of fire precaution and firefighting intervention activities based on cost benefit.

# TECHNICAL PAPER C

## RESPONSE AND RESOURCE REQUIREMENTS

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# 1 INTRODUCTION

In developing this new fire cover planning process, one important consideration was the criticism contained in the Audit Commission report *In the Line of Fire* (see Technical Paper K, Reference 16*)*, and an often-expressed complaint from some sections of the fire service, that the existing standards of fire cover were too prescriptive and did not allow innovation. Also, the existing standards of fire cover no longer fully accounted for all of the other types of emergency activities the fire service were expected to undertake, such as the extrication of casualties from road traffic accidents (RTAs).

Under the new Fire Service Emergency Cover (FSEC) system, brigades can move away from this prescriptive approach and deliver to incidents only the resources that are required. In order to do this, the new system assists them in identifying the required resources and in the grouping of these resources together on to vehicles for their delivery to incidents. The system also helps in the allocation of these vehicles to fire stations to achieve the necessary attendance times.

# 2 RESPONSE REQUIREMENTS

## 2.1 WORST CASE PLANNING SCENARIOS

In planning the response to a particular risk, the guiding principle is that of the 'Worst Case Planning Scenario': -

*"For a particular hazard, this is the worst case selected by a brigade for which FSEC is to be planned. It reflects what is reasonable provision for a particular area, not the worst circumstances which can be imagined."*

The key words in this definition are 'reasonable provision'. It would not be reasonable to select a Lockerbie type incident in planning for fires in a housing estate. If the housing estate contains semi-detached houses and bungalows, it would probably be reasonable to plan on the basis of having to make a couple of rescues from the first floor, making access either by ladder or via the stairs. It is important to appreciate that a Worst Case Planning Scenario (WCPS) is simply a planning tool used to identify the resources required at an incident. It is not intended to be prescriptive in telling brigades how to address a specific incident. There will always be some incidents in a particular area where make-up beyond the WCPS resource levels will be required, and there will be many incidents which are not as severe as the WCPS, requiring similar or fewer resources. In the FSEC system, any Enumeration District may have a number of different risks and each of these will have associated with it a WCPS. If all hazards were present in an enumeration district, then the following maximum number of WCPSs would be required: -

- 1 Dwellings scenario
- 9 Special Services scenarios
- 17 Other Buildings societal risk scenarios (day)
- 17 Other Buildings societal risk scenarios (night)
- 14 Other Buildings property risk scenarios

- 7 Major Incident scenarios
- 3 small fire scenarios

The risk assessment toolkits place various constraints on the WCPSs for some risks. These include:-

- For Other Buildings societal risks, scenarios should plan for sufficient resources to be present to commence multiple rescues within ten minutes of the time of call.
- For all Other Buildings scenarios, all resources must be present within 40 minutes of the time of call.
- For Major Incident scenarios, all resources must be present within 60 minutes of the time of call.

## 2.2 DATABASE OF PLANNING SCENARIOS

To assist brigades in generating their WCPSs, a software package called Brigade Response Options System (BROS) has been developed. This provides a database of 35 planning scenario templates from which brigades can select the most appropriate or create their own. The CFBAC Fire Cover Review Task Group agreed to the use of this database for the Pathfinder trial. The scenarios are listed in Table C1.

| Incident Group | Incident Type | Scenario Name | Ref. No |
|---|---|---|---|
| **FDR 1 Fires: Dwellings** | Multiple occupancy high rise | 2 to 4 casualties involved rescue via internal staircase | (C-1) |
| | Multiple occupancy low rise | 2 to 4 casualties involved rescue via 135 ladder | (C-2) |
| | | 2 to 4 casualties involved rescue via 9/105 ladder | (C-3) |
| | | 2 to 4 casualties involved rescue via Internal staircase | (C-4) |
| | Multiple occupancy medium rise | 2 to 4 casualties involved rescue via 135 ladder | (C-5) |
| | | 2 to 4 casualties involved rescue via 9/105 ladder | (C-6) |
| | | 2 to 4 casualties involved rescue via aerial appliance | (C-7) |
| | | 2 to 4 casualties involved rescue via internal staircase | (C-8) |
| | Multiple occupancy single basement | 2 to 4 casualties involved rescue via internal staircase | (C-9) |
| | Single occupancy | 2 to 4 casualties involved rescue via 135 ladder | (C-10) |
| | | 2 to 4 casualties involved rescue via 9/105 ladder | (C-11) |
| | | 2 to 4 casualties involved rescue via internal staircase | (C-12) |
| | Underground complex | 2 to 4 casualties involved – using firefighting lift | (C-13) |
| **Special Services : Casualty retrieval from** | Hazardous material incident | Generic incident – BA CPS with HRJ - 1 casualty retrieved | (C-14) |
| | | Generic incident – BA GTS with HRJ - 1 casualty retrieved | (C-15) |
| | Height | Rope rescue equipment – 1 casualty retrieved | (C-16) |
| | | With 135 extension ladder – 1 casualty retrieved | (C-17) |
| | | With 9/105 extension ladder - 1 casualty retrieved | (C-18) |
| | | With aerial appliance – 1 casualty retrieved | (C-19) |
| | Lift | Lift - 1 casualty retrieved | (C-20) |
| | Lock-in | Conventional - 1 casualty retrieved | (C-21) |
| | | With 135 extension ladder – 1 casualty retrieved | (C-22) |
| | | With 9/105 extension ladder - 1 casualty retrieved | (C-23) |
| | | With aerial appliance – 1 casualty retrieved | (C-24) |
| | | With short extension ladder - 1 casualty retrieved | (C-25) |
| | Water | 1 Casualty retrieved | (C-26) |
| **Special Services : Casualty trapped** | Extrication from machinery / structures | 1 Casualty trapped | (C-27) |
| | Rail transport above ground accident | 2 Carriages - 1 casualty trapped in each carriage | (C-28) |
| | RTA | Generic incident – 2 vehicles - 1 casualty trapped in each vehicle | (C-29) |
| | Ship accident | 1 Ship - 2 casualties trapped | (C-30) |
| | Small aircraft accident | 1 Aircraft - 2 casualties trapped - with LX foam branch | (C-31) |
| | Small boat accident | 1 Small boat - 1 casualty trapped | (C-32) |
| **FDR 1 Fires: Property Other Than Buildings** | | Generic small fire | (C-33) |
| **FDR 3 Fires** | Chimney | Generic fire | (C-34) |
| | Secondary | Generic small fire | (C-35) |

***Table C1 : Planning Scenarios Supplied to Pathfinder Brigades***

# 3 RESOURCE REQUIREMENTS

## 3.1 PLANNING SCENARIO TASK ANALYSIS

Each incident type may have a number of scenarios e.g. *FDR 1 Fires: Dwellings - Multiple Occupancy Medium Rise* may have several scenarios involving different sorts of ladder or equipment, depending on the specific nature of the buildings. BROS presents each scenario as a bar chart detailing the tasks which each firefighter might be undertaking at different stages of the scenario (see Figure C1).

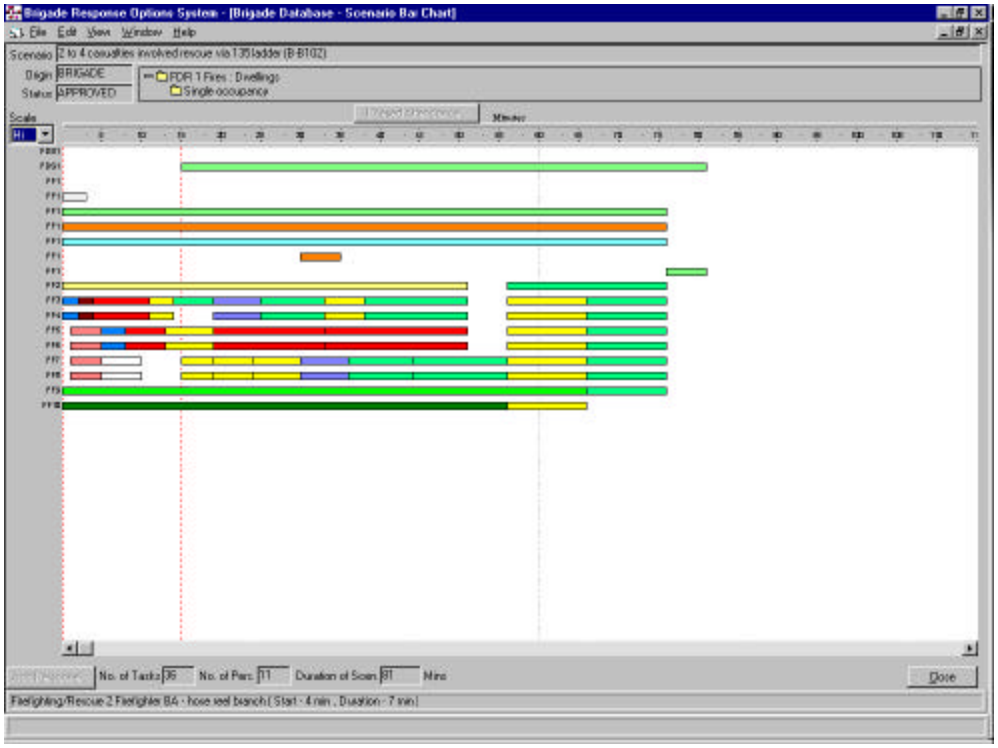


***Figure C1 : Example of a Worst Case Planning Scenario Bar Chart***

For each task, the database contains a list of the number of personnel, equipment and attributes needed to complete it. Thus the task information in the scenario is combined by the software and used to generate a list of the total number of resources (personnel, equipment and attributes) required (see Table C2).

| **Equipment List** | |
|---|---|
| Equipment | Number |
| 45mm Hose | 2 |
| 70mm Hose | 6 |
| BA Control Board | 1 |
| Barriers/Cones/tapes | 1 |
| Branch Pipe (Nozzle) | 1 |
| Breaking-in Gear | 1 |
| Breathing Apparatus | 4 |
| First Aid Kit | 1 |
| Hydrant Standpipe | 1 |
| Pump with LP Capability | 1 |
| Radios | 7 |
| Resuscitator | 1 |
| Salvage Equipment | 1 |
| BA Spare Cylinder | 4 |
| Small Gear | 1 |
| Thermal Imager | 1 |
| Set of Hose Ramps | 1 |
| Turning Over Tools | 1 |

| **Personnel List** | |
|---|---|
| Personnel | Number |
| FDS Officer | 1 |
| Firefighter | 9 |

| **Attributes** | |
|---|---|
| Attributes | Number |
| Junior Officer Rank | 1 |

***Table C2 : Resource Requirements List***

Each brigade can amend the BROS planning scenarios to suit their particular circumstances. For example, some brigades use Positive Pressure Ventilation (PPV) and some do not. However, the scenarios contained in the BROS database have been produced as a result of an extensive consultation exercise, and the bar charts constitute a record of the thought processes involved in producing them. For a brigade to diverge from this guidance, they must undertake a risk assessment that justifies their alternative procedure(s).

To assist brigades in generating their own WCPSs, the software package permits the on-screen manipulation of the bar chart, and ultimately asks for the reason for the changes, to produce a documentary record (an audit trail) of what has been done. Where a scenario involves more than 20 personnel, the creation of a bar chart in BROS to plan the tasks undertaken by each person becomes a complex and time consuming activity. Consequently, for these larger incidents, brigades simply allocate a scenario name in BROS and the required resources are defined later (see Section 3.3).

## 3.2 ALLOCATING RESOURCES TO MODULES

The next stage is for brigades to decide how the resources identified in each WCPS are to be delivered to the scenario. They could, of course, elect to continue with their existing fire appliances, provided that they carry the appropriate resources. However, it would no longer be a requirement for them to use standard pumping appliances. Alternative solutions would be permitted, and it is up to brigades to come up with the most appropriate one for their particular circumstances.

To assist them in doing this, a second computer program called Brigade Resource Allocation to VEhicles (BRAVE) has been developed. This allows brigades to specify which of the resources required for their scenarios need to travel together. These collections of resources are termed ‘modules’. A module can be:

- a single firefighter,
- groups of equipment that must always travel together,
- attributes such as junior officer rank, hydraulic platform operator or 10.5m ladder function.

In the following example, a module has been produced which consists of a low pressure pump and associated equipment (see Table C3).

| Low Pressure Pump Module | |
|---|---|
| **Resource** | **Number** |
| 45mm Hose | 2 |
| 70mm Hose | 6 |
| Barriers/Cones/Tapes | 1 |
| Branch Pipe (Nozzle) | 2 |
| Hydrant Standpipe | 1 |
| Pump with LP Capability | 1 |
| Radios | 1 |
| Set of Hose Ramps | 1 |

***Table C3 : Specification of a Module***

The examples in Table C4 show a firefighter module, which consists of a single firefighter, and a junior officer rank module, which consists of a junior officer rank attribute. In BRAVE, to meet a scenario resource requirement for a junior officer would require both the firefighter module and the junior officer rank module since the later is not a 'person' but an attribute that the firefighter must have.

| **Firefighter Module** | | **Junior Officer Rank Module** | |
|---|---|---|---|
| Resource | Number | Resource | Number |
| Firefighter | 1 | Junior Officer Rank Attribute | 1 |

***Table C4 : Examples of Firefighter and Junior Officer Rank Modules***

This process is repeated until all of the resources required by the WCPSs created in BROS have been assigned to modules.

## 3.3 ALLOCATING MODULES TO SCENARIOS

Once all of the modules have been defined, BRAVE is used to match these to the resource requirements of each of the smaller BROS WCPSs (those that require 20 or less personnel).

For larger scenarios (those that require more than 20 personnel) BROS was used to name these scenarios but not to define the activities within them, consequently their resource requirements have not been defined either. For these larger scenarios, BRAVE is used to define the resources required by allocating appropriate modules to these scenarios. The examples in Table C5 show the modules that could be allocated to a medium hotel WCPS and a hospital WCPS. The hospital WCPS is personnel intensive, requiring 30 firefighters but only two low pressure pumps: -

| WCPS | Modules Carried | Number |
|---|---|---|
| Medium Hotel | Low Pressure Pump Module | 2 |
| | Firefighter Module | 20 |
| | Junior Officer Rank Module | 2 |
| | Casualty Treatment Module | 2 |
| | Aerial Appliance Module | 1 |
| Hospital | Low Pressure Pump Module | 2 |
| | Firefighter Module | 30 |
| | Junior Officer Rank Module | 4 |

***Table C5 : Resource Requirements at a Large Incident***

## 3.4 ALLOCATING MODULES TO VEHICLES

Next, BRAVE is used to define vehicles in terms of the modules of resources that they carry. Table C6 provides an example of a type 'X' vehicle that has been specified in terms of modules.

| Vehicle Type | Modules Carried | Number |
|---|---|---|
| Type X | Low Pressure Pump Module | 1 |
| | Firefighter Module | 5 |
| | Junior Officer Rank Module | 1 |
| | Rescue Ladder Module | 1 |
| | 10.5m Ladder Function Module | 1 |
| | General Tools Module | 1 |
| | RTA Module | 1 |
| | BA Module | 2 |

***Table C6 : Example of a Vehicle Specification***

## 3.5 ALLOCATING VEHICLES TO SCENARIOS

Finally, BRAVE is used to identify the vehicles that are required to attend each of the WCPSs in order to match the modules, and hence resources, required by them. The software allows up to 32 different combinations of vehicles to be allocated to each WCPS. This is sufficient to allow for the variation in vehicles already used by brigades in attending incidents and to enable more unconventional vehicles to be modelled in the future. Some example vehicle allocations are given in Table C7.

| Scenario ID | Vehicles Required |
|---|---|
| C2349 | 2 Type X OR 1 Type X , 1 Type Y |
| B6322 | 2 Type X, 1 Type Y |
| B9283 | 1 Type Y |
| B7319 | 2 Type X<br>2 Type X 5 minutes later<br>1 Type Z 10 minutes later |
| C2348 | 1 Type X, 1 Type Y |

***Table C7 : Examples of Vehicles Allocated to Scenarios***

## 3.6 OTHER BUILDINGS RESOURCE REQUIREMENTS

In order to determine the resource requirements for Other Buildings WCPSs, all of the site assessments in each risk area need to be considered. Several thousand site assessments may be collected by each brigade and so, to assist them in this process, a computer spreadsheet has been developed. This spreadsheet, for each risk area, and for each Other Buildings occupancy type within each risk area, identifies those sites which account for the top 80% of the societal and property risk loss.

For all these sites, it produces an estimate of the major resources likely to be required for each. This estimate is based on general assumptions about the relationships between fire size, the number of rescues required and the number of storeys and numbers of low pressure pumps, aerials, ladders, breathing apparatus sets and personnel. As a final step, the spreadsheet determines the maximum numbers of these resources required to cover all of the sites of that occupancy type in that risk area.

This spreadsheet provides an indication of the likely resource requirements, and a brigade's WCPSs can be based on these estimates. Brigades are free to develop their own estimates should they wish to do so. However, in all cases, brigades must document their decision process. Once the estimates have been determined, BROS and BRAVE are used to plan the required scenarios.

## 3.7 PLANNING FOR PHASED ARRIVALS IN WORST CASE PLANNING SCENARIOS

WCPSs can also be created which allow resources to arrive at an incident at different times (Phased Arrival). This gets translated, in BROS and BRAVE, into allowing vehicles to arrive at different times during the scenario. In practice, phased arrivals are only defined where it is clearly preferable for this to happen if the incident is to be dealt with efficiently, or where it is clear that some resources are not required until later in the incident. In a large incident, for example, it may be logistically undesirable for all of the vehicles to arrive at the same time.

Where phased arrivals are specified, these must be done with health and safety considerations in mind. For instance, it is essential to avoid situations which could motivate or pressurise firefighters to act unsafely in the interests of saving life. The WCPSs must therefore clearly

show which tasks can be completed with the resources that have arrived at the incident and which ones will have to wait until other resources have arrived.

# TECHNICAL PAPER D

## THE TOR RESOURCE ALLOCATION STRATEGY

1 TOLERABILITY OF RISK (TOR) FRAMEWORK ..... 1

# 1 TOLERABILITY OF RISK (TOR) FRAMEWORK

In developing risk-based emergency cover the Tolerability of Risk (ToR) framework developed by the Health and Safety Executive (HSE) has been adopted. This envisages risk being divided into three bands, namely, intolerable, tolerable, and negligible. These bands are delineated by the upper and lower bounds of tolerability of risk.

In areas falling within the aegis of HSE legislation, no-one is allowed to be exposed routinely to intolerable risk. Should intolerable risk occur, it must either be reduced (without regard for cost), or the activity causing it must cease. The underlying assumption is that the owner of the risk should be responsible for its reduction.

Risk within the tolerable region should also be reduced As Low As Reasonably Practicable (ALARP) without incurring disproportionate cost. (Tolerable risk is sometimes known as ALARP risk.)

The underlying concepts are illustrated in Figure D1.

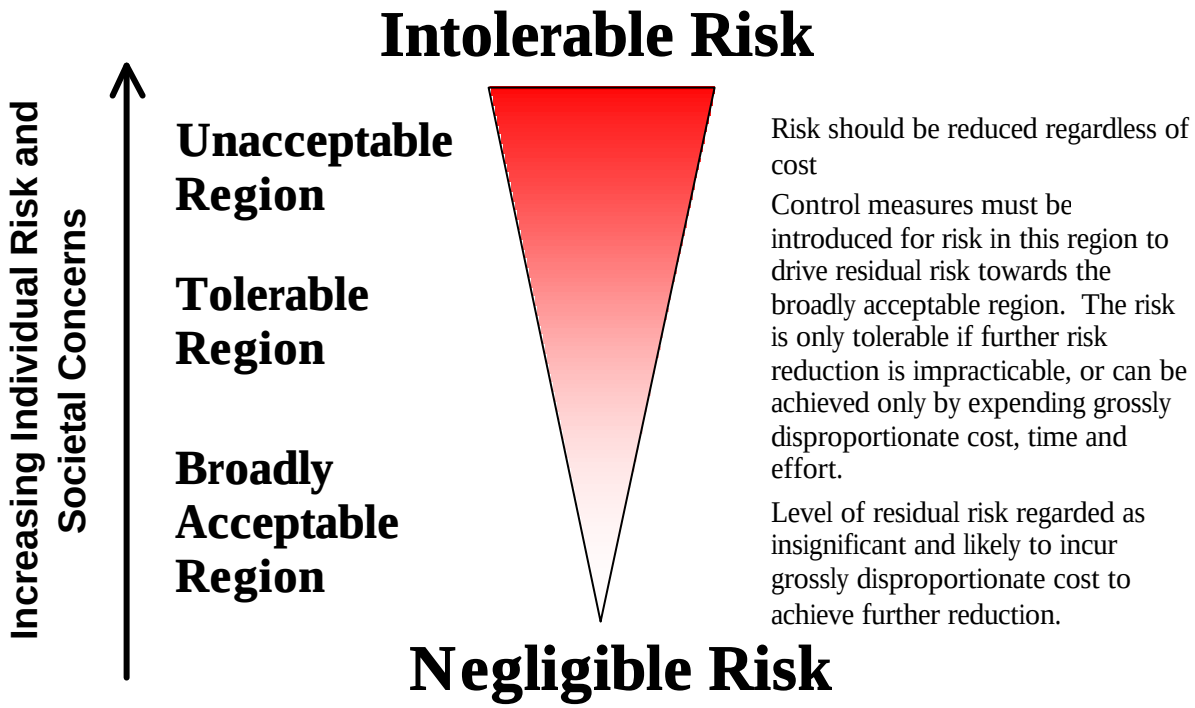


***Figure D1 The Risk Model***

The ToR framework defines an **Upper Limit of Tolerable Risk** (ULTR), beyond which the risk is considered to be unacceptable. In industry, Health & Safety legislation requires that risk in excess of the ULTR should be reduced no matter what the cost. In these circumstances, there is the ultimate sanction that if a risk cannot be reduced the activity can be shut down. In the case of fire, the same does not apply. Whilst fire authorities can restrict or prohibit the use of certain premises where serious risk is found, many premises, including most dwellings, are the responsibility

of the owners, and the risk of fire can only be reduced by persuasion. Where possible it is intended that the owner of the risk shall be held responsible for it's reduction and any associated costs. However, especially in domestic dwellings, it is difficult to maintain this stance if the occupants act irresponsibly since there are few practical sanctions which can be applied. In consequence, there will be occasions when the not inconsiderable cost of providing high levels of emergency cover in order to avoid exposure to intolerable risk cannot be avoided or recovered.

The ToR framework also defines a level of risk which is considered **negligible**. In this region no measures need be taken to reduce the risk further, but it should be monitored to ensure that the risk remains negligible.

Between the ULTR and the negligible risk zone, lies an area where the risk can be described as **tolerable**. Here, risk must be reduced if it is possible to do so without incurring grossly disproportionate cost. This is generally referred to as the ALARP region, where the risk should be reduced to As Low As Reasonably Practicable. Here risks are reduced where it is practicable and cost-effective to do so.

The evaluation of alternative risk assessment methodologies for the fire service can be found in Technical Paper K, Reference 6. The applicability of the ToR approach to sparsely populated areas was considered and reported (Technical Paper K, References 26 and 27). Finally, discussions on the risk criteria and cost effectiveness guidelines suggested for Pathfinder trials can be found in Technical Paper K, References 7, 12 and 19.

# TECHNICAL PAPER E

## ASSESSING THE IMPACT OF A RESOURCE ALLOCATION STRATEGY

1 GENERAL....1
2 DWELLINGS....1
3 SPECIAL SERVICES....3
4 OTHER BUILDINGS....4
5 MAJOR INCIDENTS....5

# 1 GENERAL

The fire service has two possible mechanisms for reducing risk by operational intervention: speed of attack and weight of attack.

The primary driver for reducing risk via operational means is attendance times. Good data exists, via Fire Damage Report Number 1 (FDR1) reports, for attendance times to primary fires and their outcomes in terms of number of casualties. Other sources of information, such as brigade incident data, provide attendance time information for other types of incidents.

There is very little data about the effect of weight of attack on outcomes – indeed only limited data on the type of equipment used at primary fires (as opposed to that which was sent) is recorded on FDR1 reports. For other types of incidents no consistent data was found.

The approach adopted by the Fire Service Emergency Cover (FSEC) process has therefore been to concentrate on the effect of attendance times on risk. The weight of attack is defined via the Worst Case Planning Scenarios (WCPSs) and the requirements of the WCPS are assumed to be sufficient to deal with incidents in the area considered. Hence any effect of weight of attack has been ignored. This is an area where additional data collection and further research would be beneficial.

For Pathfinder purposes, attendance time is defined as:

> **The time from when the call taker has sufficient information to mobilise resources to when the resources arrive at the given address.**

This definition ignores call handling time and the time taken to begin firefighting and rescue after arrival at the scene, but includes the turnout time of appliances.

The calculation of attendance times by the FSEC includes many factors, such as:

- the road network
- variations in road speed by time of day
- turnout time of crews
- road speed of vehicles
- size of Enumeration Districts (EDs)

An explanation of the basic calculation can be found in Technical Paper K, Reference 9. The effect of attendance time was studied for the various toolkits.

# 2 DWELLINGS

The risk assessment process for dwellings counts the numbers of fires and casualties per head of the population in an area. A casualty for this purpose is defined as a fatality, an injury or a rescue. This is because it is expected that the ratio of fatalities to injuries and rescues will be determined by the attendance time of the fire service. If the fire service takes longer to respond to incidents in an area, it is expected that the number of fatalities would increase in relation to the total number of casualties.

Conversely, if the fire service responds quickly to incidents in an area then it can be expected that the number of fatalities would decrease. For example, for a Census Enumeration District (ED) with 350 residents, which has been assigned to a group (See Technical Paper B Section 2.2) which has a casualty rate of 1 casualty per 3000 residents then the number of casualties in the ED is given by:

$$350 \times 1/3000 = 0.1167 \text{ casualties.}$$

Hence the rate of casualty per person is used as the risk assessment and as the basis for the response time relationship shown in Figure E 1. This means that the number of casualties is independent of the response time of the fire service, and so is also independent of risk criteria and resourcing strategies, i.e. the number of casualties is assumed to stay constant, regardless of attendance time (no relationship between attendance time and casualty rate was found by Entec UK Ltd).

The number of dwelling fire fatalities predicted per annum for the Pathfinder areas is based upon the number of casualties (as derived above) and the attendance time of the brigade. The calculation of the number of fatalities is carried out at each ED, as both the casualty rate and the attendance time can vary between adjacent EDs. The attendance time of the brigade will naturally vary depending upon the type and location of appliances and the incidents they have to attend. However, the number of casualties that become fatalities is dependent upon attendance time, according to the relationships derived by Entec UK Ltd shown in Figure E 1 which comes from Technical Paper K, Reference 20.

This relationship was derived from an analysis of FDR1 fires in dwellings over 15 years and shows that a faster fire service response reduces the risk of death. This finding is intuitively right, but it is the first time that any such relationship has been derived. The figure also identifies levels of fire risk, where operational response alone cannot reduce the risk to tolerable levels. In these areas, a combination of fire prevention and operational response must be applied.

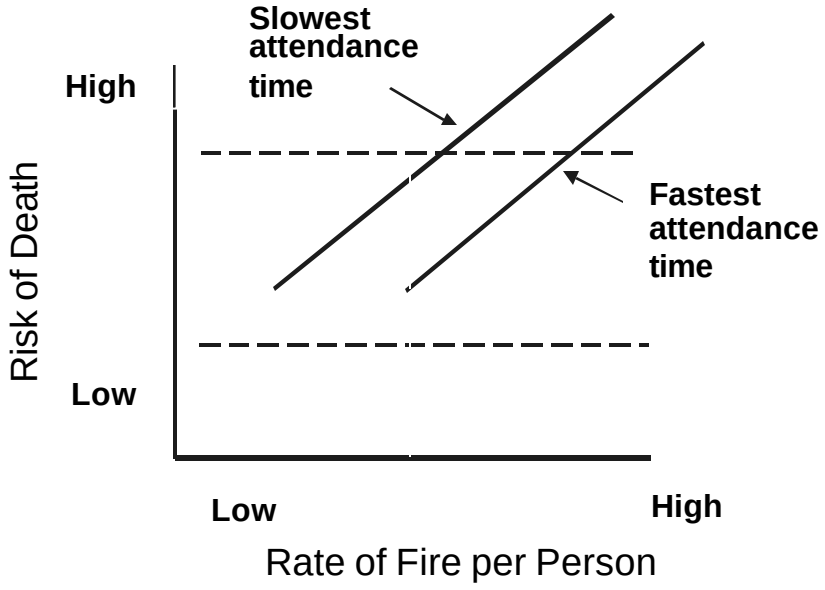


***Figure E 1: Relationship Between Attendance Time and Fatality Rate in Dwellings***

This relationship is summarised in Table E 1 below.

| Attendance time | Rate of fatality per casualty |
|---|---|
| <= 5 minutes | 0.038 |
| > 5 minutes and <= 10 minutes | 0.042 |
| > 10 minutes and <= 15 minutes | 0.055 |
| > 15 minutes and <= 20 minutes | 0.072 |
| > 20 minutes | 0.16 |

***Table E 1: Attendance Time Versus Rate of Fatality per Casualty***

So for the example ED above, 0.1167 casualties and an attendance time to the ED of 12 minutes for all time periods, this would give

0.1167 casualties x 0.055 = 0.006416 fatalities

The actual number of fatalities on an ED is the sum of the fatalities for each of the six four hour time periods, as the attendance time can vary between time periods. To derive the number of casualties in each time period, the total number of casualties is divided by 6.

Further work on the relationship between attendance time and dwelling fatality rates can be found in Technical Paper K, Reference 23.

# 3 SPECIAL SERVICES

Risk assessment of special services is carried out by simply counting the number of incidents, which occurred in an area per annum. This count is then shared amongst the EDs, which comprise the areas and groups, based upon geographic area. This can be unwieldy in some rural areas where EDs tend to be large for incidents such as Road Traffic Accidents, which tend to occur in very specific regions within the EDs. However, this may be resolved in the future by splitting EDs and by the introduction of the 2001 census data, which will have smaller EDs.

The number of fatalities predicted is based only on the number of Category A incidents – those where there is imminent risk to life. The response time relationship shown in Figure E 2 was derived from data relating to *emergency service* response to RTAs in the USA and elsewhere. At the time, no data was found to enable a relationship for *fire service* response in the UK for RTAs or any other type of special service incident to be derived. Hence the response time relationship, summarised in Table E 2, for RTAs was applied to all types of special service.

| Response Time (mins) | Fatality Rate per Category 'A' Incident |
|---|---|
| <10 | 0.025 |
| 10-20 | 0.075 |
| >20 | 0.1 |

***Table E 2: Response Time Relationship for RTAs***

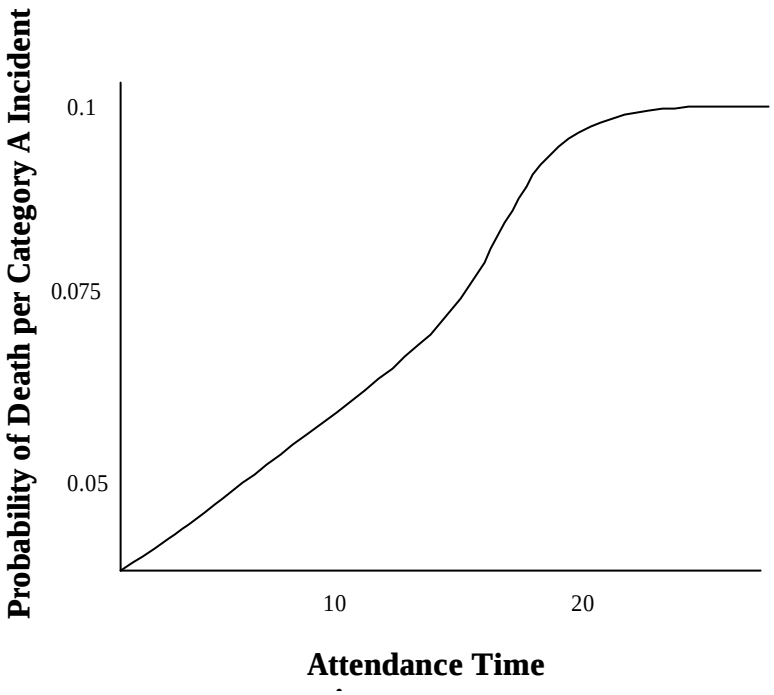


***Figure E 2 : Relationship Between Attendance Time and the Probability of Fatality for Road Traffic Accidents (for Category A Incidents)***

A study of vehicle fires and attendance times (Technical Paper K, Reference 32) found no clear relationship between fire brigade attendance time and fatalities.

# 4 OTHER BUILDINGS

There was very little data on which to establish a relationship between the attendance time of the fire service and the societal risk to life in other buildings because, fortunately, there are very few large fires that endanger life in such buildings. However, an empirical relationship was derived (Technical Paper K, Reference 30), based upon fire reports of a number of large fires, and is depicted in Figure E 3. This has been highlighted as an area where further work would be beneficial.

Relationships were also derived for the property damage caused in these buildings, by type of occupancy (Technical Paper K, References 21 and 8). These were derived from FDR1 statistics and insurance data and are depicted in Figure E 4. A relationship between attendance times and the losses associated with large heathland and woodland fires was also derived (Technical Paper K, Reference 29), although this was not implemented during the Pathfinder project. Again, more data and analysis post Pathfinder may provide better relationships.

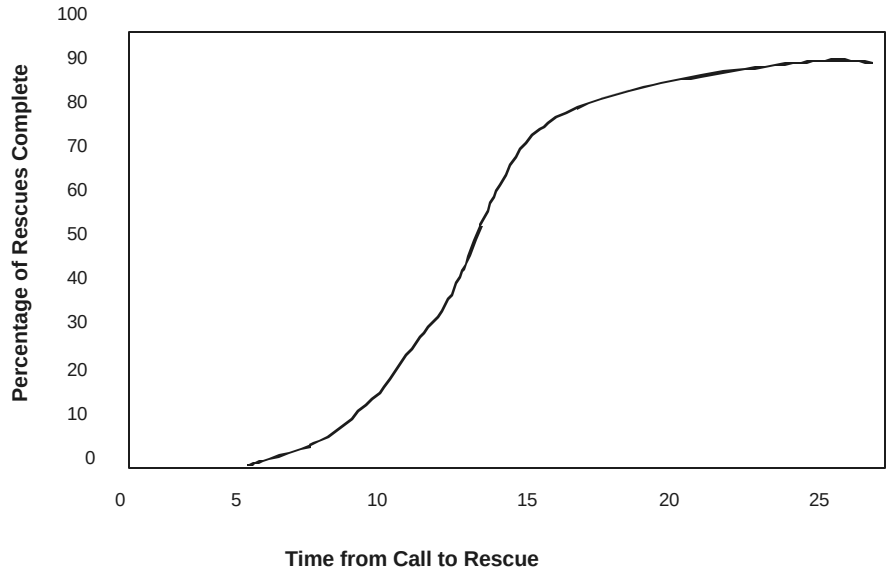


***Figure E 3: Relationship Between Attendance Time and The Percentage of Rescues Completed for Societal Risk Fires in Other Buildings***

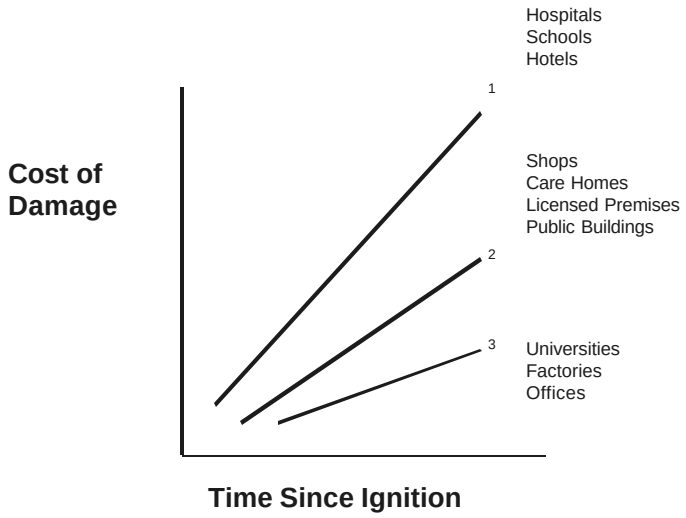


***Figure E 4: Relationship Between Time Since Ignition and Cost of Damage***

# 5 MAJOR INCIDENTS

Major incidents are very rare events and so no data could be found that could link the attendance time of the fire service to outcomes. Consequently the assessment of major incidents during Pathfinder is limited to the ability of the service to provide sufficient resources for WCPSs.

Further details on incorporating Major Incidents into FSEC can be found in Technical Paper K, Reference 17.