**Fire Cover Review**
**Pathfinder Trials Documentation**

# Major Incident
# Risk Assessment Toolkit

## Version 1.0

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The work described herein was carried out under contract to, but is not necessarily endorsed by, the Home Office.

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**ABSTRACT**

This document provides an explanation of how to assess the risk posed by major incidents, such as aircraft crashes and major flooding, and thence match fire service emergency response resources to this risk.  The aim is to ensure that low frequency incidents are accorded an appropriate weight within the planning of fire cover and that all reasonably practicable steps are taken to minimise loss of life and injury.

The 1992 Boeing 747 aircrash into high rise flats adjacent to Schipol airport - 43 deaths, 36 wounded and 266 apartments rendered uninhabitable.

When it came to planning for major disasters, this was regarded by Amsterdam emergency services as a relatively low priority issue - until the disaster happened.

**The 1988 Clapham Junction railway disaster.**

35 persons died and nearly 500 injured, 69 seriously. The rescue of 5 trapped casualties was long and difficult and involved delicate manoeuvring, lifting and cutting of wreckage.

The 1989 Boeing 737/400 aircrash on approach to East Midlands airport. 65 of the initial survivors lost consciousness or suffered lower limb injuries and would have died if the engine fire had not been contained by the emergency services.

# MAJOR INCIDENT RISK ASSESSMENT TOOLKIT

## MANAGEMENT SUMMARY

Rarely, if ever, does a year pass in the UK without a number of major incidents occurring. These incidents are often severe, involving dozens and occasionally hundreds of casualties. Whilst these incidents are relatively infrequent, compared with more common incidents such as Road Traffic Accidents and house fires, they nonetheless comprise an important part of the fire services emergency role. Experience has shown that the lives of dozens of casualties trapped at incidents is reliant on the actions of the fire services.

Due to the low frequency of these events it is often difficult to assess the risk based on local experience alone. Therefore, advice is given here on how to assess the risk posed by major incidents in a specific area by drawing on national and international experience. Advice is then given on how to assess the significance of this risk and whether it is reasonable, practicable and necessary to include a special response to particular incidents as part of "normal" fire cover.

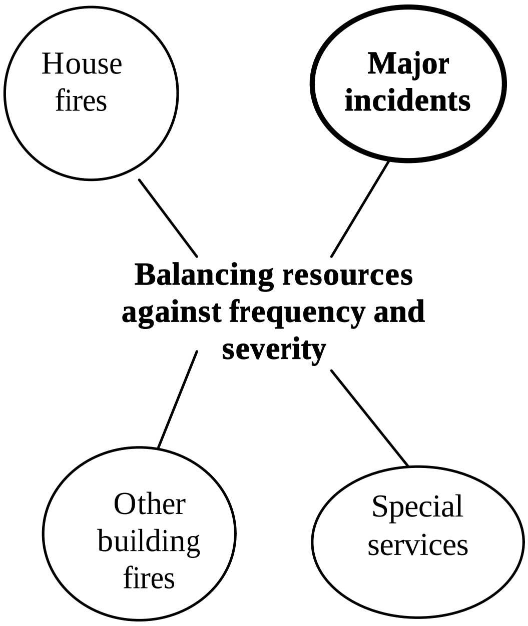
Information is provided on the frequency and scale of major incidents to assist in the completion of risk assessments and the review of local fire cover capabilities.

## CONTENTS

# 1 INTRODUCTION

## 1.1 Background

Recent experience indicates that there are about five major incidents per year in mainland UK, after excluding fires in buildings. These include incidents such as severe storms and floods, train crashes, terrorist bombs, aircraft crashes and ferry fires. These incidents can involve tens or even hundreds of fatalities and serious injuries and widespread damage and disruption. The scale of loss would be even greater but for the emergency services upon whom the safety of numerous injured and trapped persons has depended on many occasions. This experience highlights the importance of awarding an appropriate level of attention and resources to major incidents along side other categories of risk within the fire cover planning process.




Resources should be matched to the predicted frequency and severity of those major incidents to which it is reasonably practicable for the fire service to make an effective and timely response.

**A strategic assessment of risk is required**

It is inherently difficult to judge the frequency and severity of major incidents based on local experience alone, due to the relatively low frequency of major incidents within any one part of the UK. The absence of a particular type of major incident in any one fire authority area cannot be taken as proof that such an event is unlikely to happen.

On the other hand, it is unreasonable to suppose that fire authorities should maintain specialist resources for <u>very low</u> frequency major incidents. Therefore, a reliable estimate of risk is required to help judge whether the adequacy of current resources should be reviewed. To achieve this, the risk assessment may often need to draw on national and/or international experience, modified as appropriate to match local circumstances, to produce more reliable estimates of risk. Whilst the uncertainties within any such prediction must be recognised, most major hazards in the UK have been subject to risk assessment by one or another authority, such as the Civil Aviation Authority, whose results can be drawn on for the purpose of fire cover review. This is particularly true for those types of major incidents that are related to local activities, such as aircraft crashes around major airports, whose likelihood can be predicted to a reasonable degree of accuracy.

Accordingly, fire brigades should first identify what types of incidents may occur in their area, assess the frequency and severity of these incidents and match resources to the risk. The particular aim of major incident risk assessment is to examine the need for special resources to be included alongside “normal” fire cover. In principle, special resources may be needed in those areas where the following conditions are met:

- there is a significant likelihood of a major incident,
- the response to this incident requires the provision of special resources, and:
- the rescue operation is not wholly the responsibility of another agency or organisation.

## 1.2 Overview of risk assessment process

An overview of the risk assessment process is given in Figure 1. Exhibit 1 overleaf provides a listing of the types of issues covered by the risk assessment and Table 1.1 provides an overview of the format of results.

The first aim of the assessment is to identify locations where there is a significant likelihood of a major incident. Next a judgement should be made about the tolerability of the risk posed by the major incident and the need to mitigate this risk through the provision of emergency resources. Precedents about the tolerability of major incident risks have been set in the UK by regulatory and planning authorities. These precedents can be used as aids to decisions on whether it is reasonable to include contingencies for specific major incidents in fire cover. Clearly, account must also be taken of the ability to reduce losses through an emergency response. There are some cases where all persons involved in an incident are fatally injured at the outset, in which case the emergency response can only be expected to contain the incident.

**Will “normal” fire cover be sufficient?**

Upon identifying an area at particular risk of a major incident, the capacity to respond in a timely and effective manner to such an incident by the use of standard resources (those made available for “normal” fire cover purposes) should be reviewed, taking account of the capacity of other organisations, such as Airport Fire Services. As part of this review, information should be sought on the scale and nature of the incident, the timing of critical events and the hazards posed to persons involved in responding to the incident.

In those cases where standard resources cannot assure a timely and effective response to a significant major incident risk, consideration should be given to the inclusion of special resources within fire cover. A fixed national response standard has not been suggested for these incidents, allowing local flexibility on an issue where there is a high level of uncertainty. However, where the probable location of a major incident can be predicted, such as within 2 miles of a named airport, and the scale, timing and nature of the event can be profiled, it is suggested that the local fire authority should be able to determine the response time and capacity needed to minimise the loss of life and injury, and damage. Any national or international examples of "best practice" should be identified when reviewing response options and capacity. Also, as appropriate, the "golden hour" rule of thumb of facilitating the rendering of medical care within one hour of injury can be applied in reviewing the adequacy of resources and their location.

The main part of this document provides general guidance on how to match resources to major incident risk and how the response to such incidents can be taken into account when planning the disposition and type of resources within a fire brigade. Additional information is supplied in the Appendix's to assist with the completion of risk assessments.

**Figure 1: Overview of major incident risk assessment process.**

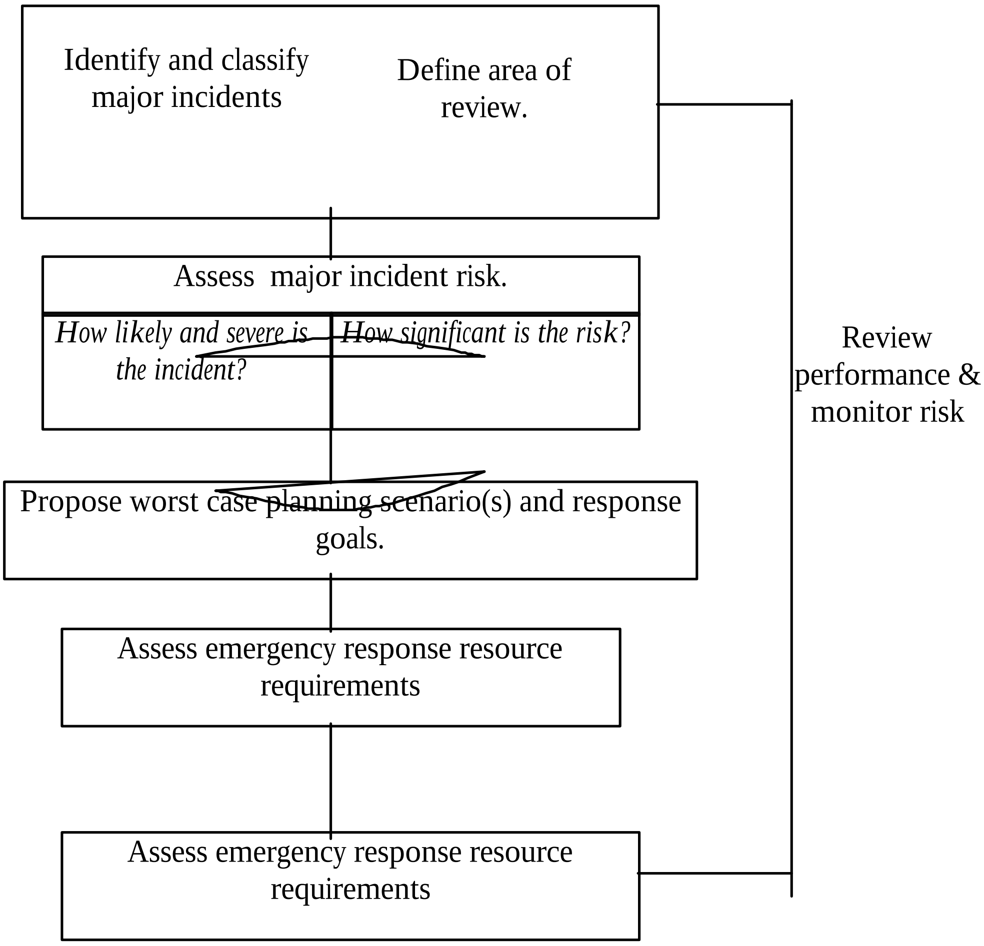



**Exhibit 1: Typical issues covered by major incident assessment**

1. What is the incident type and location(s)?

2. What is the predicted frequency of this incident within the surveyed area?

3. Approximately, how many casualties and how large an area may be involved?

4. What type of incident scenario(s) should the emergency response be designed for?

5. What is the response goal?

6. In what time does an effective fire and rescue operation need to have been mounted for (preventable) deaths to be averted, medical care to be rendered to mitigate critical injuries and the incident (e.g. fire spread) contained?

7. What fire and rescue roles will other agencies and organisations play?

8. What are the fire and rescue goals of the fire authority emergency response?

9. What are the key response tasks and target response time(s)?

10. What resources are required and where do they need to be located in order to achieve these tasks in the required time(s)?

**Table 1.1: layout of results of assessment for a single area.**

| Incident type | Risk category | Worst case planning scenario | Potential loss of life and property | Response goal | Response time | Fire service role and tasks | Resource needs |
|---|---|---|---|---|---|---|---|
| Railways | | | | | | | |
| Vehicles | | | | | | | |
| Ships | | | | | | | |
| Aircraft | | | | | | | |
| Bombs | | | | | | | |
| Flood | | | | | | | |
| HAZCHEM | | | | | | | |
| Other | | | | | | | |

# 2 RISK ASSESSMENT OF MAJOR INCIDENTS

## 2.1 Identification and classification of major incidents

For the purpose of fire cover review, all incidents which are likely to call on a similar range of skills, equipment and resources can be grouped together. However, events which demand significantly different response times due to variations in the speed of escalation or casualty survival times, should be considered separately, such as ferry engine room fires versus fires in common parts of passenger ferries, even where the emergency resources are the same. The aim here is to ensure that the positioning and mobilisation arrangements offer an appropriate response time in each case. For example, major incidents could be grouped as follows:

1. railway related incidents;

2. major vehicle incidents, such as coach crashes;

3. fires on passenger vessels;

4. passenger aircraft crashes in and around airports (excluding light aircraft);

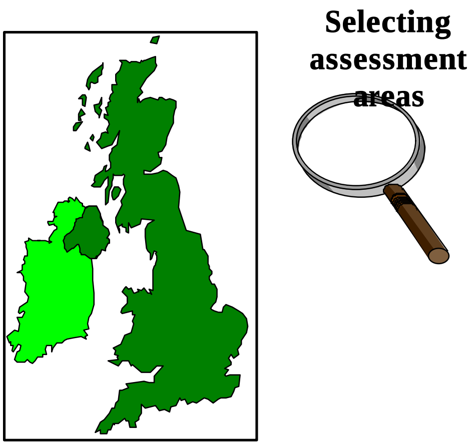
5. CIMAH site, COMAH site and HAZCHEM transport incidents, including cargo aircraft and military aircraft;

6. explosions and;

7. rapid widespread floods in populated areas.

## 2.2 Definition of geographic area included in assessment

It is possible, but not certain, that the resources mobilised to a major incident will be drawn from a number of points across a large geographic area. Similarly, the precise location at which certain types of major incidents may occur cannot always be predicted with confidence. Therefore, it is likely that an assessment of emergency cover for major incidents will need to take account of all of the resources available across large areas and the likelihood of incidents across the whole of these areas. The area to be included in the assessment should initially be defined, using professional judgement, according to "natural" geographic or resourcing parameters.




Two questions need to be asked in unison:

1. From what area are resources likely to be mobilised in response to the major incident?

2. In what area(s) may the incident occur?

Examples of "natural" boundaries may include:

- the group of (say) 10 fire stations nearest to a major airport from which the initial response would be drawn in event of an aircraft crash at or around the airport,

- the whole of a county, such as when incidents such as structural collapse of buildings may occur in any built-up area.

Similarly, sources of risk should be grouped together according to geographic and hazard characteristics. Some examples are given below:

- whole or parts of the London Underground Ltd railway network,

- all chemicals sites in Cleveland,

- both major airports in west London (Heathrow and Northolt),

- all shipping in Thames estuary,

- all shipping in Dover strait,

- all motorways and trunk roads in north Kent - presuming that the response would be mounted solely by north Kent resources,

- all flood prone areas in a brigade or region.

The area so defined is termed the "risk group". A risk group may comprise a number of "risk areas", such as each chemical site in Cleveland, or each section of motorway in Kent.

Whilst any special resources may ultimately be located in a few selected points the initial review should cover the whole of the defined risk group. Also, the geographic area (risk group) under consideration may change as the assessment advances, especially if it transpires that a more localised response capability is required for an effective and timely intervention to be mounted. This may only become apparent once the required response time and resources has been established by the subsequent stages of assessment.

## 2.3 Assessing the risk

This comprises two steps, namely:

1. How likely and severe is the incident?
2. How significant is the risk?

### 2.3.1 Step 1. What is the likelihood and severity of the major incident?

The frequency and severity assessment need only derive gross approximations.

"Is it likely to occur sometime in the next few years or decades"?

"Will there be tens or hundreds of casualties"?.

a ) Alternative methods

There are at least 3 ways in which an assessment can be made of major incidents, namely:

1. **Examination of local fire brigade records.** Some major incidents have occurred on a number of occasions in certain brigades, hence providing a historical record on which to assess risk. For example, there have been a sufficient number of railway incidents and major explosions in London to provide a recent historical record of major incident experience. However, in many cases an individual fire brigade may never have experienced a particular type of major incident.

2. **National and international records.** In those cases where a certain type of major incident occurs less frequently, the rate of incidents (such as rate of aircraft crashes per take off) can be estimated using national and international records, and then multiplied by the number of movements or sites in the local area to give a predicted risk. In many cases risk assessments have been completed of major incidents by other authorities, whose results can be interpreted for fire cover purposes. Data and guidance is available in the Appendices of this toolkit on the following types of major incidents:

   - transport related incidents, including ships, aircraft, trains, bus and coach incidents, and
   - major HAZCHEM, CIMAH site and COMAH site incidents
   - severe flooding,
   - structural failure incidents.

3. **Judgement.** The assessment of risk of certain major incidents may rely on judgement in some cases, such as;

   - where an event has yet to occur or is sufficiently rare to lack a reliable track-record,

- where past experience is not a reliable guide to the future, such as in the case of terrorist bombs or where circumstances have changed, such as a greatly increased attendance at a carnival, or;

- the activity in a brigade area may be unique or sufficiently different from similar activities elsewhere to prohibit the reading across of experience.

In particular, data is unlikely to be available to judge the likelihood of

- major crowd safety incidents at carnivals etc.,
- terrorist bomb risk (outside of major conurbation's),
- terrorist bomb risks at special events - such as one-off international political summits.

It could be argued that the successful completion of carnivals in Notting Hill Gate, Trafalgar square, Leeds and elsewhere over the past few decades provides some record of "risk". However, many hundred such events would need to have been completed without incident to confidently conclude that the possibility of a major crowd incident can be classed as negligible. Also, it would need to be accepted that there have been no changes in the circumstances, behaviour, scale and management of events which might have increased the possibility of a major incident, i.e. the absence of major incidents in the past is not always a reliable guide to future performance, particularly if circumstances have changed. Accordingly, in the absence of reliable information on the frequency of major incidents, reliance may need to be placed on "expert judgement" and/or review of "near-misses". This necessitates:

- gaining access to appropriate expert opinion, such as police assessment of terrorist risk, and

- gaining information on occurrence of near misses, such as occurrence of non-fatal crushing of people at major crowd events.

The judgement required is whether the frequency of a major incident is sufficiently high to warrant the provision (as needed) of special resources, training and contingency planning. For example, in the case of annual crowd events, such as carnivals, the judge need only determine if the likelihood of a serious incident is 1 in every 10 to 100 carnivals or much less than this. Occurrence of a single "near miss" in (say) the past 5 to 10 years would indicate a significant risk exists unless complete confidence can be placed in new precautions.

b ) Rating guidance and sources of information

Sets of simple guidelines for rating the likelihood of incidents are given in Table 2.1. The sources of information for applying these guidelines are identified in Table 2.2. Table 2.3 provides guidelines on the typical severity of incidents. However, in the case of chemical sites, a judgement is required of the scale of potential loss, using the guidance in Table 2.4.

Guidance has been developed for the more common types of major incidents for which data is available. Other types of major incidents should be assessed on a case by case basis using one or another of the approaches described in a. above.

## Table 2.1: Rating guidance for major incidents

| | Assigned major incident frequency | **Major vehicle incidents.** Rating guideline | **Railway major incidents** Rating guideline (per county or major sub-division of authority area) | **Aircraft** Rating guidelines | **Shipping** Calculate rate by multiplying number of ferries operating in area by 0.0025. |
|---|---|---|---|---|---|
| High | >1 in 10 per year | High volume of vehicle movements along over 100 miles of M-way and/or high speed regional A road. | 5 or more mainline railway termini or commuter/ intercity through routes and/or underground train lines.<br>7 or more significant incidents reported by HMRI each year. | Airports where likelihood of aircraft crash meets or exceeds 1 in 10 p.a. (as per total crash frequency on appended table) | Ports and shipping channels in UK waters where likelihood of uncontrolled fire on ferry or other vessel with dozens of persons exceeds 1 in 10 p.a. |
| Medium | Between 1 in 10 and 1 in 100 years | High volume of vehicle movements along between 10 and 100 miles of M-Way and/or high speed regional A road | 1 to 4 mainline railway termini or commuter/ intercity through routes and/or underground train lines.<br>1 significant incident every 2 years to 6 years reported by HMRI. | Airports where likelihood of aircraft crash is between 1 in 11 and 1 in 100 p.a. (as per total crash frequency on appended table) | Ports and shipping channels in UK waters where likelihood of uncontrolled fire on ferry or other vessel with dozens of persons is between 1 in 11 and 1 in 100 p.a.. |
| Low | Below 1 in 100 years | High volume of movements on less than 10 miles of M-Way and/or regional A roads. | No mainline railway termini or commuter/ intercity through routes and/or underground train lines - and less than 6 regional routes.<br>Less than 1 significant incident every 2 years reported by HMRI. | Airports where likelihood of aircraft crash is between 1 in 101 and 1 in 1000 p.a. (as per total crash frequency on appended table) | Ports and shipping channels in UK waters where likelihood of uncontrolled fire on ferry or other vessel with dozens of persons is between 1 in 101 and 1 in 1000 p.a. |

| | **Assigned major incident frequency** | **Floods** | **Bombs** | **Major HAZCHEM incidents** | |
|---|---|---|---|---|---|
| | | | | Rating guidelines | Rate of hazardous chemical incidents reported to HSE |
| High | >1 in 10 per year | An area with risk of flood greater than 1 in 100 years, that has either over 100 mobile homes/bungalows or many roads crossing rivers, over 400 multi storey houses and a few dozen mobile homes | Urban areas with high rise buildings and numerous economic and political targets. (eg centre of capital cities) | Highly industrialised area(s) of chemical works, factories and related transport activities; or<br>Length of route for transport of motor spirit from one or more fuel depots/manufacturing sites is 260km or more, or;<br>Over 800 km of LPG transport route.<br>2 or more top tier CIMAH sites | 7 or more serious hazchem incidents per county or brigade area, or:<br>1 or more <u>major</u> incident noted in local brigade fire reports in past 10 years. |
| Medium | Between 1 in 10 and 1 in 100 years | An area with risk of flood greater than 1 in 100 years, that has either (1) a few dozen mobile homes/bungalows or (2) many roads crossing rivers and over 400 multi storey houses. | Urban areas with high rise buildings and a few economic and political targets. (eg regional cities with high value commercial areas, military or political establishments of national importance) | Area(s) of normal mix of factories, hospitals and commercial activities - occasional gas holder and factory using chemicals or 1 top tier CIMAH site.<br>Length of route for transport of motor spirit from one or more fuel depots/manufacturing sites is 30 to 260 km, or;<br>100 to 800 km of LPG transport route. | 2 to 6 serious hazchem incidents per annum per county or brigade area, or:<br>1 or more <u>major</u> incident noted in local brigade fire reports in past 50 years. |
| Low | Between 1 in 10 and 1 in 100 years | An area with risk of flood greater than 1 in 100 years, that has no more than 10 or 20 mobile homes/bungalows, a few roads crossing rivers, and under 400 multi storey houses. | Rural and suburban areas lacking high rise or dense buildings. | Predominantly rural, residential or office based activities. No CIMAH sites.<br>Under 30km of motor spirit routing and under 100km of LPG routing. | 1 or less serious hazchem per annum per county or brigade area. |

**Table 2.2: Sources of information**

| Type of incident | Source of information |
|---|---|
| Railway incidents | HMRI for reports on Significant Incidents.<br><br>Fire brigade identification of local number of stations and length of high speed track.<br><br>Fire brigade reports on major railway incidents. |
| Airports | Appendix A of this report, and/or Civil Aviation Authority. |
| Vehicle incidents | Fire brigade estimation of length of high speed motorways and regional A roads.<br><br>Fire brigade reports on major vehicle incidents. |
| Shipping | Port authorities for number of ferries (including lorry ferries) catering for over 50 persons. |
| HAZCHEM | HSE reports of serious HAZCHEM incidents.<br><br>Fire brigade count of CIMHA/COMAH sites.<br><br>Information from local distributors/ manufacturers on length of routes for transporting LPG and/or motor spirit. |
| Bombs | Fire service judgement, informed by discussion with local police service. |
| Flood | Environment Agency. |
| Other | Local fire service judgement or other source identified by fire brigade. |

**Table 2.3: Typical severity of incidents**

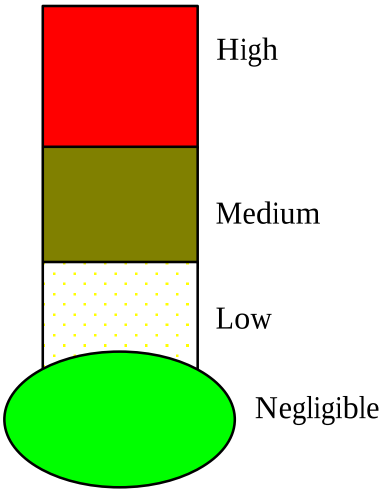
| Type of incident | Lives saved and other benefits of intervention | Comments |
|---|---|---|
| Aircraft | Typically 50 to 100, depending on size of aircraft and mode of crash. | Assume 50 rescues on average to allow for catastrophic incidents |
| Railways | Varies from under 5 to hundreds depending on mode of incident. | Assume an average of 10 lives saved (or their equivalent number of injuries/assisted persons). |
| Shipping (passenger ferries) | Varies from under 10 to dozens or even hundreds depending on passenger numbers. | Fraction of passenger loading on local ferries- say 50% or 50 per incident for large passenger ferries. |
| M-Ways | 6 to 36 | Assume 20 lives saved on average for purpose of fire cover review |
| Flood | 2 to 5 rescues if no mobile homes.<br><br>Dozens of rescues if mobile homes in flood zone. | Assume 25 if mobile homes at risk, or 1% of people in permanent houses in flood zone. |
| Bombs/structural failure | Under 10 to hundreds depending on warning, building hit and strength of blast. | Assume 10 to allow for minimisation of disruption as well as rescues. |
| HAZCHEM | Varies according to site size and type. | Base value on type of site or road transport incident concerned, using equivalence scale. |

**Table 2.4**: **Rating scale for severity of major incidents**

| Lives saved | Persons assisted from traumatic events (e.g. assist evacuation of trains stuck in tunnels) | Aversion of damage and disruption | Equivalent financial value |
|---|---|---|---|
| - | 10 | Clean up minor hazchem spill (~100kgs) on public highway. | £10,000 |
| - | 100 | Clean up major hazchem spill on motorway or other high volume highway (such as commuter route). | £100,000 |
| 1 | 1000 | Prevent uncontrolled fire spread across chemicals warehouse or factory using chemicals. | £1m |
| 2 to 5 | 1000 to 5,000 | - | £3.5m |
| 6 to 10 | 5,000 to 10,000 | Prevent uncontrolled fire spread across lower tier CIMAH site or NISH site. | £8m |
| 11 to 50 | >10,000 | Prevent uncontrolled fire spread across top tier CIMAH site | £30m |
| 51 to 100 | - | - | £75m |
| Over 100 | - | | £150m |

2.3.2 Step 2: How significant is the risk?

The provision of special resources should be considered where the expected likelihood of an event is high. The significance of a major incident risk can be assessed in absolute and relative terms against a number of criteria or benchmarks, some of which have been codified below. A major incident risk may be considered significant if it satisfies one or more of these criteria.




**Gauging risk**

These criteria have been condensed in Exhibit 2.

**Exhibit 2: Risk criterion**

**It is reasonable to classify any type of major incident (which has the potential to cause ten or more deaths) that is predicted to occur (within a brigade or a division of a brigade) about:**

- **once every 10 years to be high,**
- **incidents predicted to occur every 100 years to be medium risks;**
- **between once every 101 and 1000 years as low risk, and;**
- **below 1 in 1,000 years as negligible.**

Typically, where risk is high or medium, the authority should aim to ensure resources are available to provide a timely response to potential incidents in the study area. However, if the risk is low or negligible, then it is reasonable to rely of resource provided for other types of incidents. Thus, specialist resources should be considered only in the case of medium or high risk areas.

(i ) UK regulatory precedents

The risk posed by one type of major incident can be compared against criteria applied to other types of major incidents. These criteria can act only as guidelines as there are no statutory obligations on fire authorities to meet these criteria through provision of fire cover, especially as the statutory duty to meet these criteria rests primarily with those organisations responsible for the activities creating the risk. The precedents are:

- the Health and Safety Executive set an upper limit of tolerability of 1 in 100 years (beyond which any risk is said to be intolerable) for any incident at a port causing 10 or more deaths in their study of transport of hazardous materials,

- the Channel Tunnel is required to have a special first response fire capability for a predicted major fire risk of one or two events every 50 years.

- the National Air Traffic Safety centre (part of the CAA) regard the risk around the top 20 airports to be high enough to justify declaring Public Safety Zones around these airports. The likelihood of a major aircrash at each of these airports ranges from about 1 in 100 years to 1 in 10 years.

The predicted frequency at which an event will be tolerated decreases proportionately as the number of predicted deaths increases. In particular, the HSE has applied an upper limit of 1 in 1000 years per port for predicted events, such as explosions, causing over 100 deaths.

The HSE guidelines above denote the maximum risk which can be considered tolerable. Risks which fall below this level can be regarded to be just tolerable. However, in accordance with local discretion and cost-effectiveness considerations, an authority may wish to make provision for less likely incidents to ensure risk remains within limits of tolerability, especially where the consequences are particularly severe.

It should also be noted that the safety requirements for aircraft, CIMAH sites, railway operations, and HAZCHEM transport public are set in accordance with the results of risk assessment. The assessments of risk usually assume (if implicitly) that an effective (life saving) emergency response will be mobilised. For example, railway risk assessments assume, implicitly, that persons with non-fatal injuries trapped in derailed trains will be extricated. In these cases the continued achievement of safety standards may depend on the provision of a major incident capability.

(ii ) Comparison against building fire risk.

Is the likelihood of the major incident considered to be approximately the same or greater than the likelihood of a major building fire or other type of major incident for which fire cover is provided?

**If this risk was posed by fires in buildings would fire cover be provided?**

In this case the provision of fire cover for "normal" fire risks is used as a precedent for determining whether the likelihood of the major incident can also be considered to be "normal", i.e. if it is considered reasonably practical to provide cover for a major building fire of a certain likelihood and severity, then it is also reasonable to provide cover for other incidents of similar likelihood and severity. This may entail comparing, by judgement or statistically, the likelihood of major incidents in an area with the likelihood of other incidents across the area from which a response will be mobilised. If possible, the historical frequency of other types of major fires and incidents in the surveyed area should be compared with the predicted frequency for the major incident in question.

This criteria is a useful guide where the area under consideration has a broad range of significant risks from which precedents can be drawn. However, this approach may not be applicable where there is an isolated special risk or where the surrounding building fire risk is low or negligible, i.e. where there are no significant risks against which to draw comparisons.

(iii ) Comparison against operating life

May the incident occur within the operating life of standard emergency resources, i.e. 20 to 30 years? In this case it is reasonable to assume that an emergency response will be mobilised to the incident at some point in the career of the local personnel and hence they should be capable of mounting an effective response.

# 3 DEFINING RESPONSE REQUIREMENTS

## 3.1 Define worst case planning scenario(s).

**What is the worst case scenario that should be planned for?**

As a rule, one or more "worst case planning scenario" should be defined for all incidents assessed as posing a high or very high risk, i.e. all major incidents predicted to occur at least once every 100 years. Lower frequency scenarios should only be used if their consequences are particularly severe (i.e. 100 or more casualties reliant on the fire service for survival).

Information on the scale and nature of past incidents of the same type in the UK and/or abroad should be used for this purpose, modified as necessary to take account of any recent technological developments or local peculiarities. Information is required regarding:

- the number of persons whom are likely to be injured or otherwise requiring assistance,
- casualty survival times,
- the physical scale of the event,
- approximate timing of critical events, such as time for fire to flash over,
- hazards.

A set of scenarios is given in Table 3.1 for the more common types of incidents. Further information on these incidents is given in the Appendices.

## Table 3.1: Typical worst case planning scenarios

| Type of incident | Worst case planning scenarios | Comments |
|---|---|---|
| Aircraft | Passenger aircraft lands in built up area with numerous incapacitated passengers trapped, with potential aviation fuel fire and secondary ground fires. | Apply to airports in/near to towns/cities. |
| | Passenger aircraft lands in field with numerous casualties and small fuel fires. | Apply to out of town airports. |
| Railways | Derailed or collided trains with dozens injured persons, 10 or more trapped. | Apply to above ground incidents. |
| | Hundreds or thousands of passengers requiring assistance | Apply to below ground incidents. |
| Shipping (passenger ferries) | Fire in common areas of passenger ferry with dozens exposed to smoke, with fire and smoke spreading through passenger areas. | Apply to all passenger ferries with over 50 persons on board. |
| M-Ways | Coach load of elderly persons trapped in overturned or otherwise severely damaged coach. | Apply to all cases. |
| Flood | • Dozens of persons in mobile homes at imminent risk of being swept away.<br>• 3 or 4 persons trapped in vehicles at different locations around county | Size of incident to be determined locally. |
| Bombs/structural failure | Two or three severely damaged buildings, numerous gas leaks and small fires, few persons trapped in rubble. | Size of incident to be determined locally. |
| HAZCHEM | • Road tanker spillage of flammable or toxic chemicals in built up area - with other vehicles involved, requiring rescue and fire control.<br>• Fire or toxic leak onsite - precautionary offsite evacuation required along with fire control. | Only consider non-vehicle casualties in built-up areas. |

## 3.2 Define response goal(s)

Having characterised the incident, a response goal should be defined. Definition of the goal will depend, in part, on the feasibility of averting casualties, as influenced by the survivability of the incident. Other important considerations include:

- the feasibility of reducing losses using current technology,
- the state of knowledge about the risk and whether it is reasonable to expect that it can be assessed and planned for, and
- "ownership" of the risk.

**What can reasonably be expected of an emergency response?**

It is unreasonable to expect a specialised response to be included in fire cover where, despite reasonable efforts on the part of relevant authorities, the necessary equipment and knowledge has not been developed and/or there is minimal understanding of a hazard amongst scientific, industrial and government bodies.

In answering this question account should be taken of latest "best available technology" both nationally and internationally, including consideration of the types of appliances and procedures applied by other organisations - and should not be restricted to consideration of what can be achieved with the resources currently held by the authority.

However, where provision for major incidents places an undue burden on the local authority, the option of securing special resources from the parties responsible for the risk should be considered, as should the option of requiring the responsible party to make the initial response to the incident - as in the case of aircraft crashes at or around airports.

Accordingly, a number of response goals are possible, such as:

- minimise the loss of life and injury amongst persons involved in the primary incident and contain the incident,
- augment response mounted by the organisation which has the primary responsibility for the emergency response, or;
- prevent casualties outside the initial area affected and contain the incident.

**Fire cover is not the only option.**

Also, fire cover is not a substitute for proper risk management and where the likelihood of a major incident is very high reliance should not be placed on emergency cover alone to keep the risk within tolerable levels. Thus, in the broadest sense, options include:

1. No additional emergency resources required due to low risk or impracticality of rescuing casualties.

2. Provision and mobilisation of special resources by the fire authority.

3. Provision and mobilisation of special resources by another agency or organisation.

4. Provision of special resources by another agency or organisation, mobilised by local fire authority.

5. Requests to organisation(s) or regulator responsible for hazard under consideration for additional preventive works.

The latter option should be given special attention where the cost of emergency cover is disproportionate to the cost of prevention.

A combination of the above is also possible.

### 3.3 Define emergency response needs

**Are special resources required to achieve the response goal?**

For the purpose of assessing the need for special training and equipment, a judgement should be made as to whether the generic skills, experience and equipment supplied for the purpose of "normal" fire cover of dwellings and factories etc., and the location of these resources, would be sufficient to achieve the stated response goal.

A statement should first be made of likely emergency response requirements against which the adequacy of existing resources can be compared. The statement should cover the following points:

- main emergency tasks to be performed by the fire authority,
- skills and knowledge needed by first attendance crews and other crews,
- special tactics and procedures,
- special equipment needs,
- special (incident specific) response time and (as appropriate) extrication time standards,
- resource location and mobilisation arrangements required for target response time to be achieved.

The following points should be considered when judging whether standard fire cover resources and their disposition would allow the stated response goals to be satisfied.

1. In what time is a response required for survivors to be rescued and the incident contained effectively? In answering this question regard needs to be given to:

- the survival times of casualties,
- the speed with which critically injured persons, including casualties trapped or confined in inaccessible places, need to receive medical attention,
- the rate at which the incident may escalate, such as rate of fire spread,
- in what interval would assistance from the local fire brigade be required by other agencies? (such as airport fire service or by the ship's crew in case of ferry fires)

2. What level of response is required to handle the predicted scale and nature of the hazards? For example,
    - how much fuel may be involved in an aircraft fire?
    - what types of cargoes are carried in the case of an aircrash?
    - what size of area would be damaged in the event of an explosion in a city centre?
    - how many persons may need to be extricated from wreckage?
3. What is the probable location(s) of such incidents?
4. What tasks will other organisations handle? What tasks remain for the local fire authority?
5. Are there any special hazards to fire fighters and other emergency personnel in areas managed by the fire service?

These questions have been elaborated on in the context of aircraft and shipping incidents in Appendix A. The appendix also lists examples of other types of incidents, such as railway incidents, on which it would be reasonable to profile scenarios and assess resource needs.

## 4 MONITORING AND REVIEW

As with all other areas of fire cover the adequacy of major incident resources and plans should be regularly reviewed and updated in line with changes in risk. However, it is possible that, due to the infrequency of major incidents, there will be an absence of actual incidents on which to assess performance or the level of risk in a particular area. Therefore, the review of response capability will probably depend on:

1. Exercises, and
2. Desk top comparisons of resources against the experience of other services who have experienced a major incident in the UK or abroad.

The monitoring of risk is likely to depend on the review of risk assessments completed by other agencies with responsibilities for each type of risk. For example, the CAA maintain records of aircrashes and the number of aircraft movements at airports, and should be able to advise on whether there have been any significant changes in risk. Similarly, the organisations, such as CIMAH sites and railway companies, are required to resubmit risk assessments to the Health and Safety Executive when ever there is a material change in their operations.

The continued review of response capabilities and risk should assure that an appropriate major incident resource is maintained.

# Annex A: Transport related incidents

## A.1. Airport related aircraft crashes.

### A.1.1 Introduction

The key issue is whether the combined resources of the local fire authority, airport fire service and other emergency response organisations would be able to minimise the number of "preventable" deaths amongst passengers and residents in the event of an aircrash. Deaths which occur at the moment of impact or prior to alert of the emergency services may, for the purpose of emergency response review, be excluded from the definition of preventable deaths - assuming there is no delay in the communication of the fire alert once issued by the aircraft.

Given that the location of these incidents can be predicted, i.e. typically within 2 kilometres of the airport, consideration should be given to ensuring:

- that resources are capable of making an effective initial response to such an incident in this area, and;

- that resources are available to mount a major extrication exercise in time to secure survival and minimise suffering of persons who survive the impact.

The timing of critical events, such as survival times of persons trapped in aircraft (both those on fire and those not on fire), and the availability of third party assistance (such as airport fire service) should be considered when determining the type and location of special resources and the feasibility of defining local major incident response time standards.

### A.1.2 Likelihood

Guidance is provided on the predicted frequency of airliner incidents in the UK. Aero club, private aircraft, military combat aircraft, military airports, military vessels and fishing vessels are <u>excluded</u> from this analysis. A major incident is taken here to include:

- uncontrolled fire on an aircraft of sufficient scale to cause major loss of life without immediate evacuation and/or emergency service intervention,

- uncontrolled (or partially) controlled impact of an aircraft - such that persons on board or in impacted areas are at imminent risk of harm in the absence of emergency assistance

The rate of incidents per movement (each landing or take-off counts as a movement) has been estimated by first calculating the rate of major incidents across the UK, and across western Europe and North America in the case of aircraft incidents. This gives a total aircraft crash frequency of $2.4 \times 10^{-7}$ per movement (1 in 420,000 movements) and an off-airport crash frequency of $1 \times 10^{-7}$ per movement, i.e. there is an approximately 50:50 likelihood of the incident occurring beyond the airport boundary fence. The per movement crash frequency has then been multiplied by the number of aircraft movements at each UK airport to derive predictions of the frequency of incidents.

Clearly the frequency of major incidents cannot be predicted with a high degree of certainty, especially as past experience is not always a reliable guide to future performance. Therefore, account should be taken of the possibility that the frequency of major incidents will be higher than the predicted frequency. This is especially true where the numbers of persons at risk are greater, demanding a precautionary approach to contingency planning. This is accounted for, in the case of aircraft incidents, by providing a range of incident frequencies, including a "best" estimate and a higher more precautionary estimate of incident frequency.

The likelihood of incidents on or near civil airports has been assessed (as of 1997), with the results shown in Table A.1. The calculation of these frequencies is illustrated in Exhibit A.1. Four frequencies are given in Table A.1, namely:

- an estimate of the frequency of large passenger and cargo aircraft crashes or uncontrolled fires on or off the airports,

- a best, an optimistic and a pessimistic estimate of the frequency of aircraft crashes offsite

Thus, for example, it is predicted that:

- there will be one aircraft crash or major fire on or around Edinburgh airport once every 18 to 55 years.

- there will be one aircraft crash off-airport at Edinburgh airport once every 44 to 395 years - with a "best" estimate of 1 in 132 years. Off-airport may be taken to typically be within 2 kilometres of the ends of the runways and up to 1 kilometre of the runway centreline.

The best estimates of crash frequency are considered to be the most accurate estimate for larger international airports, such as Heathrow and Gatwick. The pessimistic incident frequencies may be more accurate guides to the incident frequencies at smaller airports, especially for turbo-prop aircraft at smaller airports.

**Exhibit A.1: Worked Example of Crash Frequency Calculation**

Taking Edinburgh airport as an example, the total (i.e. on and off-airport crashes) frequency of an aircraft crash associated with the airport is given by:

*crash frequency per movement x no. of movements per year*

= $2.4 \times 10^{-7}$ x 75984 = $1.82 \times 10^{-2}$ per year, i.e about once every 55 years.

The frequency of off-airport crashes associated with the airport is given by:

*off-airport crash frequency per movement x no. of movements per year*

= $1 \times 10^{-7}$ x 75984 = $7.6 \times 10^{-3}$ per year, i.e. approximately once every 132 years.

Sensitivity analysis has been carried out for the off-airport crash frequency based on a sensitivity factor of 3. Therefore the "optimistic" frequency of off-airport crashes is obtained by dividing the off-airport crash frequency by 3 giving:

$(7.6 \times 10^{-3})/3$ = $2.53 \times 10^{-3}$ per year, i.e. approximately once every 395 years.

The anticipated "pessimistic" frequency for off-airport crashes is obtained by multiplying the off-airport crash frequency by 3 giving:

3 x $7.6 \times 10^{-3}$ = $2.28 \times 10^{-2}$ per year, i.e. approximately once every 44 years.

Thus, the likelihood of a crash off-airport is in the order (after rounding) of 1 in 40 to 1 in 400 years. As the areas adjacent to the ends of the runway are largely uninhabited, casualties are likely to be confined to passengers, probably just under 100 given the typical size of aircraft at a regional airport. With a risk criteria of 1 in 100 years for major incidents, this level of risk is on the borderline of tolerability, especially if account is taken of the higher rates of crashes amongst turbo-prop aircraft that use regional airports and the likelihood of close on 100 casualties. Thus, a review of emergency response capability is warranted.

| | AIRPORT | (Movements per year) TOTAL | Total excluding aero club & private | Crash frequency Total on or off airport per year | Total (1 crash every X years) | Off-Airport per year | (1 offsite Crash Every X Years) Best estimate | Optimistic | Pessimistic |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Heathrow | 440343 | 434671 | 1.04E-01 | 10 | 4.35E-02 | 23 | 69 | 8 |
| 2 | Gatwick | 221810 | 220162 | 5.28E-02 | 19 | 2.20E-02 | 45 | 136 | 15 |
| 3 | Manchester | 163866 | 151181 | 3.63E-02 | 28 | 1.51E-02 | 66 | 198 | 22 |
| 4 | Aberdeen | 107637 | 94973 | 2.28E-02 | 44 | 9.50E-03 | 105 | 316 | 35 |
| 5 | Stanstead | 95531 | 86594 | 2.08E-02 | 48 | 8.66E-03 | 115 | 346 | 38 |
| 6 | Birmingham | 96265 | 83110 | 1.99E-02 | 50 | 8.31E-03 | 120 | 361 | 40 |
| 7 | Glasgow | 91783 | 82968 | 1.99E-02 | 50 | 8.30E-03 | 121 | 362 | 40 |
| 8 | Edinburgh | 98809 | 75984 | 1.82E-02 | 55 | 7.60E-03 | 132 | 395 | 44 |
| 9 | Belfast International | 92985 | 73790 | 1.77E-02 | 56 | 7.38E-03 | 136 | 407 | 45 |
| 10 | Newcastle | 80438 | 53888 | 1.29E-02 | 77 | 5.39E-03 | 186 | 557 | 62 |
| 11 | Guernsey | 63439 | 52377 | 1.26E-02 | 80 | 5.24E-03 | 191 | 573 | 64 |
| 12 | Jersey | 86814 | 51715 | 1.24E-02 | 81 | 5.17E-03 | 193 | 580 | 64 |
| 13 | Prestwick | 60738 | 49179 | 1.18E-02 | 85 | 4.92E-03 | 203 | 610 | 68 |
| 14 | East Midlands | 68173 | 45537 | 1.09E-02 | 92 | 4.55E-03 | 220 | 659 | 73 |
| 15 | Liverpool | 81916 | 45074 | 1.08E-02 | 92 | 4.51E-03 | 222 | 666 | 74 |
| 16 | Luton | 56241 | 43513 | 1.04E-02 | 96 | 4.35E-03 | 230 | 689 | 77 |
| 17 | Belfast City | 40509 | 39374 | 9.45E-03 | 106 | 3.94E-03 | 254 | 762 | 85 |
| 18 | Exeter | 41908 | 35484 | 8.52E-03 | 117 | 3.55E-03 | 282 | 845 | 94 |
| 19 | Coventry | 54701 | 33591 | 8.06E-03 | 124 | 3.36E-03 | 298 | 893 | 99 |
| 20 | Cambridge | 56067 | 32958 | 7.91E-03 | 126 | 3.30E-03 | 303 | 910 | 101 |
| 21 | Bristol | 54098 | 31233 | 7.50E-03 | 133 | 3.12E-03 | 320 | 961 | 107 |
| 22 | Leeds Bradford | 51426 | 29713 | 7.13E-03 | 140 | 2.97E-03 | 337 | 1010 | 112 |
| 23 | Southampton | 51338 | 29580 | 7.10E-03 | 141 | 2.96E-03 | 338 | 1014 | 113 |
| 24 | Norwich | 42710 | 29063 | 6.98E-03 | 143 | 2.91E-03 | 344 | 1032 | 115 |
| 25 | London City | 27059 | 26821 | 6.44E-03 | 155 | 2.68E-03 | 373 | 1119 | 124 |
| 26 | Sumburgh | 25293 | 25148 | 6.04E-03 | 166 | 2.51E-03 | 398 | 1193 | 133 |
| 27 | Cardiff Wales | 59351 | 24416 | 5.86E-03 | 171 | 2.44E-03 | 410 | 1229 | 137 |
| 28 | Isle of Man | 34922 | 23601 | 5.66E-03 | 177 | 2.36E-03 | 424 | 1271 | 141 |
| 29 | Plymouth | 29591 | 18041 | 4.33E-03 | 231 | 1.80E-03 | 554 | 1663 | 185 |
| 30 | Teesside | 57527 | 17439 | 4.19E-03 | 239 | 1.74E-03 | 573 | 1720 | 191 |
| 31 | Humberside | 34673 | 14974 | 3.59E-03 | 278 | 1.50E-03 | 668 | 2003 | 223 |
| 32 | Inverness | 26776 | 13572 | 3.26E-03 | 307 | 1.36E-03 | 737 | 2210 | 246 |
| 33 | Carlisle | 26386 | 13546 | 3.25E-03 | 308 | 1.35E-03 | 738 | 2215 | 246 |
| 34 | Bournemouth | 95806 | 12691 | 3.05E-03 | 328 | 1.27E-03 | 788 | 2364 | 263 |
| 35 | Isles of Scilly (St Mary | 12488 | 11533 | 2.77E-03 | 361 | 1.15E-03 | 867 | 2601 | 289 |
| 36 | Alderney | 13991 | 10205 | 2.45E-03 | 408 | 1.02E-03 | 980 | 2940 | 327 |
| 37 | Kirkwall | 11630 | 9642 | 2.31E-03 | 432 | 9.64E-04 | 1037 | 3111 | 346 |

| | | | | | | | SENSITIVITY ASSESSMENT FOR OFF-AIRPORT CRASHES | | |
|---|---|---|---|---|---|---|---|---|---|
| | | (Movements per year) | | Crash frequency | | | (1 offsite Crash Every X Years) | | |
| | AIRPORT | TOTAL | Total excluding aero club & private | Total on or off airport per year | Total (1 crash every X years) | Off-Airport per year | Best estimate | Optimistic | Pessimistic |
| 38 | Blackpool | 45140 | 9231 | 2.22E-03 | 451 | 9.23E-04 | 1083 | 3250 | 361 |
| 39 | Shoreham | 71228 | 8557 | 2.05E-03 | 487 | 8.56E-04 | 1169 | 3506 | 390 |
| 40 | Southend | 57361 | 7624 | 1.83E-03 | 547 | 7.62E-04 | 1312 | 3935 | 437 |
| 41 | Stornoway | 7780 | 7458 | 1.79E-03 | 559 | 7.46E-04 | 1341 | 4023 | 447 |
| 42 | Battersea Heliport | 10757 | 6434 | 1.54E-03 | 648 | 6.43E-04 | 1554 | 4663 | 518 |
| 43 | Gloucestershire | 76385 | 6046 | 1.45E-03 | 689 | 6.05E-04 | 1654 | 4962 | 551 |
| 44 | Wick | 6935 | 5825 | 1.40E-03 | 715 | 5.83E-04 | 1717 | 5150 | 572 |
| 45 | Penzance Heliport | 5529 | 5509 | 1.32E-03 | 756 | 5.51E-04 | 1815 | 5446 | 605 |
| 46 | Londonderry | 10184 | 4821 | 1.16E-03 | 864 | 4.82E-04 | 2074 | 6223 | 691 |
| 47 | Lydd | 21800 | 4718 | 1.13E-03 | 883 | 4.72E-04 | 2120 | 6359 | 707 |
| 48 | Scatsta | 4461 | 4455 | 1.07E-03 | 935 | 4.46E-04 | 2245 | 6734 | 748 |
| 49 | Benbecula | 3661 | 3543 | 8.50E-04 | 1176 | 3.54E-04 | 2822 | 8467 | 941 |
| 50 | Dundee | 42671 | 3245 | 7.79E-04 | 1284 | 3.25E-04 | 3082 | 9245 | 1027 |
| 51 | Hawarden | 10384 | 2923 | 7.02E-04 | 1425 | 2.92E-04 | 3421 | 10263 | 1140 |
| 52 | Lerwick (Tingwall) | 2582 | 2568 | 6.16E-04 | 1623 | 2.57E-04 | 3894 | 11682 | 1298 |
| 53 | Islay | 2678 | 2114 | 5.07E-04 | 1971 | 2.11E-04 | 4730 | 14191 | 1577 |
| 54 | Biggin Hill | 92624 | 1971 | 4.73E-04 | 2114 | 1.97E-04 | 5074 | 15221 | 1691 |
| 55 | Bembridge | 9164 | 1851 | 4.44E-04 | 2251 | 1.85E-04 | 5402 | 16207 | 1801 |
| 56 | Unst | 1786 | 1786 | 4.29E-04 | 2333 | 1.79E-04 | 5599 | 16797 | 1866 |
| 57 | Isles of Scilly (Tresco) | 1468 | 1458 | 3.50E-04 | 2858 | 1.46E-04 | 6859 | 20576 | 2286 |
| 58 | Campbeltown (c) | 1454 | 1322 | 3.17E-04 | 3152 | 1.32E-04 | 7564 | 22693 | 2521 |
| 59 | Barra | 1316 | 1286 | 3.09E-04 | 3240 | 1.29E-04 | 7776 | 23328 | 2592 |
| 60 | Kent International | 14097 | 937 | 2.25E-04 | 4447 | 9.37E-05 | 10672 | 32017 | 3557 |
| 61 | Tiree | 1017 | 878 | 2.11E-04 | 4746 | 8.78E-05 | 11390 | 34169 | 3797 |
| 62 | Barrow-in-Furness | 1702 | 160 | 3.84E-05 | 26042 | 1.60E-05 | 62500 | 187500 | 20833 |
| | **TOTAL** | | 2224061 | 5.34E-01 | 2 | 2.22E-01 | 4 | 13 | 1 |

### A.1.3. Worst case planning scenarios

As discussed below:

- there is a high likelihood of large numbers of passengers surviving the initial stages of an incident,

- there is an approximately 50:50 chance of a crash occurring off-airport, and;

- off-airport crashes are typically within 2 kilometres of the ends of the runways and up to 1 kilometre either side of the runway centreline.

CAA records of major and minor aircrashes in the UK for the period 1980-1997 give thirteen incidents. In nine of the thirteen major aircraft incidents (at or near airports) a large proportion of passengers and crew survived, mainly due to emergency service intervention. In the remaining four cases all persons on board died on impact and/or in the ensuing fire. Key details of selected cases are given in Table A.2. In addition, it is worth noting that at the 1997 crash of a 747 approaching Guam, the emergency services, who took some tens of minutes to reach the scene 3 miles from the airport, were still able to pull some survivors from the plane before the plane and remaining passengers were consumed by fire. Similarly, the survival of 65 trapped passengers at the 1989 Kegworth aircraft crash was assured by the extinction of a fuselage fire. This suggests that it should not be assumed that an aircraft will always be consumed by fire within a few minutes in the event of ignition. The severity of aircraft crashes, and their survivability, is influenced by:

- the speed and angle of impact. Death is likely at impacts over 100 knots and in crashes at steep angles (say) over $45^0$.

- age and type of aircraft (with more recent models possessing more crash safety features),

- fuel load, with landing aircraft tending to have lighter fuel loads,

- point of impact, such as onto buildings versus onto “soft” ground.

It should be further assumed for the purpose of fire cover review that:

- there is a potential for at least 10 to 100 casualties (survivors) per passenger aircraft incident in or around airports.

- provision of medical care of seriously injured casualties trapped or confined to the aircraft within the first hour of injury critically influences survival rates,

- the incident scenario could comprise either a major aircraft fire (with persons attempting escape) or a crash not involving fire (but with a potential large fuel spill) with large numbers of persons requiring extrication,

- an aircraft heavily laden with fuel may suffer extensive fire damage in under 10 minutes,
- there may be a relatively low likelihood of rapid fire spread in an aircraft with low fuel levels (i.e. landing aircraft),
- the crash may occur off-road (such as in a field),
- radioactive materials, hazardous chemicals and carbon fibres may be present,
- there may be about 100 tonnes of aviation fuel, plus cargo.

Table A.1.2 provides further information on the events at a sample of aircraft crashes.

**Table A.1.2: Key aspects of previous incidents**

| Incident | Key points |
|---|---|
| Kegworth, (nr. E. Midlands Airport) 8 January 1989. | Boeing 737 experiences engine failure on approach during emergency landing and crashes on motorway adjacent to the airport at about 80 to 100 knots. Plane separated into 3 sections. Many passengers trapped as fuselage disintegrates. 14 out of 118 passengers and 8 crew self-evacuate, remaining passengers required assistance. All but 5 casualties had serious trauma injuries.<br>Airport and local authority fire services, pre-deployed at airport, on scene in 4 minutes. Only small fires due to low fuel load on plane at time of crash. Fires quickly put out by fire services, continuous foam blanket applied during rescue of trapped passengers. Last of casualties removed 7hrs 47 minutes after crash. |
| Marchington, Staffordshire<br><br>19 August 1984 | Vickers Varsity crashes on emergency approach to East Midlands airport. Plane separates into 2 sections - 11 people killed by asphyxia/crash injuries in forward section. Three survivors in rear section with serious injuries - one trapped in fuselage, two self-evacuate. Small fires surrounding trapped survivor extinguished by first witnesses on scene. Local authority fire services on scene in 16 minutes. Water tender supplies exhausted fighting fire in forward fuselage section, additional water drawn from a static source. |
| Schiphol Airport, Holland, 4 October 1992 | El Al, B747 Freighter carrying 3 crew members and one passenger experienced engine problems and was returning to Schiphol airport for an emergency landing. Due to control problems the aircraft overshot runway and crashed into the apex of two connected angled apartment blocks in an Amsterdam suburb. Aircraft disintegrated on impact and spilled fuel resulted in an explosion. Fire and explosion damaged the apartments.<br><br>After sighting a large fireball to the east, the fire brigade unit was directed to the scene of the accident. Four airport fire brigade vehicles in co-ordination with Amsterdam City fire brigade started fire fighting activities after arriving at scene of the accident. The main fire was under control within several minutes using foam.<br><br>3 crew and 1 passenger fatality, 43 external fatalities. 11 serious and 15 minor injuries to people external to the aircraft. Fragments of the aircraft and building were scattered over an area about 400m wide and 600m long. |

| Incident | Key points |
|---|---|
| Luton International Airport, 29 March 1981 | Jetstar overshoots airport runway on landing and crashes at airport perimeter. 7 passengers and the pilot evacuate unassisted, with minor injuries. The co-pilot is trapped in cockpit with serious injuries. Airport rapid intervention team (RIT) on scene in 2 minutes, knock down cabin fire with on-board dry-powder supply. Airport fire appliances arrive after 4 minutes, knock down fuselage fire with foam and douse cabin with foam to allow a search.<br><br>Local emergency services arrive after the fire is under control, 19 minutes after the landing. Co-pilot removed from cockpit by medical services after 1hr 32mins. |
| Manchester International Airport, 22 August 1985 | Boeing 737 experiences catastrophic engine failure on take off and parks on taxiway. Fire rapidly engulfs plane from severed fuel tank. Airport rapid intervention vehicles (RIvs) on scene in 2 minutes. Airport fire appliances arrive 2-5 minutes after alert, lead vehicles discharge water within 2-3 minutes, apron hydrants initially dry, entry of BA teams delayed due to low water<br><br>Last of surviving casualties removed 5 minutes after fire began. Fire flashed over in cabin 8 minutes after alert. GMC emergency services arrived 13 minutes after the fire started and enter cabin. Last casualty removed 33 minutes after start of fire. 55 fatalities and 68 casualties. |

### A.1.4 Assessment of emergency response needs and goals

The following issues should be examined when considering emergency response requirements.

1. What fire fighting, search and rescue and salvage tasks can it be expected that the Airport Fire Service will be able to undertake in the event of:

    - an aircrash on the runway,
    - an aircrash within the airport boundary but off the runway
    - an aircrash off airport.

    This question should be considered with respect to two crash scenarios:

    - an aircrash involving a rapidly developing aviation fuel fire - spreading across the aircraft and any buildings struck by the aircraft, and;
    - an aircrash involving large numbers of trapped persons, with a fuel spill risk - but no developing fire on arrival of the emergency services

2. What fire fighting, search and rescue and salvage tasks does this leave for the local fire brigade to undertake?

3. Would the local fire brigade be able to undertake these tasks to full effect by the use of standard fire fighting appliances, equipment and procedures alone? This question should be considered in the context of:

    - an airliner crash involving a serious aviation fuel fire in order of tens of tonnes of spilled fuel,
    - an airliner crash involving large numbers of trapped persons, with a risk of an aviation fuel fire.

4. Would the local fire brigade encounter any difficulties in carrying out the latter tasks, in the event of:

    - a crash on the runway
    - a crash on airport but out of reach of airport hydrants,
    - a crash off airport and off road, such as a field.

    In particular,

    - would the brigade encounter any difficulties in providing water in a timely manner for a second foam attack in the event of a crash off-hydrant at the airport?

- how would the brigade approach the task of applying a foam blanket in a timely manner to spilled fuel (in order of tonnes or tens of tonnes of fuel) in event of a crash off road / off airport?

- how would the brigade access an aircraft off road / off airport for purpose of extricating trapped passengers?

- how long does the brigade expect it would take to extricate (say) 50 or so trapped survivors in an aircraft?

- how long does the brigade expect it would take to initiate application of a foam blanket in event of an aircraft crash off-road?

## A.2 Ferry fires

### A.2.1 Introduction

The aim here is to consider the case for having special resources in specified localities or incorporating ship fires into general capability, taking account of the ability of a ships' crew to provide an emergency response. The timing of critical events, such as the speed of fire spread from engine rooms and/or from one floor of a ship to another, should also be considered when reviewing the type and location of special resources and mobilisation arrangements.

### A.2.2 Likelihood

The annual local passenger fire risk can be approximated by multiplying the rate of fire per year of ferry operation by the number of ferries operating to/from the harbours and ports in questions. With 137 passenger and passenger/cargo ferries operating in the UK and at least two serious ferry fires in the period 1990-1996 (Norrona and Sally Star), **the rate of serious fire is about one in every 411 ferry years** (0.0025 per ferry year). Taking Kent as an example area, with 28 passenger vessels operating in the Dover strait and seven in the Medway area, the frequency of serious passenger ferry fires are:

- 0.0025 fires per ferry year X 28 ferries = 0.07 fires per year, **i.e. one in 15 years in the Dover strait,**

- 0.0025 fires per ferry year X 7 ferries = 0.017 fires per year, **i.e. one in 60 years in the Medway area.** (based on ferry movements to/from ports in the Medway and Isle of Sheppey).

### A.2.3 Worst case planning scenarios

The potential for a very large loss of life on passenger ferries and passenger/freight ferries has been demonstrated by a number of recent fires, as summarised in Table A.2.1 below. In both cases fire and smoke effected occupied areas immediately on discovery, with mustering not completed for at least 50 minutes. The crew did not control the fire in either cases. In contrast, the engine room fire on the Sally Star in August 1995 was contained in the engine compartment allowing safe transfer of passengers and non-essential crew by tug boat about 1hr 20 mins from discovery. Therefore it should be assumed, for the purpose of fire cover review, that serious passenger ferry fires originating outside of the engine room have the potential to rapidly spread (within minutes) and cause numerous casualties.

**Table A.2.1: Ferry fires profiles**

**The Scandinavian Star - 1990**

Loss of 168 lives out of 500 people on board after a “deliberate” fire broke out in two cabins. Key points:

- the multinational origin of the 91 crew members led to poor communication.
- ships crew failed to attempt fire fighting and failed to close doors onto the area of fire origin, and failed to begin evacuation by lifeboat until arrival of a rescue vessel 1 hour after fire discovered.
- of an estimated 500 people on board, about 330 were rescued by lifeboat and helicopter and 168 died - 71 of those in the fire and the rest drowned.
- many of the 71 persons killed by fire were found in their cabins, presumably trapped by the fire and smoke or overcome whilst asleep,
- all survivors had been evacuated to lifeboats within 1.5 hours of discovering the fire on the case of the Scandinavian Star.
- The fire fighters rescued 6 casualties about 2.5 hours after the evacuation; 2 unconscious, 4 conscious.

**Norrona ferry fire - 1990**

One death and 34 injuries (9 critical). It should be noted that the Norrona was on a “cargo” run and hence did not have many passengers, under 100. Normally it could accommodate about 1000 passengers. This was a factor in minimising the number of casualties.

Fire on C deck spread to A deck with heavy smoke logging to passenger areas - which required assistance from Dyfed fire brigade to control fire spread. In the case of the Norrona ferry fire:

- the ship’s crew closed watertight doors to contain horizontal fire spread, although smoke still percolated through the ship,
- ship’s crew undertook fire fighting operations but relied on Dyfed fire brigade to control fire and search affected areas.
- passengers and crew were mustered within 51 minutes of discovery of the fire.

Dyfed fire brigade attended in 1hr 5 mins and knocked-down main fire within 40 minutes. There were 9 critically injured casualties removed by helicopter 1 hr 45 mins after fire discovery.

### A.2.4 Assessment of emergency response needs

The following issues should be examined when considering emergency response requirements.

1. What tasks can it be assumed that on board ships fire teams, other ships and emergency services (except local fire brigade) will be able to undertake? Such as first aid fire fighting, search and rescue of smoke logged cabins, tug services etc.

2. What tasks does this leave for the local fire brigade and/or other emergency services to undertake? Such as search and rescue, controlling fires, closing fire doors etc.

3. Would the local fire brigade be able to undertake the latter tasks onboard a ship by the use of standard fire fighting appliances, equipment and procedures alone? This question should be considered in context of ships on fire:

- whilst at the dock, and;
- whilst at sea.

1. What tasks would the local fire brigade be able to undertake in the following ship fire scenarios:

a) fire originating in the engine room of a ferry - confined to the engine room for 1 or more hours by passive and active fire precautions.

b) fire originating in a passenger area of a ferry, such as a car deck, cabin area, restaurant area - whilst at sea. This scenario can be further split into two:

- ships crew close fire doors on area affected by fire,
- ships crew fail to close doors on area affected by fire.

Does this range of tasks cover all of the critical tasks noted in point 2?

Would the local fire brigade be able to initiate on-board fire fighting and/or rescue operations prior to conditions in passenger and crew areas becoming life threatening (or at least prior to large scale loss of life), assuming that:

- fires originating in engine rooms are likely to be contained for more than 1 hour,
- fires originating in other areas, such as car decks and cabin areas can start to spread across decks and then between decks immediately unless contained by closure of fire doors by ships crew.

## A.3 Railways

Table A.3.1 provides some examples of railway incidents on which it is reasonable to plan resources in High and Medium risk areas. Other examples of major railway incidents can be found from local fire brigade records.

| Incident | Lives saved and persons assisted/evacuated | Comments |
|---|---|---|
| Southall, collision, London, 1997 | 16 passengers cut free. Fire in front power car had to be dealt with before rescue operation started. | 7 dead, 160 injured. Several coaches crushed. |
| Bexley derailment, London, 1997 | Freight train derailed and fell onto factory. Dozens trapped in 4 archway workshops. | 4 injured by rubble. |
| Watford Junction collision, Herts, 1996 | Exit of many passengers and injured assisted by brigade. | 1 death, 118 injuries |
| London Underground power failure, 1996. | 33 trains stalled in tunnels - 1000 passengers detrained, 40 suffered smoke inhalation | |
| Channel Tunnel fire, Kent, 1996 | 34 rescued from smoke filled coach - exposed for 10 - 15 minutes. | • Full evacuation took 86 minutes.<br>• 11 minute delay in contacting French fire fighting team.<br>• French fire fighters arrived on scene 20 minutes after train stopped |
| Rickerscote (Staffordshire) collision, 1996 | BA teams rescued up to 20 casualties, many unconscious from area affected by $CO_2$ cloud. | 1 dead and 8 injured in freight train/mail train collision. Train de-gassed. |
| Cowden collision, 1994 | Leading 2 carriages severely damaged but appears only dead were trapped. | 5 died (3 crew and 2 passengers), 12 injured (minor injuries and shock) |
| Central line power failure and evacuation, London, 1993 | Numerous persons led out and carried out of tunnels | 19 trains stalled in tunnels, 20,000 persons evacuated |
| Severn Tunnel collision, Avon-Gwent, 1991 | Two train loads of passengers trapped in tunnel. 180 injured, at least 5 seriously. 300 passengers on two trains. | 300 passengers on two trains. Emergency train provided by operator. Fire service helped evacuate injured. |
| Central line evacuation, 1991, London. | 6700 passengers evacuated from trains - 33 sent to hospital | Trains stopped and power lost after bomb scare. |
| Bank tunnel fire and evacuation, 1991. London | 5000 passengers evacuated , 5 trains stopped in tunnels. Smoke filled the tunnels. | 2 people taken to hospital. |
| Cannon Street buffer collision, 1991, London | 10 to 20 trapped persons cut out. | Some casualties with serious injuries took over an hour to release. 2 died. |
| Purley, London,1989 | Several coaches severely damaged. 3 trapped in leading carriage freed by police. Brigade did search and rescue of | 5 dead, 94 injured of which 32 detained in hospital. |

| Incident | Lives saved and persons assisted/evacuated | Comments |
|---|---|---|
| | many casualties. | |
| Clapham Junction collision, London, 1988 | 5 persons cut out. | 35 died, 500 injured |

## A.4 Motorways and trunk roads

Table A.4.1 below provides some examples of major vehicle incidents on which it is reasonable to base resource planning in Medium and High risk areas. Other incidents, such as Motor way "pile ups" can be identified and profiled from local fire brigade records.

| Date and location | Summary | Lives saved |
|---|---|---|
| 5/7/95 Gwent A40 | 32 trapped casualties in a coach crash. Coach had overturned on roundabout. Attended by 3 water tender ladders and 2 rescue tenders. First attendance in 7 minutes found 15 casualties wandering around scene and 32 trapped in and under coach. All 32 released using hydraulic cutting equipment and air bags in 2 hours. 7 of 32 trapped casualties died at scene i.e.. 25 initially survived although 10 died in total. Thus at least 22 of 32 trapped casualties survived | 25 |
| 10/11/93 Kent M2 | Coach spun 180 degrees and came to rest on its side on a steep embankment. Water tender ladder arrived in 5 minutes discovering coach in danger of slipping down embankment. They secured coach using Tinfar winch. Two women trapped under coach rescued by use of hydraulic spreaders to lift side of coach. Other crews helped lightly trapped from coach. 10 died on the scene (trapped beneath the coach), 36 survived, 22 detained in hospital for at least 1 night. | 36 |
| 1992 M40 Oxfordshire | 3 died and 6 seriously injured when coach crashed into bridge. Bridge upright had penetrated to fourth row of seats. 9 trapped persons and injured of which 3 died. Fire services cleared path through coach to relieve access to casualties, using hydraulic ends and rows. Last casualty released 2.5 hours into incident. | 6 |
| 25/8/94, Ramsgate, Kent | Ferry walkway collapsed with 14 casualties. 6 died (5 on the scene) and 8 seriously injured. Ladders used to access casualties walkway secured using wire ropes and winches. Crews helped carry stretchers out of incident area. | 8 |

# Annex B: Flood

### What rescue resources are required ?

To inform consideration of the potential rescue resource requirement, it is appropriate to consider the different rescue situations that may be encountered. The nature of the flood source is in many respects immaterial to the rescue situations that are likely to be encountered, though they may affect the nature of the rescue that has to be affected and whether this is in still or moving water. Where a breach of defence occurs there is likely to be greater risk of property collapse due to the pressure of rapidly moving water, whereas further away from the breach it is the depth of water that will pose a more immediate threat. Moving water is not however confined to breach situations and may occur where an event significantly exceeds a defence design such that significant quantities of water overtop a defence height. It is considered reasonable to assume that in any major incident there is a strong possibility that rescue demands will include rescues from both still water and from moving water within the same general location.

To illustrate the different nature of rescue situations a matrix has been developed with a short description provided for each type.

| **Rescue Situation** | **Still / Very Slowly Moving Water** | **Moving Water** |
|---|---|---|
| People in permanent buildings | Basement. Rescue needed when water starts to enter. | Basement. Rescue needed when water starts to enter. |
| | Single Storey. Rescue needed when water reaches depth at which individual unable to safely walk out. Depth lower for the young, the elderly, those with limited mobility (through physical or visual disability). | Single Storey. Rescue needed when water reaches a depth at which individual unable to safely walk out or if force of water likely to affect the structural integrity of the building. Safe walking depth lower for the young, the elderly, those with limited mobility (through physical or visual disability). May only be a matter of a few centimetres if water moving rapidly. |
| | Multiple Storey. Refuge can be sought in upper floors though rescue needed if depth of flooding affects highest accessible storey. Subsequent rescue may be needed if flood is of significant duration. | Multiple Storey. Rescue needed if force of water likely to affect the structural integrity of the building such that refuge in upper storeys unsafe. Subsequent rescue needed if flood is of significant duration. |
| People in temporary buildings | Caravans, including those referred to as 'permanent', rescue needed when water reaches the lower of either a depth at which individual unable to safely walk out or at which the caravan will float and may be unstable. Safe walking depth lower for the young, the elderly, those with limited mobility (through physical or visual disability). | As single storey above but may be shallower than a fit able bodied person may be able to walk through if caravans start to be moved.<br><br>Rescue from floating/ moving structure may be needed if individuals do not evacuate early. |
| People in vehicles | Cars/vans/lorries. Rescue needed when water reaches a depth at which individuals are unable to safely walk out or when water level starts to enter vehicle. It is assumed that climbing onto car roofs is not a safe option. | All vehicles. Rescue needed from all vehicles stopped in flood waters that are moving due to risk of vehicle and occupants being swept away. |
| People on foot (also include canoeists who get into difficulty) | Rescue needed when water reaches a depth at which individuals are unable to safely walk out or where stranded on high ground with no means of shelter and thus at risk of hypothermia. May be remote locations away from roads. | Rescue needed when water reaches a depth or speed of flow at which individual unable to safely walk out..<br>In some circumstances individuals may be trapped in confined spaces (especially underground) with no above water escape route.<br>The locations may also be remote and away from hard surfaced roads. |

Whilst varied these situations do indicate a number of common rescue resource requirements, including:

- appropriate clothing and personal safety equipment for Brigade personnel;

- equipment (typically boats) to facilitate rescue from vehicles/structures surrounded by deep, still water, potentially of people from upper storeys;

- equipment (typically boats and/or tractors have been used) to facilitate rescue from vehicles/structures surrounded by fast moving water, again potentially of people from upper storeys. The worst case scenario may require people to be rescued from buildings/vehicles being carried along in deep fast flowing water at night;

- appropriate training in dangers associated with working in water and with the different rescue approaches and equipment that

# Annex C: HAZCHEM

Due to the immense variation in the size, layout and inventories of sites, it is advised that the scenarios and emergency response resources are assessed on a case by case basis. However, a review of major incidents on CIMAH sites indicates that fire service intervention has prevented the spread of fire to high value plant and products, controlled secondary fires and protected plant from heat radiated from nearby fires. Therefore, the tasks should include, as a minimum, control of fire spread, assisting in the isolation of leaks, containing spread of gases and liquids, controlled burns and search and rescue of casualties. This is illustrated by the following four cases:

1. Alloid Colloids fire, 1992.

The HSE report indicates that fire service actions prevented the ignition of plastic drums of flammable liquids in a storage area connected to the area of fire origin. This prevented the spread of fire to 600 tonnes of acrylonitrile, 40 tonnes of methyl chloride and the production area. It is reasonable to assume that this averted the loss of millions of pounds worth of product and machinery/building, averted a much larger fire and large scale evacuation of the public.

2. Hickson and Welch, 1992.

Whilst there was no opportunity to control the initial short-lived jet flame which erupted from the storage tank, the fire service did prevent the spread of fire in the office building hit by the jet flame.

3. Texaco, 1994

Whilst the fire was allowed to burn-out until the source of fuel was exhausted and the plant was isolated process equipment, the brigade did cool adjacent plant (vessels and equipment) thereby reducing the loss and averting further fires and explosions.

4. Associated Octel, 1994.

Fire service personnel in full chemical suits closed isolation valves. The brigade, Shell and Octel provided foam to extinguish the fire. The combination of passive protection and emergency response prevented escalation that could have been very severe, with fatal effects out to 140m from the vessel.

# Annex D: Bomb incidents

## D.1 Effects of an explosion

The role of the fire service in a terrorist attack is no different from any other incident and the effects are considered in the light of these responsibilities namely:-

a) The rescue of casualties and those trapped in damaged buildings;

b) Dealing with fires, and;

c) Maintaining a safety presence until there is no further danger from gas explosions, falling debris etc.

A simplified explanation of the dynamics of an explosion are as follows:-

- **Blast:** Air is propelled at tremendous force and speed creating an over-pressure travelling outwards in all directions away from the source. The bigger the blast, the greater the distance and potential for damage.

- **Augmented Pressure:** The pressure wave is reflected and channelled by the design of buildings and the layout of streets. This causes the pressure effect to last longer and can increase structural damage.

- **Fragmentation:** Any item that is part of, or near to the bomb when it explodes, becomes a projectile. The larger the explosive charge, the further the fragments will travel. Fragments normally travel in straight lines but, like a bullet, they can be deflected.

- **Secondary Fragmentation**: As the blast over-pressure hits and breaks structures, e.g. windows, doors, office equipment etc. they become projectiles.

- **Partial Vacuum:** Immediately following the over-pressure from the blast the air pressure returns to normal and at this stage, windows not blown in by the initial blast may be sucked out.

- **Ground Shock**: The blast wave pressure is also transmitted through the ground and this causes problems with gas, water, electricity, sewers, telecommunications etc. It may also cause structural damage to the foundations of buildings and subway systems such as underground railways.

The density, height and structure of buildings and the width of streets exacerbate the overall effects of the explosion.

In built up areas the blast can disperse in what appears to be a haphazard manner but it is the type of environment which causes this situation i.e. density and height of buildings. Some parts of buildings will be badly damaged whilst other parts of the same buildings suffer far less. Buildings in line of sight of the blast may escape with minor damage, whilst other buildings some distance away and not in line of sight can be badly damaged. This only adds to what is already a difficult situation when responding to such an incident.

Damage and injuries can be anticipated in a radius of 400 metres from the device and even beyond that distance if it is a very large device.

In a dense built-up area substantial damage will occur within a 100 metre radius with buildings adjacent to the device possibly collapsing or partially collapsing if the blast is great enough. The inner cordon for the most seriously damaged buildings in the Bishopsgate bomb covered an area of 20 acres. Damage on the outer extremities of the explosion will be more superficial with glass, tiles etc, being affected.

Tons of glass and debris will fall, and continue to fall, for some time afterwards, often from great heights, presenting a most hazardous situation. Over 500 tonnes of glass and debris was cleared from the streets during the St Mary Axe clear-up operation. The Natwest Tower, which is 600 feet tall, was seriously damaged in the Bishopsgate explosion and glass and debris showered on to the streets from all levels of the building. The danger from glass falling from this height needs no explanation and glass and fragmentation causes most of the injuries. This should be foremost in the minds of those responsible for preparing contingency plans.

The type of construction of the buildings will also affect the damage that results. Buildings that have a great deal of glass are less likely to be structurally damaged than one of a more solid construction, although the potential for injuries from flying glass is far higher. A good example is the Commercial Union building in St Mary Axe which was adjacent to where the bomb detonated. It is a tall building of 1960's construction faced with glass. The blast just ripped through the building as the glass presented little resistance and as a result it suffered little structural damage.

The only serious fire that has occurred has been at the World Trade Centre where the bomb was placed inside the building damaging fire protection systems and causing substantial problems from smoke throughout the complex. The fact that there have been little or no problems from fires where the devices have been detonated in the street is very fortunate, but is no guarantee that there could not be fire(s) in any future incidents.

In addition to destruction at street level and above, damage occurs below ground to building foundations and all the utility services. Damaged gas, electricity and water supplies will present on-going problems for the emergency services for some time after the explosion and there is the serious risk of further explosions from escaping gas. Weather conditions and vibration from trains and aircraft can also affect the scene.

Consideration also has to be given to other structures that may run under the site of the explosion, such as an underground railway or a road tunnel. Serious problems will result if the tunnel is near the surface [as is the case with some of the London Underground lines] as the blast is likely to enter the tunnel and travel for some considerable distance, exiting wherever it can and possibly trapping people in trains etc.

The possibility of secondary devices must be taken into consideration when responding to an incident.

In the midst of all this mayhem will be people. They will be injured in the streets and in buildings. There may also be people trapped in lifts or buildings that may have collapsed or be filled with smoke, as occurred at the World Trade Centre. They are likely to be anywhere in the debris - at the top of a high rise office block or in the basement of a collapsed building. The worst case planning scenario should have regard to these eventualities.

The most interesting statistic on the incidents set out on Table D.1 is the level of casualties. The fact that far fewer people were killed in the London and Manchester bombings compared with those in the U.S.A. and Nairobi is as much due to the times they detonated as to the fact that warnings were given. Warnings are obviously a benefit but experience has shown that they cannot be relied upon as they often give misleading information, as clearly illustrated by the bombs at St Mary Axe and Omagh.

If a device is discovered before it detonates it will obviously assist but many factors affect the outcome and determine the level of casualties. The most important issues are the time of detonation in relationship to its discovery, the level of preparedness that exists in the emergency services, business and the public, and what systems are in place to warn people etc. The security services also have a much greater capability to deal with these bombs than in the past but there will always be the problem of time and accessibility.

The time that the fire service will need to maintain a safety presence after the scene has been evacuated following an explosion will need to be measured in days rather than hours.

## D.2 Worse case planning scenarios

The greatest potential for a large loss of life and people trapped will be when a VBIED is detonated in a highly populated, densely built area with high rise buildings, during the working hours, without warning. Even with a warning there is still a serious threat to life and property. The casualties at the Oklahoma bomb are a good indication of what could occur and these would have been substantially increased if the building attacked had been surround by buildings of a similar size.

## D.3 Assessment of emergency response requirements

Dealing with this type of incident will be a major operation for the fire service. This raises two questions:

1. Would the local fire brigade be able to discharge these duties to full effect by the use of standard fire fighting appliances, equipment and procedures alone?

2. If there were a need for special equipment what would be required?

The local authority should have plans to use heavy lifting gear etc to make the scene safe and return to normality as soon as possible but it is unlikely that these will be immediately available. The rate at which casualties are rescued, the scene is made safe and is returned to normality will depend on the level of inter-agency co-operation and planning. This raises the additional question of whether the fire brigades plans are sufficient to meet these needs?

| DATE & LOCATION | TYPES OF VEHICLE AND EXPLOSIVE | ENVIRONMENT | PERPETRATOR | CASUALTIES |
|---|---|---|---|---|
| 21.20 hours Friday 10th April 1992<br><br>St Mary Axe, London, EC2 | Ford Transit van with a Luton body.<br><br>HME. | Business | PIRA | 3 killed, 170 injured |
| 01.08 hours Saturday 11th April 1992 Staples Corner, London, NW | Van.<br><br>HME. | Major road junction | PIRA | None |
| 10.24 hours Saturday 24th April 1993 Bishopsgate, London, EC2 | Stolen tipper truck.<br><br>HME. | Business | PIRA | 1 killed, 70 injured |
| 19.01 hours Friday 9th February 1996 Canary Wharf, London. | Purpose built disguised vehicle removal lorry.<br><br>HME. | Business | PIRA | 2 killed, 56 injured |
| 11.17 hours Saturday 15th March 1996 Corporation Street, Manchester | Box van.<br><br>HME. | Retail shopping | PIRA | 206 injured |
| 15.10 hours Saturday 15th August 1998 Omagh, County Tyrone | Car.<br>HME. | Retail shopping in town. | Real IRA | 26 killed, 206 injured |
| 12.18 hours Tuesday 26th February 1993 Basement of World Trade Centre, New York | Van.<br><br>HME. | Business | Islamic fundamentalists | 6 killed, 1042 injured |
| 09.02 hours Wednesday 19th April 1995 Oklahoma City | Truck.<br><br>HME. | Government building | American extremists | 168 killed, over 500 injured – hundreds assisted out & extracted from rubble |
| 03.40 hours Friday 7th August 1998<br><br>Nairobi, Kenya | Car.<br><br>HME | U.S. Embassy in business area | Islamic fundamentalists | 247 killed, 5500 injured |
| 03.45 hours Friday 7th August 1998<br><br>Dar Es Salaam, Tanzania | Car.<br><br>HME. | U.S. Embassy in residential area | Islamic fundamentalists | 11 killed, 70 injured |