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ELABORATION OF A RISK ASSESSMENT TOOLKIT FOR THE UK FIRE SERVICE

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Final report
October 1996
By
*EN*TEC

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October 1996

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FINAL REPORT RELEASE SHEET

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ACKNOWLEDGEMENTS

The authors of this report would like to thank Kent Fire Brigade, Mid and West Wales Fire Brigade and West Midlands Fire & Rescue Service for their time and effort expended on assisting with the development and review of this report.

In addition, many constructive and useful written comments and ideas were received from the London Fire and Civil Defence Authority, Greater Manchester Council Fire Service, CACFOA and Cheshire Fire & Rescue Service. We have striven to incorporate these ideas into the report and acknowledge with thanks the essential contribution made by these brigades.

SUMMARY OF PROPOSALS

This report addresses the recommendations of the Audit Commission's report "In The Line of Fire" for a more flexible and empirical national framework of response standards and increased focus on life risk and the prevention of fires. The report provides an insight into the form that a fire service risk assessment toolkit might take and how it might be developed and applied, so as to provide a basis on which to judge whether to initiate the development of an actual toolkit.

The toolkit has been designed to provide an empirical assessment of the life, property and other risks on which the fire service can plan both preventive (safety and education) resources and emergency response resources and specify goal based standards, taking account of expectations regarding risk levels, fire fighter safety and the cost of service provision. The toolkit is not designed to specify the exact number of persons or equipment required to carry out certain tasks but instead is limited to identifying the "operational capacity" that can be warranted. Also, this report does not seek to establish the respective weight which should be given to risk assessment versus other considerations such as local economic considerations, except to cite examples of the limits applied to the role of risk assessment elsewhere. The exemplar toolkit focuses on the planning of services rather than fire ground or control centre risk assessment. Key features of the proposed toolkit include:

1. The scope of assessment should be in accord with the range of life risk incidents attended by the fire service.

2. Equal weighting is given in the toolkit to the role of risk assessment in fire safety education, fire safety, fire cover and operational capacity standards.

3. **National level risk assessment.**

   A system of nationally applied Risk Categorisation is retained but the process of defining risk categories and associated standards is significantly changed, as follows:

   - a risk assessment would be carried out at a national level with the aim of deducing the optimal mix of preventive (fire safety education and building control regulations) and response measures to reduce risk, hence allowing identification of preventive measures which might in time reduce the incidence and/or severity of fires,

   - this assessment would be used to define Risk Categories and response standards as well as designating priority areas for fire safety education and review of building regulations, giving proportionate weight to life risk, property risk and other risks such as environmental pollution and loss of heritage.

   - the risk assessment would be carried out for discrete classes of incidents and premises which display significantly different levels or types of risk, with distinctions made on the basis of occupant characteristics, fire incidence, fire

safety systems, building construction, building density and occupancy as appropriate,

- such risk assessment would draw on information contained in incident reports and real fire research, such as FDR1s, to ensure that due account is taken of observed fire behaviour, fire incidence rates and evidence regarding the effect of fire safety and fire safety education.

- revise the wording and subdivision of Risk Categories to ensure they reflect variations in life risk arising from variations in occupant characteristics, fire safety systems, the incidence of fire, etc, with the option of using quantitative measures of fire severity to judge the level of risk in an area or type of premise.

- extend the range of risk categories to include life threatening special service such as RTAs and extraction from machinery, and high value non-premise fire risks, such as commercial forest fires.

- include a reference to the need to target fire safety education and fire safety work in areas awarded higher risk categories with the goal of reducing the frequency of larger scale incidents,

- make reference to the likelihood of serious fires in the definition of risk categories and link response standards to the scale of incidents, such that the response standard operating in an area changes over time in reaction to changes in the frequency of larger scale incidents.

The work required to apply the risk categories is not expected to be prohibitive, i.e. risk categories and associated risk assessment methods are designed such that they can still be applied through station watches, operations departments and fire safety staff. Indeed, it is expected that the current risk categories of a large part of the UK would remain unaltered, particularly in rural and remote rural areas. However, the reference to fire incidence and occupant factors in the Risk Categories would suggest that the risk categorisation process would benefit from analysis of fire rates, local authority development plans, census information, and survey of local uptake of fire safety measures in domestic and non-domestic premises.

4. **Fire education and fire safety.**

The risk categories would include service planning guidelines on the targeting of educational and other preventive work, with accompanying methods to target fire safety and fire safety education work onto higher risks:

- criteria relating to the rate of casualties and fires in areas, for discrete demographic groups and types of premises, to help identify where fire safety and education work would be of particular value,

- methods for identifying target groups, causes of fire and related issues (such as how to escape) for the purposes of fire education and safety initiatives,

- methods for use in designating High, Medium and Low fire safety risk ratings of premises for use in certification exemptions and inspection schedules, and methods for use in developing supporting arguments for fire safety advice.

Given that fire safety and operations both seek to assess risk in non-domestic premises, a common set of methods should be available for both fire cover and fire safety purposes.

5. **Locally applied points based and other risk assessment methods**

Replace the current points based system with a suite of risk assessment methods which take account of occupant characteristics, fire incidence and modern fire safety systems as well as building construction, building density and occupancy. The suite of methods includes simple points based schemes through to more sophisticated methods. Different methods are exhibited for "normal" premise fire risks, special fire risks, special service incidents and for verifying which "design tasks" apply. The risk assessment methods could be designed so as to generate the same or greater initial response as designated by a corresponding Risk Category, as well as providing information for use in fire safety, fire fighter safety and related matters.

6. **National response planning guidelines (standards)**

Revise the format of national minimum response standards to express the "tasks" that the initial response is expected to carry out and the operational capacity required to carry out these tasks, and at the same time ensuring that these reflect the goals of:

- minimising life loss and injuries (of both the public and fire service personnel),

- minimising fire related losses,

- while keeping the risk to fire fighters "as low as reasonably practical".

The formulation of response planning guidelines on the basis of "design tasks" would:

- provide a meaningful basis on which to then define the operational capacity needed to carry out these tasks, and;

- facilitate the match of response to local variations in risk.

Design tasks and response operational capacity planning guidelines are illustrated below:

- a **"design task"** could be specified as, for example, containing a fire confined to the room of origin in a dwelling whilst also carrying out a limited search and rescue operation for occupants without incurring undue risks, and subsequent in

situ first aid treatment of fire related injuries. Clearly a response designed to achieve this task would also be able to handle less onerous fire scenarios.

- an **operational capacity planning guideline** for the latter design task could be deemed to require a minimum of (say) 1 high pressure hose team, 1 BA search and rescue team, an OIC capable of commanding such a scenario, with 1 team member capable of rendering in situ emergency medical treatment, with attendance in X minutes.

Thus, the guideline explicitly differentiates between fire fighting and rescue resources, without prescribing the exact number of personnel, means of conveyance or appliance design. The reference to "operational capacity" provides a definition of the range of tasks that it is expected that teams need to be able to carry out.

As with the current national minimum standards, such a formulation would imply that there is a limit to the range of tasks that the initial response is expected to carry out, beyond which additional support is required. This cut-off would be determined by judging the maximum incident size and minimum incidence of such fires for which it is economically practicable to provide more than a certain level of response and which matches public expectations regarding "reasonable service provision". Further evaluation could identify those tasks which require additional support and thence define a further set of (second and subsequent response) operational capacities.

Risk-related permutations of design tasks

The design task would clearly be related to the scenario likely to be found on arrival (on a certain percentage of occasions) by the initial attendance. Accordingly, where the likely scenario in a particular premise varies in a sufficiently predictable manner, so the design tasks could also vary. For example,

- where the premise (or an area) can confidently be said to be un-inhabited during certain periods, the design task may change from one involving firefighting and search and rescue to one predominantly involving firefighting alone. Hence, two "design tasks" could apply to a single type of premise (or area) according to whether the premises are inhabited or not.

- where the fire loading or distant location of particular dwellings is greater than that of other dwellings which are equal in all other respects, the design task might involve fighting a larger fire, hence demanding an increased weight of attendance.

- where a certain type of call can be confidently discriminated from other calls (from the same type of premise) in terms of the fire risk, the design task could change accordingly. Thus, it might be predicted with sufficient confidence that the initial attendance task for AFAs from certain designated properties comprises one of verifying the alarm and/or handling a confined small undeveloping fire. Hence the required operational capacity of the initial response would be less than that for

other calls from the same premise where the initial fire scenario is expected to be more serious.

Thus, a series of permutations could be built into the national response planning guidelines to accommodate foreseeable variations in risk within and between otherwise comparable premises.

The toolkit could include risk assessment methods for evaluating local circumstances and hence demonstrating, on the grounds of risk, which permutations of the national response guidelines apply. Clearly, the design task could also change over time in accordance with changes in the likelihood of serious fires, hence prompting a continuous review of response standards.

As with the current risk categorisation system, these guidelines could be defined as recommended minima which can be departed from at a local level.

7.0 Predominance

A number of approaches to the issue of predominating risk can be considered:

(i) As with the current points based system, an area could be surveyed using either risk categories and/or one or more of the risk assessment methods to develop a profile of the risk. A single initial response standard could thence be designated for the area for planning purposes on the basis of predominance, as at present. Predominance could be based on:

- the percentage of ground area covered by each type of premise,
- the percentage of households falling into each risk category within an area, and the percentage of floor space falling into each risk category for non-domestic premises,
- the percentage of each type of call in an area, (or the percentage of calls to confirmed fires from each type of occupied premises).

(ii) Alternatively, planning could be carried out on the basis of being able to meet a range of response standard in the area as per the risk category of the premises. Again, this could involve either:

- seeking achievement of each response standard on each call excluding 2nd and other calls in an area or;
- meeting the response standard on a set percentage of occasions. This would also allow account to be taken of the impact of 2nd and 3rd calls on station grounds, periods of peak loads and major incidents on the standard of fire cover and allow a common response standard to be set for, (e.g.) dwellings regardless of location, as discussed in Appendix A.

Similarly, mobilisation could be managed on an address/locality/incident basis, as opposed to district based mobilisation, to a greater extent than at present.

8.0 Operational capacity

A reference to operational capacity in the response guidelines, linked to a finite range of "design tasks" and scenarios, would require assessment of response standards to address both the "quality/capacity" of the response as well as the timeliness and weight of the response. It would also imply that:

- the initial attendance should be capable of carrying out a defined set of tasks and managing the full range of hazards which can reasonably be expected on arrival,

- the expected range of capacities possessed by a team does not need to exceed those required to handle a finite range of tasks and scenarios, where it can be assured that they are unlikely to encounter other demands and that appropriate support (i.e make-up) would be available to handle other hazards and scenarios.

Hence, where operationally feasible, a brigade would have an option of defining a core finite range of tasks which initial response teams should possess, with a requirement for support from others to carry out other tasks and/or a limit on the range of tasks which individuals are expected to perform. The range of core tasks could vary between brigades depending on the range of predominating risks and operational policy.

The toolkit could include methods to:

- assess and review the predominating hazards and events for which equipment, procedures and skills need to be planned to assure an effective response, and;

- assess the impact of proposed changes to equipment, procedures and skills on performance.

9.0 Consistency, risk communication and inspection

Inter-assessment consistency could be achieved by a combination of (1) designing risk categories and locally applied risk assessment methods so as to recommend comparable standards, (2) issuing methodology guidelines, (3) central review and approval of locally applied methods and inspection by HMFSI.

Risk assessment can be used in governmental decision making, lobbying of governmental and other agencies, public awareness and education initiatives and public consultation purposes. Depending on the match of "objective" and "subjective" risk assessments the risk assessment may be drawn on to either gain a higher or lower perception of risk. In the case of local

planning, it is suggested that the precedent of classing Health and Safety Executive risk assessments of proposed developments in vicinity of major hazard installations as advice, hence allowing local authorities discretion to take account of local social and economic considerations, be considered. In addition, given the experience elsewhere of public perceptions of risk differing from scientific statements, that risk assessment be viewed as one input to consultations and be set in the context of other views and considerations. Notwithstanding the latter, the development of more meaningful service planning guidelines (i.e. design tasks) and objective risk assessment should provide a basis for such consultations. Moreover, information on local levels of loss is vital to gaining the commitment of local authorities and other agencies to fire safety matters as well as forming a key element of local fire safety education initiatives.

10.0 Next steps

It is suggested that a pilot risk assessment study be carried out of a representative sample of fire calls from a single type of occupied dwellings, such as single occupancy dwellings, with a remit to:

- determine an optimal mix of fire safety education, building regulations and response,
- define the design tasks and operational capacity response planning guidelines,
- define the risk category prose and/or quantitative criteria for designating an area under this category,
- review the quality of information available to undertake such a risk assessment,
- produce a points based scheme for distinguishing high risk from lower risk residential areas,
- specify in detail the work required to designate an area using the new prose and/or quantitative means of categorisation.

Given that the effects of any additional fire safety education or regulations would not be immediate, the response would be based on the current risk.

11.0 Further complementary research

In the short term it is suggested that it would be useful for research on the effectiveness of different types of fire safety education to be collated and reviewed, including a review of the relationship between cost of initiatives and their measured effect on fire spread and casualties in dwellings. Such work would assist in the assessment of the potential for fire safety education to reduce the severity of fires and thence provide a firmer basis for considering the respective roles of fire safety education and response in reducing losses. It would also provide a basis for developing guidelines on the “fire safety educational capacity” which should be sought for areas of high risk.

CONTENTS

PART ONE

OVERVIEW OF RISK ASSESSMENT TOOLKIT CONCEPT, RESOURCING AND BENEFITS

1. INTRODUCTION

1.1 BACKGROUND

This report has been prepared in response to a request from the Joint Committee on the Audit Commission Report (JCACR), a sub-committee of the Central Fire Brigade's Advisory Councils, for an elaboration of the design and operation of a toolkit of risk assessment methods for the UK Fire Service. This request was made at the 22nd July 1996 meeting of the JCACR during which Entec outlined a range of risk assessment methods that the UK fire service could draw upon. It is also pertinent to note the implications for risk assessment of the proposals for widening of fire certification exemptions and increased emphasis on advisory input to exempted premises, namely that methods may be required to designate premises as High, Medium or Low risk and for supporting fire safety advice.

A toolkit of methods has been considered on the grounds that:

- the extent and required form of fire prevention, safety, education and emergency response may vary between areas,
- the uniformity and level of risk varies between areas and premises in such a way that categorisation would suffice for some areas but other areas and premises could benefit from more exhaustive forms of risk assessment,
- the types of risks differ between areas, such that planning should give greater regard to certain types of risks in some areas,
- whilst some areas are dominated by "normal" risks for which standard procedures and equipment should suffice, other areas involve a higher number of significant risks and complex risks which could demand special resources.

In addition, it is considered that any form of assessment used for planning purposes should:

- be based on an empirical assessment of risk,
- take account of life risk and, to some extent environmental, social and cultural (heritage) risks, as well as economic and property risks,
- model all of the factors which underlie variations in life risk, including occupant characteristics and fire safety features as well as occupancy, construction and building density factors,
- facilitate planning for low frequency incidents, such as major disasters and low frequency life threatening special services,

- take account of the way in which the severity of incidents can vary from one occasion to another in the same type of premise,

- take account of the possibility that a caller may not be able to identify which building is involved in a fire and the possibility that a well protected building may be adjacent to an unprotected building,

- provide a basis for matching the response to the level of risk,

- not prohibit effective communication with the public and elected representatives of the basis of decisions regarding resources and policy.

And should facilitate;

- identification of the most cost-effective combination of prevention, safety, educational and response strategies,

- revision of the deployment and level of resources in accordance with changes in risk within areas, particularly changes in the number and severity of incidents as opposed to changes solely in predominant building stock,

- development of alternative mobilisation arrangements, operational procedures and equipment,

- the identification of improvements in the type and quality of resources, including the competence of personnel.

Thus, risk assessment should be designed such that it meets the recommendations of the 1995 Audit Commission report “In the Line of Fire” for a more flexible and empirical approach to planning, targeting of resources on life risk and increasing the emphasis placed on fire prevention. Thereby providing a framework for reducing the levels of fire related losses in the UK. As noted in Entec’s earlier report (1996, a), the sought for goal of risk assessment is:

> “ to provide a demonstrable basis for striking an optimal balance between, on the one hand, expected levels of public and fire-fighter life, property and environmental risk, and, on the other hand, the level, type and deployment of fire safety, fire-fighting and special service resources for normal and exceptional fire and other emergency incidents”

Paradoxically although, a flexible approach to planning is sought to take account of inter and intra area differences in risk, there is at the same time a wish to maintain some form of national minimum standards of response. In particular, it has been argued that:

- there is a public demand for a system of national minimum response standards,

- the assessment of brigade performance is facilitated by the designation of a set of measurable national minimum standards.

Thus, the design and operation of a risk assessment toolkit should not prohibit retention of national minimum standards and should avoid creating inconsistency in the standards achieved by brigades. In addition, the toolkit should minimise local liability risks arising through local selection of risk assessment methods and lend itself to auditing by Her Majesty's Fire Service Inspectorate.

Finally, the resource demands of risk assessment should not be prohibitive or disproportionate to the benefits of assessment. Ideally, it should be possible to operate risk assessment using existing resources, with additional resources called upon only for special needs and where the benefit of such work exceeds the cost.

1.2 AIMS AND SCOPE OF THIS STUDY

This study aims to provide sufficient information on the design, operation and implications of a risk assessment toolkit to allow a judgement to be made of the case for further development of the toolkit. This report provides an overview of the differences in the types, level and uniformity of risks in different areas and elaborates on the design and application of a toolkit of methods to match these variations. This study does not provide final or complete versions of assessment methods. It is restricted to providing illustrative examples of the forms of risk assessment envisaged as part of a toolkit.

The report also provides a view on the ability of brigades to implement the toolkit using existing resources, the impact of the toolkit on communications with the public and elected representatives and the impact of the toolkit on the work of HMFSI.

1.3 APPROACH TO THE WORK

The approach to the study is illustrated in Figure 1.1. The approach is based on the following points:

- a clear idea of the procedures of risk assessment is required to judge the resources needed to carry out such assessment and how methods need to be modified.
- if it is assumed that different methods may be drawn on depending on circumstances in a brigade area, an understanding of these circumstances is required.
- similarly, an understanding of the range of property types in terms of complexity, types of hazards etc. is needed to allow a judgement to be made of the range of methods, scoring schemes etc. required.
- if the range and type of risk assessment may vary between brigades, a judgement is required of the types of methods different brigades may use to estimate resources required to carry out assessment at a local level.

- feedback should be gained from the fire service at key points in the work, to allow ideas to be refined.

- the way in which risk assessment could be linked to risk criteria and response standards is required to provide an overview of the toolkit and to determine the types of methods required.

- similarly, the impact that risk assessment could have on the form of standards used is required to assess the communication and auditing issues.

Kent, Mid and West Wales and Wets Midlands Fire Brigades were consulted during this study. In addition, workshops were held for members of the Joint Committee on the Audit Commission Report covering an interim version of this report. Comments and suggestions voiced during the workshops and during consultation with the former brigades have been incorporated into this report.

1.4 REPORT STRUCTURE

The report is split into two parts, with part one covering,:

1. Background to the study and the fire services risk assessment requirements.

2. A summary of the variations in risk which envisaged methods should be able to model.

3. A summary of the purpose and use of the proposed risk assessment toolkit.

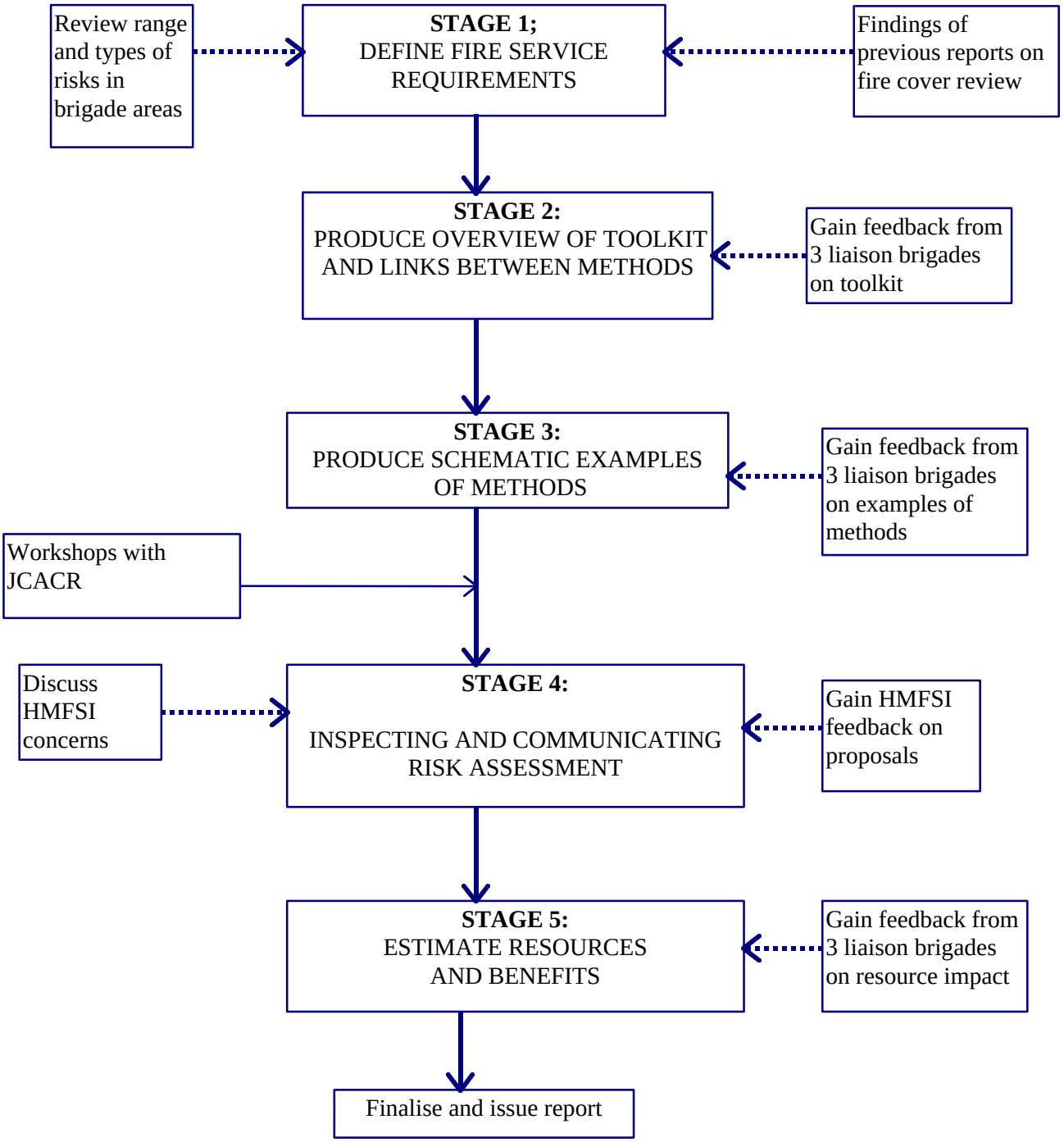
4. Summary of resource implications

5. Summary of benefits of the envisaged risk assessment toolkit.

6. Impact of the toolkit on the work of HMFSI.

Part two of the report provides a summary of the role of risk assessment in defining fire safety policy at a national level, development of risk categories and fire safety education work, and illustration of methods.

FIGURE 1.1 OVERVIEW OF APPROACH



2. VARIATIONS IN RISK

2.1 SUMMARY

This part of the report elaborates upon the variations in the types, ranges and levels of risks found in different areas and between different types of incidents and premises to provide a basis for the subsequent design and evaluation of a flexible risk assessment toolkit. In particular, an overview of the ways in which risks vary should help:

- provide an understanding of those local circumstances where area based versus alternative forms of risk assessment could be useful,
- identify the variations in risk and factors to which the methods in a toolkit need to be sensitive,
- identify the types of factors which risk assessment should be able to model, over and above common factors such as fire loading and numbers of occupants.

2.2 SOCIAL-DEMOGRAPHIC FACTORS

The 1988 and 1992 British Crime Surveys

The findings of the 1988 and 992 British Crime Surveys, as summarised below and in Table 2.1, clearly indicate that risk varies significantly according to social-demographic factors:

> "The risk of household fires seems greater for the socially disadvantaged. Risks were higher in council housing areas, among single parents and among manual workers. Household composition also makes a difference. Young families with children were more prone to fires, perhaps reflecting more crowded living and heavier catering demands."
>
> "The indications are that Afro-Caribbean families have more fires than white households, and Asian families have fewer."
>
> "(Smoke) Alarm ownership was lowest among adults living alone, couples without children, single parents, elderly households, and council tenants. Lower incomes is likely to underlie these patterns. Alarm ownership was lower among Afro-Caribbean and, in particular, Asians than among whites."
>
> (United Kingdom Fire Statistics, 1992)

Table 2.1 Experience of fire by area and social factors (1988 and 1992 British Crime Survey data combined)

% of households having a fire last year (average = about 2.5%)			
Standard area		**Age of household head**	
East Midlands	4.4		
North	3.1	16-35	4.0
West Midlands	2.8	36-59	3.3
North West	2.8	60+	1.4
South East	2.7	**Family Type**	
Wales	2.7	Single Parent	4.9
Yorkshire/Humberside	2.6	Couple/children	3.9
South West	2.6	Other	3.7
East Anglia	2.5	Couple/no children	1.9
		Lone Adult	1.9
ACORN		**Tenure**	
G. Council Estates - category III	5.0	Council	3.9
D. Older terraced housing	3.6	Owner occupier	2.5
F. Council estates - Category II	3.6	Other	3.1
E. Council Estates - Category I	3.2		
J. Affluent suburban housing	2.9	**Accommodation**	
K. Better off retirement areas	2.8	Flat/other	3.1
A. Agricultural areas	2.7	House	2.8
H. Mixed inner metropolitan areas	2.6		
I. High status non-family areas	2.4	**Social Class**	
B. Modern family housing, higher incomes.	2.4	Manual	3.2
C. Older housing of intermediate status	2.2	Non-manual	2.6
		Household income	
		£15,000 or more	3.3
		Under £15,000	2.6
Children in household		**Ethnic origin**	
Three +	4.5	Afro-Caribbean	3.6
Two	4.2	White	2.9
One	4.3	Asian	1.7
None	2.3		

Note: The ACORN typology used here is that based on 1981 census data. ACORN was developed by CACI on the basis of cluster analysis of some 40 Census variables including class, tenure, dwelling type and car ownership. Each Census Enumeration District has been assigned an ACORN code.

Institute of Child Health research

The Institute of Child Health (Roberts and Power, 1996) looked at childhood deaths by different social class between 1981 and 1991. As illustrated in Table 2.2 there are large variations in the rate of child deaths from fire and flame according to social class with the death rate for social class V children 13 times that of social class I to IIIN in 1989-92. At the same time the British Crime Survey suggests that the uptake of smoke detectors is lowest and the rate of fire is highest amongst council tenants.

Table 2.2 Death rates per 100,000 children by social class, 1979-83* (ages 1-15) and 1989-92 (ages 0-15).

	Rate per 100,000 (no)		
Social class	1979-83*	1989-92	% change
I	1.20 (7)	0.90 (5)	-28
II	1.00 (22)	0.90 (23)	-5
IIIN	0.90 (9)	1.10 (10)	+22
IIIM	2.80 (97)	2.40 (59)	-13
IV	4.10 (60)	4.90 (54)	+18
V	9.50 (46)	13.10 (47)	+39
Other	8.8 (87)	6.4 (115)	-31
Non-manual	1.00 (38)	0.96 (38)	-3
Manual	4.55 (290)	4.77 (275)	5

*excludes 1981.

Note: *these rates were quoted for a 4 year period. To get an annual rate of death per 100,000 children it is necessary to divide the above data by 4. Thus, the annual rate of death from fire for social class V children in 1989-92 was about 3.25 per 100,000 (or 32 per million compared with about 7.2 per million children of all classes in 1992)*

The work by the Institute of Child Health also indicates that there has been a significant increase in child fire-related mortality rates since 1979-83 amongst the manual social class and that the social class disparity has likewise increased. They found that deaths from fire:

- dropped by 28% in social class 1 and 5% in social class 2,
- increased by 18% in social class 4 and by 39% in social class 5.

The latter increase in fire related child mortality in manual social classes can be compared with a fall across all social classes in the child mortality rate from motor vehicle accidents, pedestrian accidents and poisoning since 1979-82. Also, whilst death from fire or flame accounts for about 6% of child mortality from injury and poisoning amongst social classes I, II and IIIN it accounts for about 13% and 16% of child mortality amongst social classes IV and V.

It is also important to note the 31% fall in child mortality rates in the "other" category (unoccupied and armed forces) set against an increase in the number of deaths from 87 to 115 between 1979-83 and 1989-92 in this category. The number of deaths in all other social classes fell or remained the same between these two periods. This was suggested to be a result of a change in the composition and size of the "other" category. In particular, they indicate that in 1979-82 the "other" category was dominated by economically inactive single parents dependent in income support. Notwithstanding the 3 fold increase in the number of single parents in the 1980's to 17% of all children, it is indicated that economically inactive single parents make up about 66% in 1989-92 instead of 89% of this category in 1979-83. The research also indicated that:

- the proportion of children with unemployed parents increased from 6 to 17% during this period,

- the number of families declared homeless doubled, with the number in temporary accommodation increasing nearly fivefold, in this period.

The authors suggest that the increase in manual social class child mortality in the 1980's is connected to the trend in housing situation of families with children, namely a five fold increase in households in temporary accommodation.

They conclude that:

> "The risk of residential fire is strongly related to the type and quality of housing. Fire risk is greater for those living in the poorest council housing and in temporary accommodation."

This latter research supports the findings of the British Crime Survey and further suggests that social variations in risk have grown in importance in the 1980's.

2.3 PREMISES RELATED VARIATIONS IN INJURY RATES

The variation in life loss between a sample of different occupancies is shown in Table 2.3, with dwellings presenting the greatest rate of life loss and injury per fire, and industrial fires the lowest rate of life loss and injury.

Table 2.3 Fatal and non-fatal injury rates per incident for various types of occupied premises (1992 data)

	Fatal injuries per incident	Non-fatal injuries per incident
Dwellings		
Single occupancy	1 in 100	1 in 5
Multi-occupancy	1 in 100	1 in 5
Elderly persons homes	1 in 100	1 in 6
Hotels, boarding houses etc	1 in 143	1 in 7
Children's homes, disabled homes etc	1 in 143	1 in 13
Psychiatric hospitals	1 in 143	1 in 25
Banking, insurance etc	1 in 500	1 in 17
Industrial	1 in 1111	1 in 16

The latter table also suggests that the casualty rate for fires in occupied dwellings is relatively high. Thus, whilst the majority of calls are unlikely to be serious and are handled with a minimum of firefighting resources, as illustrated below, any form of planning related risk assessment for residential areas needs to be able discriminate between calls to occupied dwellings and other calls. Planning resources on the principle of meeting the needs of a simple majority of incidents could lead to underprovision for the minority of incidents which account for the majority of losses. As elaborated below, the vast majority of calls involve the use of just 1 or no hoses;

- according to the "In The Line of Fire" report (p31), the vast majority (90%) of fire calls to occupied buildings are handled either without recourse to a hose (42%) or by use of a single hose (48%).

- with about 360,000 false alarms and about 45,000 of fires in occupied buildings (42% of all fires) not involving the use of hoses, the majority of fire calls do not involve the use of a hose.

The latter figures must be viewed in the context of a 1 in 100 fatality rate, a 1 in 5 injury rate and 1 in 20 rate of persons rescued by brigades in dwelling fires.

Clearly the quality of fire safety and subsequent fire risk varies between premises of the same occupancy. The impact of active fire protection is illustrated in Table 2.4 by the spread of fire in occupied buildings with and without smoke detection. Similarly, the fatality rate per fire

discovered by smoke detectors is about one third of the fatality rate for fires not discovered by smoke detectors, i.e. about 3 per 1000 fires versus 10 per 1000 fires.

Table 2.4 Impact of smoke detection on fire size (%)

Fire spread	Fires discovered by smoke alarms	Other fires
Confined to item	67	37
Beyond item but confined to room	31	52
Elsewhere in building	2	9
Beyond building	0	3

2.4 SPATIAL AND TEMPORAL VARIATIONS IN UNIFORMITY OF RISK

As elaborated below, the level of life risk within an area of broadly comparable building stock can vary spatially and temporally. Moreover, the extent to which these variations are apparent and the combination of variations differs between areas, with some areas more uniform than others.

SPATIAL VARIATIONS IN UNIFORMITY OF BUILDING STOCK

The uniformity of risk varies between areas, as illustrated below. Hence where the area is dominated by a single type of risk the need for site specific assessment may be less than other areas where no single type of risk predominates or where the predominating type of risk does not account for the majority of calls and/or losses.

- some rural areas tend to comprise broadly comparable densities and types of building stock,
- some rural areas have large plots of commercial forestry and national parks, some of which have involved fires demanding over 10 pumps, as well as business parks and retail centres.
- many residential areas comprise uniform building stock, particularly estates, and comparable levels of life risk throughout these areas,
- some urban areas do not conform to the traditional concentric pattern of development, with high density low quality buildings in the centre and less dense higher quality buildings in the suburbs. Rather some areas have very large low quality housing estates on the edge of urban areas as well as large out of town shopping centres and business parks.

- some urban areas have a greater mix of premises, as typified by B risk areas, where there is a mix of commercial, service sector and industrial premises and residential dwellings.

PREMISES RELATED VARIATIONS IN AREAS OF COMPARABLE OCCUPANCY

Moreover, risk is considered to vary within areas of comparable building stock in some parts of the UK, such as:

- areas dominated by commercial, industrial and service sector premises can have some premises with high levels of fire safety and protection and some premises with much lower levels of fire safety and protection, and/or higher level of flammable materials (including timber, polystyrene etc as well as highly flammable materials such as liquefied flammable gas)

- residential areas of broadly comparable building stock can comprise both modernised and unmodernised buildings, with unmodernised buildings displaying higher fire risk (such as modernised versus unmodernised Scottish tenements).

SOCIAL AND DEMOGRAPHIC VARIATIONS IN UNIFORMITY OF RISK

As suggested in section 2.1, the life risk in premises of comparable building stock can vary according to the age, physical and mental, and socio-economic attributes of the occupant. For example, children, elderly, deprived and impaired persons are regarded to experience higher risk than other occupants of the same building stock. Thus, life risk can vary across residential areas with comparable building stock due to occupant factors.

Consultation with brigades during this study suggested that there is no simple geographic pattern of affluence-deprivation. Market towns and old industrial towns and cities may conform to a traditional concentric patterns of commerce, mixed commerce and residential and then suburbs, with industrial towns tending to have an inner ring of lower quality housing. However, it was noted that there can be significant areas of low quality housing on the edge of towns and cities, particularly in the form of out of town local authority estates, areas of rural deprivation and resort areas where hotels have been converted into HMOs. Similarly, many inner city areas of housing have experienced redevelopment, presenting a more mixed picture.

TEMPORAL VARIATIONS IN RISK

The extent to which the number of incidents vary across day and night, and seasonally may not be consistent across areas of comparable building stock but may instead vary according to the predominant occupancy in an area, as exemplified below. Accordingly, the way in which fire cover should vary temporally may also vary between areas of comparable building stock.

- The number of calls can vary enormously across day and night. Similarly, there is a mass depopulation of the City of London over night. However, other A and B risk areas in the UK may not exhibit comparable temporal variations, particularly where there is greater mix of commercial and recreational premises in city centres,

i.e daytime office populations are replaced to some extent by evening leisure and residential populations. Also, the number of night time calls can vary across the years.

- Inversely "dormitory" towns and centres of entertainment typically have a higher level of habitation in the evenings and night time than during the day time.

- As well as a national variation in the number of incidents across the year, certain parts of the UK have some risks which are more pronounced at certain times of the year, such as

  - high levels of habitation of hotels and boarding homes during spring, festive and summer periods at resorts, with many hotels either sparsely occupied or closed during off-peak periods. Thus, certain areas with large number of hotels etc may experience high seasonal variations. However, other areas may experience less seasonal variation in hotel usage, such as major cities.

  - high levels of secondary fires involving heathland, forests etc in certain rural areas during spring and summer periods.

- some areas have experienced rapid changes in building stock and/or occupancy in relatively short periods of time, such as the 1980's decline in heavy industry in the West Midlands which was followed in the late 1980s and 1990s by an increase in large out of town shopping complexes, light industry and (to some extent) introduction of some new medium-heavy industry.

2.5 VARIATIONS IN DOMINANT TYPES OF RISKS

The range and type of "normal" fire risk can vary between brigades. Given that the emphasis on certain types of skills and resources may vary for different types of risk, such as industrial risks versus hotel risks, the type and weight of response may vary between areas of comparable building size and density. As illustrated in Tables 2.5 to 2.7, brigades with comparable populations can vary, such as:

- Greater Manchester having a much higher level of offices than West Midlands, but West Midlands having a great many more non-certificated factories, Section 72 of the Building Act flats and HMOs.
- Avon having twice as many offices but less than half of the non-certificated offices as Derbyshire.
- Dorset having many more certificated Hotels, Section 72 flats and HMOs than Durham (as well as many more Hotels than either Manchester or West Midlands).

Thus, as might be expected, the reported mix of properties can vary between metropolitan and between non-metropolitan brigades with comparably sized populations, reflecting the predominant commercial activities in each area, such as leisure versus office based services versus industrial activities.

Table 2.5 Number of types of premises in two comparably populated metropolitan brigades (circa 2,500,000 population)

Brigade	Non-certificated factories	Certificated offices	Flats (sect: 72 of building act), HMOs hostels and HMO flatlets
West Midlands	12298	2769	5249
Greater Manchester	1488	4799	249

Table 2.6 Number of certificated offices and non-certificated factories in two comparably populated non-metropolitan brigade (circa 900,000 population)

Brigade	Non-certificated factories	Certificated Offices
Avon	1134	1627
Derbyshire	2892	788

Table 2.7 Number of types of premises in two comparably less populated non-metropolitan brigades (each circa 550,000 population and circa 250,000 hectares).

Brigade	Certificated Hotels	Non-certificated factories	Certificated shops	Flats (sect: 72 of building act), HMOs hostels & flatlets
Dorset	1331	2367	253	3985
Durham	229	919	0	250

Similarly, the relative importance of agricultural and secondary fire risks is greater in certain parts of the UK, such as areas with high levels of commercial forestry and/or recreational open space such as national parks.

Similarly, whilst some brigade areas can include just a few examples of “special” risk, other brigade areas can involve a much higher level and range of special risk. Also, the type of special risk varies, from tunnels and large retail complexes to CIMAH sites and shipping. Thus, the issues arising from special risks as well as the importance attached to the assessment of special risks may vary between areas. For example;

- West Midlands includes 8 CIMAH sites, major road junctions, NEC, Merryhill retail complex, clusters of very tall low quality residential tower blocks, etc

- London includes over 100 underground stations, extensive tunnel networks, 4 airports, a number of CIMAH sites, numerous office and residential tower blocks, shopping complexes, railway junctions, etc
- Mid and West Wales have 7 CIMAH sites, major shipping lanes, docks, & St Davids Cathedral, large expanses of commercial forestry,
- Kent includes Rochester and Canterbury cathedral, a high level of heritage such as the old town of Canterbury, Sheerness Dover Folkstone and Ramsgate docks, Channel Tunnel, Dungeness nuclear power station, Bluewater shopping centre, out of town boarding schools, poorly protected uncompartmented large paper stores.

2.6 VARIATIONS IN LIFE LOSS

Given the variations in risk described in sections 2.2 to 2.5 it is perhaps unsurprising that there are large variations in the rate of fire related casualties between areas as illustrated in Figure 2.1, namely:

- there is a 6 fold variation in the casualty rate per head of population across brigades, with about 600 fire casualties per 1,000,000 people in one metropolitan brigade and less than 100 casualties per 1,000,000 people in Warwickshire.

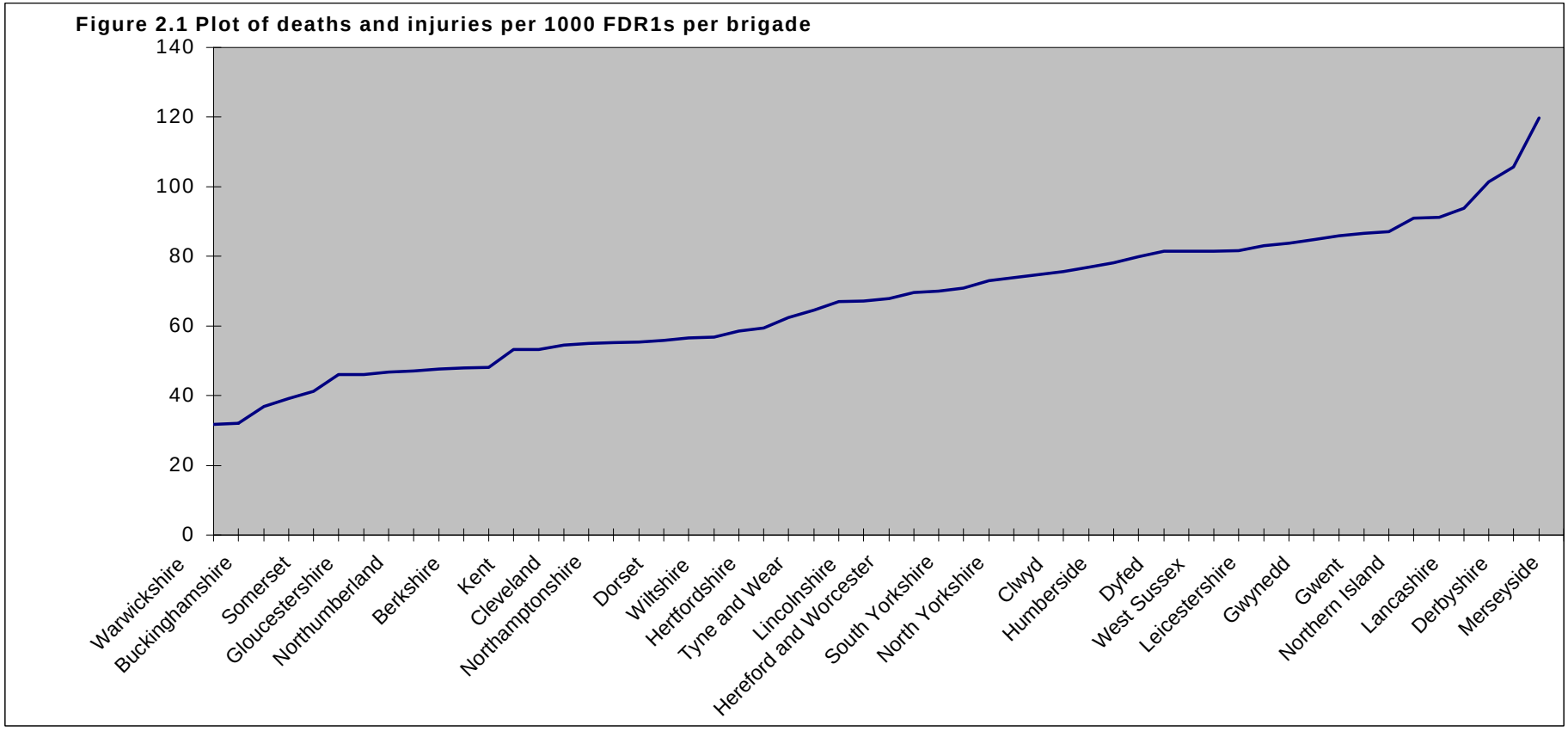
- there is a 4 fold variation in the number of casualties per 1000 FDR1s across brigades, with about 120 casualties per 1000 FDR1s in Merseyside and about 30 per 1000 FDR1s in Warwickshire.

Also, based on 1993/94 fire reports, there is a statistically significant, if low, positive correlation (a pearson product correlation of 0.267) between the number of people in a brigade area and the number of deaths and injuries per 1000 FDR1s, i.e as the number of people in a brigade's area increases so does the likelihood of a death or injury per fire. This is comparable with the finding of the In The Line of Fire report that the casualty rate per fire is highest in B and C risk areas (p29). Consequently brigades with higher proportions of B and C risk areas are likely to exhibit higher rates of casualties.

It is also interesting to note that there is a statistically significant, if low again correlation of 0.287 ($p < 5\%$) between the number of fires and the number of deaths and injuries per 1000 FDR1s, i.e. the more fires that occur the greater the likelihood of a death or injury per fire. Thus, not only do more populated areas have more fires but each fire is more likely to involve a casualty.

Note: a correlation of 0 means that there is no statistical relationship between two sets of data, whilst a correlation of 1 means that as one factor increases so does another, and a negative correlation of -1 means that as one factor increases so another decreases. A $p < 5\%$ means there is less than a 5% (1 in 20) chance of the correlation being spurious.

Figure 2.1 Plot of deaths and injuries per 1000 FDR1s per brigade



2.7 SPECIAL SERVICES AND RTAs

2.7.1 Variation in number of fire versus special service incidents

Based on 1993/94 data, there is a significant negative correlation of -0.28 between the per centage of total incidents which are special services and the population per hectare, i.e. as the population per hectare decreases so special services tend to comprise a greater proportion of all incidents, with some exceptions. For example, special services comprised 28.3% of Gwynedd incidents versus 6.9% of Tyne and Wear's incidents in 1993/94. London is an exception where 34.1% of 1993/94 incidents were special services, mainly lift-related. It is also interesting to note that there is no significant correlation between the number of FDR1s and the number of special service incidents in the UK, with a correlation of only 0.07.

In addition, taking Hereford and Worcester as an example, there were (based on 1994 data):

- 161 people released from 521 RTAs
- 76 people released from other special services
- 32 people rescued from fires (with 1887 primary fires in total)
- 6 fatalities at fires
- 70 casualties at fires

Thus, whilst deaths due to vehicle fires comprise a minority of total fire related deaths, brigades can release more people from RTAs and other emergency incidents than are rescued from fires.

2.7.2 Variations in risk between special service calls

The life risk and resource needs of special service calls varies significantly. For example, based on 1994 data, for Hereford and Worcester,

- 1 in 3 RTAs involve releasing a person (i.e. 161 releases from 521 RTAs)
- 1 in 12.5 emergency special services calls (excluding RTAs) involved releasing a person.

2.8 IMPLICATIONS FOR RISK ASSESSMENT

The variations in rates of losses and types of risk between areas and between premises outlined in the preceding sections suggest that fire risk is not determined by the density of population and buildings and type of occupancy alone. In particular, fire risk appears to be related to occupant characteristics, engineered fire safety, fire safety management (including security), the level of arson in the area as well as occupancy, construction and proximity to other hazards, as illustrated in Table 2.8. Thus, fire risk in two buildings of comparable

construction, occupancy and proximity to other buildings can differ due to variations in these other factors.

TABLE 2.8 SUMMARY OF FIRE RISK FACTORS

Occupancy • fire loading, • ignition sources, • toxicity/flammability of materials, • spacing between flammable materials, • number of occupants, • sleeping risk.	**Occupants** • mobility and mental agility, • vulnerability to effects of smoke and fire, • fire related behaviour, • fire education, • familiarity with building layout.
Fire safety management • hot work control, • storage and separation of materials, • fire drills & staff training, • building security & security of fire protection, • emergency management and fire officers, • maintenance of fire doors, duct seals, exits and sprinklers etc.	**Engineered fire safety/protection** • AFD & smoke & heat detectors, • smoke control, (forced ventilation, shutters etc) • fire suppression, • fire protected escape routes, • sprinkler water supply reliability (mains vs pumped, secured vs unsecured)
Locality risk • level of arson in area, • nature of adjacent risks, • water supplies, • proximity to adjacent risks.	**Construction** • structural fire resistance, • compartment size and separation, • number of floors, atria, open staircases, • fire doors, roof voids, ducts etc • internal layout & distance to “safe” areas.

It is concluded that a risk assessment toolkit needs to be sufficiently flexible to support:

- assessment of qualitatively different types of risk,
- assessment of areas predominated by a uniform type of risk as well as the assessment of areas with a wide range of risks,
- identification of areas where risk is sensitive to occupant factors as opposed to building stock factors,
- modelling of different temporal variations in risk.

3. PURPOSE AND USE OF RISK ASSESSMENT TOOLKIT

3.1 OVERVIEW

An outline of a toolkit is shown in Figure 3.1. The figure includes questions regarding the uniformity and types of risks in areas. Depending on the answers to these questions, a brigade is directed towards RISK CATEGORISATION and/or RISK ASSESSMENT, preceded in both cases by an assessment of the potential for prevention strategies to reduce losses. A distinction is made hereafter between:

NATIONAL RISK ASSESSMENT, defined as the assessment of risk at a national level for the purposes of defining risk categories, service planning guidelines and priorities for fire safety education and review of building regulations.

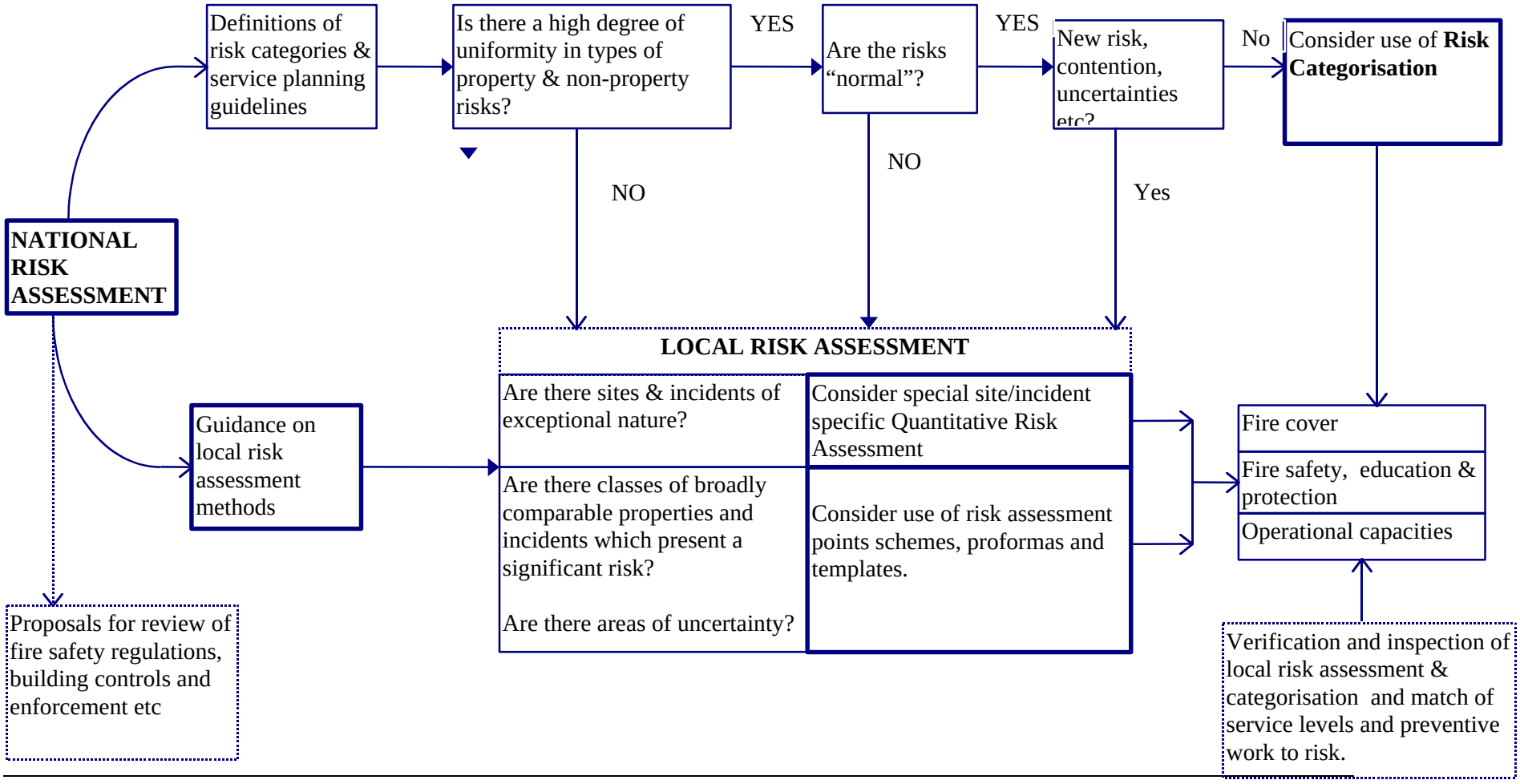
RISK CATEGORISATION, defined as the use of categories relating to the risk associated with different types of areas according to the dominant type of premise and/or non-premise risk.

LOCAL RISK ASSESSMENT, defined as the application of methods to individual sites, types of premises and types of incidents which may or may not be located in the same area.

The principles of the toolkit design are that:

- risk categories and associated service planning guidelines be developed through a process of national level risk assessment of the “as is” situation,
- risk categorisation could be used locally for fire cover decisions in areas of low risk and areas with uniform types of “normal” risks,
- the potential for fire safety, education and prevention work to reduce losses should be given special consideration for areas of high risk, with the goal of reducing fire risk over time,
- local risk assessment could be used for fire education, safety, prevention, fire cover and operational capacity decisions in areas of high risk, special risk or non-uniform risk,
- all risk categories and associated standards should be based on empirical assessment of risk, taking account of the number of fires, occupant characteristics and fire safety, as well as construction, occupancy and number of occupants,

FIGURE 3.1 OVERVIEW OF RISK ASSESSMENT TOOLKIT



- a more flexible and dynamic form of response standards should be developed to facilitate (as necessary) the matching of service levels to local circumstance, and subsequent change of service levels in reaction to changes in circumstance:

- local and national risk assessment methods should be available to evaluate changes to standards, procedures and equipment etc.

Given that a brigade may comprise both high and low risk areas, any individual brigade could draw on both Risk Categorisation and Local Risk Assessment. The size of an "area" would not be predefined for the purposes of risk assessment. Instead areas could be denoted solely on the type and level of risk in a geographically discernible space. Thus, the size of an area could range from (say) 2500 km^2, such as the whole of a brigade's D risk area, through (say) 1 km^2 areas such as housing estates, to 100m x 100m blocks of high risk buildings in an otherwise low risk area.

3.2 DESIGNATION OF HIGH AND LOW RISK

The toolkit would include guidance on what comprises HIGH, INTERMEDIATE and LOW risk, based on an assessment of the variation in the rate of deaths, injuries and large fires both across the UK, between discernible groups of people and between occupancies/building stock. The guidance would be based on a statistical analysis of historical records, namely fire service reports and census information.

Subsequently, these criteria could be used to identify discernible groups of people and premises who are experiencing a high level of risk as well as designating areas experiencing high levels of other events, such as RTAs, for the purposes of both targeting fire safety education and fire cover review. Such groups could comprise occupants of certain types of dwellings, age groups, ethnic groups or socio-economic groups, areas of a socio-economic status and types of commercial properties etc.

The purpose of assessing the risk of death and injury for sub-categories of people can be illustrated by the following comparison of child fire deaths amongst social classes. Given that there is factor of 13 difference in the rate of child death from fire between social class I and V (with social class I rate being one third of the average for all children), and a rate of death of 15 per million children aged 1 to 4, if it is assumed that the social class disparity applies to all age groups, this would suggest that the annual rate of death for children aged 1 to 4 is:

- 1 in 200,000 (5 per million) amongst social class I, and;

- 1 in 14,400 (69.6 per million) amongst social class V.

Clearly, any additional effort focused on social class V households with children would be much more cost effective than comparable effort spread across all households, assuming the effort was equally successful across all social classes. Consequently, any cost benefit analysis which does not distinguish between households in terms of social class is likely to over state the cost to benefit ratio for manual social classes. Moreover, any review of the tolerability of

risk which similarly fails to distinguish between social classes and age groups will underestimate the risk incurred by "the most exposed group", namely children aged 1 to 4 in manual class households.

The idea of specifying quantitative morbidity targets is not new. Indeed, the Department of Health stated a target of reducing childhood (age <15) accidental deaths from 6.7 per 100,000 population in 1990 to no more than 4.5 per 100,000 population by the year 2005, as part of *The Health of the nation: a strategy for health in England.* This target covers childhood deaths from fire and flames which account for about 14% of all childhood accidental deaths, and about 22% of accidental deaths of children aged 28 days to 4 year.

3.3 NATIONAL LEVEL RISK ASSESSMENT

This would involve:

- completing risk assessments of discernible classes of premises and special service incidents to determine the optimal mix of preventive (fire safety education and fire safety regulations) and response standards, giving due regard to the balance of risk and cost of each option,

- the national Risk Assessment (of the sizes of fire, casualty rates and rate of fire and smoke growth) would be used in the definition and any subsequent revision of categories and national minimum response standards, taking account of the frequency and severity of fire in different types of premises, occupancies and for types of occupants.

- developing a set of risk categories and service planning guidelines on the results of the latter risk assessment (with response standards based on the "as is" situation), including a reference to risk categories where local fire safety education should be targeted,

- specifying those types of areas and occupancies where national fire safety and fire safety education initiatives should be targeted.

3.4 LOCAL TARGETING OF FIRE SAFETY, EDUCATION AND PREVENTION

The proposed use of risk assessment to target local fire safety education on particular groups of people, premises and issues is consistent with the Health Education Authority finding that:

"For a range of community-wide interventions the key to success is the sustained use of population surveillance systems and commitment to inter-agency co-operation. Surveillance systems provide local information to target preventive actions, stimulate local interest in the injury problem and provide an operational monitoring and feedback tool to evaluate the effect of preventive programmes." (p2, HEA 1993)

Fire safety education

Fire education work could be advocated in high risk areas to reduce the level of losses, particularly where there is little opportunity for a faster response to avert losses. Given that the majority of life losses involve domestic dwellings, the assessment of local fire education needs relies on use of fire reports, fire statistics and survey of local uptake of fire safety. This would aim to characterise the circumstances of incidents according to, for example;

- causes of fire,
- contributors to fire growth,
- casualty behaviour,
- location of casualties, such as room of origin vs room remote from fire origin.

The objective of this assessment is to provide information on which to judge the opportunity for fire education work to reduce the incidence of such fires and casualties, and thereafter target such work on particular groups of people and causes of fire and harm.

Fire safety and protection

Given that fire safety focuses on certificated premises and non-certificated commercial premises, this involves site specific assessments and assessment of categories of premises. The risk assessment methods noted in section 3.6 could be drawn on to assist in risk rating premises for the purposes of exemption, inspection schedules and fire safety/protection advice.

3.5 FIRE COVER RISK CATEGORISATION

As conveyed by the questions shown in Figure 3.1, the toolkit envisages that Risk Categories be considered for use where there is a low level of risk or a high degree of uniformity in the types of risks and the risks are “normal”. As illustrated in section 4.0, these categories would comprise prose based descriptions linked to a set of national minimum response standards, as with the current risk categories. However, there would be a number of key differences in the design of the categories and associated standards, namely;

1. Categories and response standards would be developed for life threatening special service incidents (based on an assessment of the casualty’s clinical needs and knock-on effects of RTA such as congestion and secondary RTAs).

2. The wording of standards would be revised to reflect the importance of life risk and the associated requirement for both rescue and fire fighting resources.

3. Response standards could be defined in two parts, namely:

- the tasks, such as suppression of a confined undeveloping fire in a small isolated industrial unit (of up to about 300m^2), upon which the pre-determined initial response is "designed",

- a guideline, based on current technology and costs, of the speed and composition of response required to achieve these tasks, such as 2 high pressure hose teams (capable of suppressing an undeveloping confined fire) and an OIC trained in command, without specifying the exact number of personnel or type of equipment.

Thus, facilitating use of different types of equipment, such as use of Land Rover based water jets for heathland fires, and procedures.

4. The weight of response would be varied according to the "design task" such that more resources are called on for larger scale incidents.

5. Quantitative measures of the likelihood of more serious fires could be included to allow for verification of risk categories applied to areas.

6. The design task could vary according to time of day/time of year where there are distinct patterns of habitation, clear variations in risk between types of calls from the same premise (such as AFAs from well protected premises versus other calls), non-life threatening special service incidents and isolated secondary fires in low risk areas.

As the categories include reference to the incidence of fire and occupant characteristics, designation of areas would benefit from analysis of fire reports as well as scrutiny of fire safety management and occupant characteristics. Ideally this would include a projection of fire demand, based on trend analysis and examination of local authority development plans.

3.6 LOCALLY APPLIED RISK ASSESSMENT

Risk Assessment would be considered locally by brigades for high risk areas, areas with a mix of significant risks, special fire risks and special service incidents involving significant imminent life and/or environmental risk. A suite of methods, ranging from simple points based systems up to Quantitative Risk Assessment, would be made available which brigades could draw on as appropriate for the type of risks in these areas. The suite of methods would range from detailed site specific forms of assessment down to less exhaustive forms of assessment such as points based schemes and templates which could support assessment of large numbers of properties and special service incidents. These methods could also be used for generating fire safety advice and site risk classification (for sake of inspection frequency) as well as for fire cover and competence decisions.

3.7 LOCAL RISK ASSESSMENT AND NATIONAL MINIMUM RESPONSE STANDARDS.

As illustrated in section 8.0 of this report, it is envisaged that:

- the Risk Categories and Risk Assessment methods be so designed that the results can be related to a common set of minimum response standards analogous to the current area based minimum response standards,

- site specific Risk Assessment methods be provided to define site specific predetermined responses (as per current special risks).

Thus, the only difference between an area assessed using Risk Categories and an area assessed using Risk Assessment would be that a single response standard would be selected for planning purposes in the former area whilst a number of response standards could apply to different types of properties in the latter area. For example, an area dominated by large poorly protected commercial buildings could receive the same response as individual poorly protected commercial buildings in an area surveyed using risk assessment. However, a different response standard could apply to well protected commercial properties in the area surveyed using risk assessment.

In addition, the "design task" selected for an area could vary across times of day/time of the year.

3.8 LINKING DESIGN TASKS TO OPERATIONAL CAPACITY

The toolkit could include guidance on how to define the hazards and operational demands to be expected in "design tasks" to a sufficient level for the personnel, training and equipment implications to be recognised. Such a method should be sufficiently flexible to allow alternative forms of training, equipment, mobilisation arrangements etc to be considered. The goal of such assessment could be to demonstrate that a satisfactory level of operational capacity would be achieved in a cost-effective manner through the proposed arrangement. The toolkit could provide guidance on the form that such assessment may take. However, as the issues cannot be wholly defined in advance it is unlikely that a single method or suite of methods could be prescribed. Instead, the form of assessment would probably need to be designed on a case by case basis, within the bounds of guidance within the toolkit, as issues and proposals become apparent.

3.9 INTER-ASSESSMENT CONSISTENCY AND VERIFICATION

In order to assure inter-assessment consistency it is suggested that:

- quantitative criteria are included in risk categories for verifying (where the risk category of an area is not certain) that there is a distinction in the risk posed by two groups of dwellings which differ only in terms of the social-demographic characteristics of the occupants and their uptake of fire safety,

- a process for verifying the accuracy of risk categorisation be developed which involves comparing the size and scale of actual fires in an area with its risk category,
- the level of inspection of fire safety education is increased to ensure that an appropriate level of effort is being applied to the prevention of unconfined fires and entrapment of persons,
- a process be developed for ensuring that risk assessment methods used by different brigades do not lead to unwarranted variations in service levels.

These parts of the toolkit are outlined in Table 3.1 below. These options can be seen to be complimentary to one another.

Table 3.1 Verification and consistency of risk assessment/risk categories

OPTION 1: Formal approval prior to use. Require a central body, such as a sub-committee of the CFBAC, to review and approve fire cover, fire education and fire safety risk assessment methods prior to application by brigades.	**OPTION 2: Occasional inspection of methods and their application by HMFSI** Include review of risk assessment methods and their application in inspections carried out by HMFSI.
OPTION 3: Occasional inspection of match of risk assessment/categorisation with rate of fires etc Inspect the match of risk categories with local rates of FDR1 fires, casualties and rescues, to judge if category reflects level of losses and fires, and whether sufficient emphasis is given to fire education versus response.	**OPTION 4: Guidance** Subsequent to disseminating Home Office guidance on risk assessment methods allow brigades to develop and apply assessment methods to match their own needs and circumstance.

3.10 BALANCING RISK ASSESSMENT AND OTHER CONSIDERATIONS

Risk assessment or the results of risk assessment can be drawn on for a number of different "risk communication" purposes, including:

- governmental legislative and policy decision making,
- education of the public, government and professions and other agencies,
- persuasion,
- generation of a response and dialogue,
- provision of information.

With the goal of ensuring that the perceived level of risk matches some "objective" measure of risk and that subsequent behaviour and decisions are proportionate to this level of risk. Accordingly, the ultimate goal of the risk communication can be to either prompt recognition and awareness of a high risk where it is considered that the risk is currently under rated or to moderate the perception of risk where it is considered that the risk is over stated. It is envisaged that the methods and results of the toolkit could be used for both purposes.

Firstly, in the context of the proposed toolkit it is pertinent to note the findings of the 1993 Health Education Authority review of the effectiveness of health promotion interventions:

> "...local injury data are necessary to gain the support of local authority organisations and the population who may not believe that the problem exists in their community.
>
> ...education and technical assistance to professionals and decision makers is equally important to change their perception about the preventability of injuries and to increase their awareness of the magnitude of the injury problem and related medical and social costs.
>
> ...the capacity to bring about legal and environmental change is often based on a change in a climate of opinion resulting from educational campaigns."

With regard to the proposed toolkit it is suggested that the analysis of local rates of fires and casualties, and their division into sub-categories of people and premises comprises a local "surveillance system" to be used to target local fire safety interventions, to stimulate interest and evaluate impact of such interventions, whether they are targeted on local authorities or the local population. Similarly, national analysis of rates of fires and casualties would likewise be used in governmental decision making and evaluation of the effectiveness of interventions.

It is likewise envisaged that the results of risk assessment be used in the process of decision making and consultation regarding fire cover. However, it is suggested that experience elsewhere has shown that the results of risk assessment are more effectively presented in a non-quantitative manner to non-specialist audiences, such as the public, whilst governmental bodies and professions often require quantitative information. Moreover, there is ample evidence that communication of risk is more complex than the simple statement of scientific facts. People perceive certain activities and hazards as considerably more dangerous than the actual risk indicates. Conversely, people also often appear unwilling to accept certain risks as being significant despite a preponderance of scientific information indicating the high likelihood of adverse effects. Consequently, there have been occasions where governmental decisions based on scientific evidence have not been wholly accepted regardless of the stated evidence. Whilst there are many factors contributing to this phenomenon, some of the more important factors include:

- **aversion to the type of hazard.** Perception of some risks are determined more by the level of aversion to the manner of harm than the likelihood of harm. One consequence of such perception is that a hazard can be perceived as being

unacceptable, regardless of the measured level of risk. For example, would any risk however low of child molestation be construed as “acceptable”?

- **scientific uncertainty.** On other occasions the scientific statement of risk has been rejected on the grounds of uncertainty, namely that the level of risk cannot be stated with certainty and hence may be greater than indicated. This is particularly likely where new evidence regarding the risk posed by a hazard emerges over time, with the potential to contradict earlier risk estimates.

- **equity.** The level of protection against a hazard should be equal across all groups of people regardless of the measured risk for each group.

- **source credibility.** The validity of the scientific risk estimate is conditioned by the degree of trust placed in the source.

Notwithstanding the latter, the development of more robust service planning guidelines and objective risk assessment should provide a basis for such consultations.

Also, factors other than the balance of risk and cost can play a role in deciding how to respond to a risk, such as public expectation and local socio-economic factors. For example, whilst local authorities are obliged to seek advice from the Health and Safety Executive regarding whether building developments should be allowed to proceed in the vicinity of major hazard installations, the local authority retains the authority to accept or reject planning applications. This arrangement allows the local authority to take account of local social and economic considerations, such as whether it seeks to improve local community facilities or attract new industry into the area. Thus, the local authority may proceed with a residential, community facility or commercial development despite advice from the HSE suggesting otherwise. However, the HSE can, and does, appeal against an authority’s decision to allow a development to proceed. In the event of an appeal a public inquiry is held regarding the proposed development at which the HSE would present its objections.

It is suggested that risk assessment be viewed as just one source of information, although important, to be drawn on in the decision making process regarding service levels. In the context of the risk assessment toolkit it is suggested that the toolkit be viewed as;

- providing information for use in local and national government decision making,

- providing information for use in fire safety education initiatives,

- providing an objective assessment of risk for use in the process of consultation regarding the provision of fire brigade services,

- providing a more meaningful statement of expectations regarding the role of the initial response (namely the “design task”) and hence a more meaningful basis for discussing the composition of the initial response.

In addition, it is also possible to build public expectations into the process of risk assessment. For example, the toolkit could include a presumption that a certain minimum level of response will be provided in all areas (perhaps exempting remote rural areas) regardless of the assessed level of risk. Clearly, the form of this minimum level of response would be conditioned by the evidence that it is not wholly warranted on the grounds of risk, i.e. the cost should be kept to an absolute minimum.

Finally, it is suggested that the broader issue of risk communication be considered as an issue in its own right outside of the design of this toolkit, and that guidance on the process of communicating risk be developed separately.

4. RESOURCE IMPLICATIONS

POINTS COVERED HERE

- national level risk assessment is equivalent to 1980-85 review of fire cover,
- additional work called on for local risk categorisation and assessment only where level of uncertainty or importance of outcome of review warrants it,
- risk category of most rural areas, low risk suburbs and poorly protected industrial/commercial properties unlikely to change or require detailed review,
- new forms of categorisation and assessment of residential areas to be carried out by station watches and central operations departments,
- survey of non-domestic premises could be subsumed in 1iD and fire safety inspection work,
- potential increase in local assessment can be handled by brigades within current staff resources,
- demand for additional information, IT and specialist risk assessment support likely to increase,
- pilot study is required to provide a firm estimate of the resources required to apply toolkit.

4.1 ASSESSMENT RESOURCES

NATIONAL LEVEL RISK ASSESSMENT

It is suggested that the completion of a national level risk assessment, for the purposes of developing risk categories and service planning guidelines, would be equivalent to the 1980-85 review of standards of fire cover, in that:

- it would be carried out on an occasional basis, say every 5 to 10 years,
- it would be carried out using an ad hoc project team.

and hence would not significantly impact brigade resources.

LOCAL RISK CATEGORISATION AND RISK ASSESSMENT

It is suggested that the likely impact of the new form of risk categories and local risk assessment on the level of resources needed by brigades to survey areas will vary between brigades according to:

1. The level of uncertainty in the risk in areas, with;

- the risk category of the vast majority of rural areas, industrial areas predominated by poorly protected units and suburban areas with low rates of fire and life loss, unlikely to change or present uncertainties,

- the risk category of mixed (low and high quality residences) residential areas and commercial premises (offices, retail outlets and industry) with high levels of fire protection likely to present less clear cut risk.

Indeed, consultation with brigades during this study indicated that they are able to swiftly distinguish residential and commercial areas with different rates of fires, fire spread and life loss through subjective judgement, based on their understanding of fire experience. For example, West and Mid Wales identified local authority housing estates around Swansea, and the Haverfordwest MOD estates, West Midlands identified Castle Vale and Handsworth and Kent identified Thanet HMOs, Swanley and local authority housing on the southern edge of Maidstone and Dartford as posing a particularly high risk of fire, injury and fire spread.

2. The frequency of fire cover review carried out by brigades, with;

    - those brigades who review risk categories on a continuous basis likely to require less resurvey than others.

3. Potential impact of new risk categories on fire cover, with;

    - less demand to verify new risk categories by analysis of fire statistics and surveys of premises where the outcome of such an assessment is unlikely to impact fire cover, versus;

    - greater demand for verification of risk categories, perhaps in the form of a quantitative review of the size of fires and rates of persons reported, where the outcome of such a review might alter the recommended fire cover and/or emphasis placed on local fire safety initiatives.

Thus, the new form of risk categorisation can be introduced in such a way that additional work required to establish a new risk category need only be incurred where the degree of uncertainty or importance of the outcome of the review warrants such work.

Notwithstanding these potential variations, feedback from West Midlands and Mid and West Wales fire brigades suggests that:

- the time required to survey an urban area might increase by 100% with the new forms of risk categories, however this was not considered to be prohibitive, i.e. it could still be accommodated in brigade workloads if with some reprioritisation of tasks. In addition, the In the Line of Fire report suggested that time could be “freed up” by placing greater limits on stand down time.
- the skills required to apply the vast majority of the proposed toolkit exist within fire brigades,

- the new forms of prose based risk categorisation could be applied by watches and station officers, with co-ordination and augmentation (i.e. analysis of fire statistics) by central fire safety or operations units,
- the assessment of non-domestic premises could be completed on a rolling basis via the 1iD process and fire safety inspections,
- fire safety officers and/or central operations support departments could undertake the more complex forms of local risk assessment, with the possible exception of Quantitative Risk Assessment for which either a specialist capability would need to be developed or external persons used on an exceptional basis.

In addition, it was suggested by one brigade, consulted during this study, that the "Proposals for widening exemption from fire certification" could allow the redeployment of fire safety officer time from fire certification work to supporting the proposed risk assessment work. However, it is not within the capacity of this study to verify this.

If it is presumed that 50% of areas covered by whole time stations will require more detailed review and that the survey of these accounts for the majority (say 80%) of fire cover review work, it could be judged that the new forms of categorisation may incur a 40% increase in the time required for fire cover reviews across the UK. However, a large proportion of this time could be subsumed within 1iD and fire safety inspections.

FREQUENCY OF RISK CATEGORISATION AND ASSESSMENT BY BRIGADES

Given a reference to fire incidence, fire safety/protection & social demographics the frequency of review would need to match the frequency of changes in these features within an area. Given that the rate of change in social-demographic characteristics of residential areas and fire safety quality of commercial/industrial buildings can change faster that the density and occupancy of premises it is likely that the new forms of risk categorisation and assessment will require a higher frequency of review in some areas.

It is suggested here that the mechanism of station watches continuously identifying where significant changes may have occurred and hence warrant review, and operations departments reviewing local authority development plans, as practised in at least one of the brigades consulted in this study, would provide a sufficient means of prompting a rolling process of reviews. Hence there is no change in the principle of reviewing fire cover in response to significant changes in risk. However, it would be useful for brigades to also review fire statistics on a continuos basis to identify trends in the size of fires, time of day variations and casualty rates, hence providing another means of identifying changes in risk.

4.2 DATA & SPECIALIST SUPPORT NEEDS

DATA

A large amount of information is already available, as witnessed by the specification of rates of fire and fire size in HMOs by Buckinghamshire fire brigade (Dugdale and Draper 1993) shown in Appendix B, which should allow risk assessments to be carried out. In addition, West and Mid Wales fire brigade were able to retrospectively sub-divide fatal fires into in low quality and high quality dwellings, based on their knowledge of local social-economic, as shown in Exhibit 4.1. This information was sufficient to be used in lobbying local authorities to install mains supplied smoke detectors and for a limited evaluation of the effectiveness of this measure.

However, experience in other industries has been that as the importance of risk assessment increases so does the demand for more accurate, comprehensive and precise information. Consequently, it is anticipated that the development and application of new risk categorisation and risk assessment methods is likely to reveal the need for additional data and information, such as additional information on:

- the size of fires & fire spread out of rooms of origin and to other floors,
- effectiveness of active fire suppression, such as a sprinkler failure rates,
- rates of fire in well protected versus less well protected premises,
- the effectiveness of local fire safety education initiatives,
- hazards posed by fire and smoke to fire fighters as well as occupants.

Other industries have developed shared data sources and data bases in response to these demands, such as the:

- Offshore Reliability Database(OREDA), which is a collation of failure rate data for offshore oil and gas platform equipment,
- IChemE, incident database, which provides qualitative information on the causes of process industry accidents and the behaviour of gases etc upon release.

It is suggested that the need for a shared incident database is particularly pronounced in the case of new constructions where there may be insufficient experience in any single brigade to assess the risks. The development of “real fire data libraries” by certain brigades suggests that it is already within the capacity of brigades to develop such data and information.

EXHIBIT 4.1

The table below summarises the number of fire related deaths in dwellings judged by brigade staff to be of low versus high quality in the southern and western command regions of Mid & West Wales Fire Brigade. Low quality was taken to include housing in a poor state of repair in areas of deprivation or low economic status. The table suggests that:

- the vast majority of deaths in higher quality housing involved a single fatality,
- there were more multi-fatality fires in lower quality than in higher quality housing,
- overall there were 50% more fatalities in lower quality housing than in higher quality housing.

The average number of fatalities over 1991 to 1993 and 1993 to 1995 for low versus high quality housing was:

	1991-93	1993-1995
Low quality	8	3.3
High quality	3	4
Both	11.6	7.33

It is interesting to note that the local authorities increased the rate of installation of mains supplied smoke detectors after 1992. Whilst the number of fatalities per year clearly varies considerably and may not comprise a reliable indicator of overall trends in mortality, the fall in the number of deaths in lower quality housing could nevertheless be related to the Local Authority initiative.

Note: Information on the proportion of population residing in low versus high quality housing was not readily available to estimate the fatality rates per head of population.

Year	HMOs & low quality housing			Sub-total	Higher quality housing			Sub-total	Total
	1	2 to 4	5 to 9		1	2 to 4	5 to 9		
*1990**	*3*	*0*	*0*	*3*	*1*	*0*	*0*	*1*	*4*
1991	0	6 (2+4)	0	6	5	0	0	5	11
1992	4	7 (4+3)	0	11	3	0	0	3	14
1993	3	0	6 (6)	9	1	0	0	1	10
1994	0	0	0	0	2	0	0	2	2
1995	1	0	0	1	7	2 (2)	0	9	10
Total	11	13	6	30	19	2	0	21	51

SPECIALIST SUPPORT

It is also pertinent to note that other major governmental users of risk assessment have developed an in-house specialist risk assessment capability, including:

- to discharge the Health and Safety Executive duty of providing advice to local authorities on proposed developments in the vicinity of CIMAH sites and other major hazards, a Major Hazards Assessment Unit is in place to carry out the risk assessments. Major national policy studies are contracted out &/or special ad hoc teams formed.

- the Environment Agency has set up a national centre of expertise on risk assessment, the Centre for Integrated Environmental Risk Assessment (CIERA), to support the agency's work on risk related matters.

With the potential for a variety of risk assessment methods being developed by fire brigades and bespoke assessments carried out on as yet undefined issues, it is suggested that the Home Office ensure that there is access to a source of expertise on risk assessment.

4.3 INFORMATION TECHNOLOGY

As with any form of survey or analysis the application of information technology can greatly reduce the resources required to carry out the analysis. In the case of the West Midlands Fire Service it is interesting to note the development of an open systems network with connections between CMC and operations departments, hence allowing computer based analysis of calls without re-entry of data. This already allows West Midlands Fire Service to identify areas experiencing high rates of, for example, malicious calls by postcode and individual streets. Also, at least 20 brigades have purchased software from the Home office which enables them to geographically plot fire calls.

It is also pertinent to note the development of the Cris system - Crime Reporting Information System at Scotland Yard for reporting and recording crime. The system which links every police station across London can list and sort crimes, record particular characteristics of offences etc. The system can be used to plot the geographic spread of offences, hence identifying worst areas for burglary etc, and is being considered for use in conjunction with London boroughs to reduce high-crime spots by improving the environment in these areas.

Clearly, a comparable system capable of producing geographic, time related, premise related etc plots of incidents and casualties would automate a large proportion of the work required to implement the envisaged risk assessment and categorisation system

CMC MOBILISATION

Consultation with brigades during this study indicated that Command Management Centres are already able to vary the response based on the type of incident and information received from the caller. Thus, the proposed shift from district based response standards to incident

type and property type based response standards is already within the capacity of fire brigades. For example, West Midlands already vary the response to incidents within (say) an A and B risk areas according to:

- RTAs, typically 1 appliance,
- isolated rubbish fires, bins fires, skips fires etc, typically 1 appliance,
- house fires, 2 appliances
- house fires with person(s) reported (3 appliances plus APL if appropriate)
- fire in large commercial property - 3 or more appliances

In addition, the western command of West and Mid Wales fire brigade

- vary the response to house fires according to time of day, with 1 appliance during the day and 2 at night, excepting at a MOD estate near Haverfordwest for which 2 appliances are dispatched due to risk of rapid fire spread,
- dispatch 2 appliances to fires in B&Q style buildings in C and D risk areas,
- split calls from refineries into Category 1, 2 and 3. Category 1 calls are dealt with by the refinery, category 2 calls receive 5 pumps and 5 special appliances and category 3 calls receive 10 pumps and 5 specials,
- 1 pump to heathland fires, unless they are close to housing or are confirmed as large fires, in which case two appliances are dispatched.
- despatch 1 appliance if RTA is on a single carriageway and 2 appliances if it is on dual carriageway.

TABLE 4.1 COMPARISON OF OLD WITH NEW RISK ASSESSMENT RESOURCE DEMANDS

Task	Who might be used?	Comparison with current resources demands
Development of risk categories (using risk assessment to develop categories & standards etc)	Risk assessment specialists in conjunction with nominated brigades. Approval by CFBAC	Analogous to work involved in 1980-85 review of standards of fire cover.
Routine application of risk categories, templates and points based risk assessment	Brigade watches, station officers & central operations groups. Likely that central departments would need to review statistical information on social-demographics etc.	On occasion would require additional work to review fire statistics, acquire social-demographic survey information, & information on uptake of smoke detectors etc.
Quantitative risk assessment & assessment of exceptional risks	Specialist risk assessors: Home Office (FRDG) CACFOA &/or lead brigades	New task to augment current judgement based assessment of special risks etc.
Training of officers in new forms of risk assessment	Fire Service College &/or brigade training departments.	New more exhaustive forms of risk categorisation and assessment require somewhat more training.
Develop risk assessment methods.	CACFOA, FRDG &/or lead brigades to develop further methods over time for specific types of premises & issues.	Whilst the development of core set of methods is a new task many brigades are already improvising risk assessment methods.
Develop & administer national database	Home Office (with input on database design from brigades)	Need to develop new database & revise FDR1 forms etc to match information needs of risk assessment & categorisation.
External auditing of risk assessments	HMFSI (with advice from specialist risk assessors)	No change in role, but inspection workload may increase with more exhaustive form of risk categorisation & assessment & less prescriptive response standards.
Address, incident &/or locality based mobilisation	CMCs	Already in operation by many brigades.
Review & approval of risk assessment methods	CFBAC & HMFSI (with advice from FRDG & CACFOA)	

5. BENEFITS

5.1 OVERVIEW

When considering the potential to reduce the fire death and injury rate in the UK it is interesting to note that the fire death rates in certain other economically developed countries such as Holland are a third of those in the UK. However, as with the reforms noted in In the Line of Fire, it is difficult to quantify the benefits arising from the proposed risk assessment toolkit, as:

- the potential to reduce losses through changes in the deployment, level or type of resources is yet to be established by the proposed risk assessment,
- the potential to reduce losses through changes in local fire safety and other preventive work has yet to be established by the proposed risk assessment,
- the impact of combining changes in response standards with changes in fire safety has yet to be established by the proposed risk assessment,
- the potential to reduce the cost of response without risking increased losses has yet to be established by the proposed risk assessment.

Notwithstanding the latter and the acknowledged inadequacies of current information, the scale of potential benefits which might be identified by the envisaged risk assessment is indicated below.

- the extension of current fire safety initiatives has the potential to reduce the number of deaths by about 30%,
- changes in response standards might reduce fatalities by between 10% and 40%.

Clearly the application of risk assessment may identify additional means of reducing losses.

This gives a range in the nominal value of averted fatalities of about £50m to £260m per year assuming a value of £750,000 per averted death and a baseline of 600 deaths per year in the UK, to which the nominal value of averted injuries and damage would need to be added. Given that the benefits of increased fire safety and response are unlikely to be additive the maximum benefit may be less than £260m.

The latter benefits are in addition to the creation of a more flexible and up to date national framework as outlined below.

5.2 FLEXIBLE AND UP TO DATE NATIONAL FRAMEWORK

EMPIRICAL RISK ASSESSMENT

The principle benefit of the envisaged toolkit is the provision of an empirical risk assessment method for determining fire safety, fire cover and operational capacity requirements. In particular, the toolkit would:

- substantiate or otherwise reconcile the local practice currently enacted by most brigades of dispatching more than 1 appliance to dwelling fires in C and D risk areas with the current national minimum response standard of 1 appliance,
- substantiate or reject the suggestion that the current response standards can be modified without a risk of under-response to take account of latter-day fire detection, fire prevention and protection systems in non-domestic premises,
- substantiate or reject the suggestion that the predetermined response to premises can be varied according to time to reflect variations in habitation, and between AFAs and other calls, without a risk of under-response.
- identify the worst case fire scenarios for which it is economically practical to plan an initial response,
- indicate the initial attendance operational capacity which is required to handle the latter fire scenarios, hence providing an empirical basis for specifying the number and type of crew and appliances required.

This should ensure that appropriate levels of fire cover are operated where there is a high life risk and/or risk of fire spread, whilst identifying areas where the initial response can be reduced without risk of under-response, hence mitigating the workload implications of ongoing increases in the number of fire calls. It would also provide a basis for defining the composition of the response.

EFFECTIVENESS OF RESPONSE

By incorporating “design tasks” and “operational capacity” the response planning guidelines would prompt assessment of the effectiveness of response as well as the timeliness and weight of response. Moreover, by referring to the rescue role of the fire service, special services and to firefighter health and safety requirements, the guidelines would reflect latter-day expectations regarding the role of the fire service and the safety of firefighters. This should act as an additional prompt for the further improvement of fire service capacity.

STRATEGIC FIRE COVER REVIEW

The option of expressing response standards in terms of a percentage of calls to be responded to in X minutes, measured across the whole or major division of a fire authority's area, would:

- allow fire cover to be reviewed strategically rather than on the current narrow station by station basis,
- allow account to be taken of fire demand, particularly the occurrence of 2nd and subsequent calls,
- offer the potential for a single response standard to be defined for all occupied dwellings in both shire and metropolitan areas, except sparsely populated areas, hence overcoming the current situation of residents in A risk areas having a standard of 3 appliances in 8 minutes and residents in D risk areas of having a standard of 1 appliance in 20 minutes.

RESPONSE FLEXIBILITY

The adoption of a less prescriptive "task oriented" set of service planning guidelines, namely the "design tasks" and operational capacity, would allow brigades to develop alternative response arrangements, crewing arrangements and appliances to match their local circumstances. For example,

- Assuming a requirement for a crew of (say) 9 in the case of fires in occupied dwellings, the options of dispatching 9 crew in a single appliance or 5 and 4 crew in two appliances or 6 and 3 crew in two appliances would be treated as equivalent. The design of these appliances could also vary so long as the necessary equipment and fire fighting agents are delivered by one or both appliances.
- In the event that a risk assessment recommended a lesser operational capacity for smaller incidents, such as chimney fires, secondary fires, lock-outs and lift rescues etc, a brigade would have the option of either developing a smaller first response appliance for such incidents or simply mobilise current appliances with fewer crew. Such incidents account for a large proportion of emergency calls. For example, a suitably equipped (1 high pressure jet, small water tank, extraction/cutting equipment and BA) specialised 4 wheel drive appliance might be deemed adequate to respond to isolated known small fires, lift rescues, lock-outs, pumping out, isolated outdoor fires etc. If the latter appliance was equipped with BA and spare hoses it might also be used to supply additional BA equipped staff and hoses for connecting up to hydrants, at house fires. If the first appliance had a 6 person crew this would give a team of 9.

In the case of the latter hypothetical appliance , if 1 crew member was a paramedic and the appliance was equipped with a defibrillator it could also act as a first response for cardiac arrests.

Thus, a shift away from the current across the board requirement for a 5 person appliance with 1600 litres of water etc might extend the range of duties for which the fire service could offer a cost-effective response.

Clearly, the feasibility of these options would be subject to local circumstance. For example, it may not be feasible to use "small appliances" at (say) every other single pump retained stations as these would arrive first to local house fires, hence failing to meet the initial response standard. Similarly, the use of a single 9 person appliance in areas with high rates of small incidents may prove inefficient. Given the need to take account of local circumstance, the selection of appliances and crewing arrangements would become a local operational decision rather than dictated by national standards.

INTEGRATING FIRE SAFETY WITH FIRE COVER

The toolkit is designed to prompt the simultaneous consideration of fire safety education, fire safety and fire cover. Thus, developers and occupants in remote areas could be lobbied to increase their levels of fire safety, whilst additional fire safety work would be focused in areas of high fire demand to mitigate or reduce such demand. Similarly, fire safety initiatives could be focused on pockets of high risk premises in otherwise low risk areas to reduce the need to increase the level of fire cover for pockets of high risk.

DYNAMIC RISK CATEGORIES

By including guidelines on where to focus fire safety education and by defining risk categories on the basis of the likelihood of larger fires and persons reported, the fire service would be prompted to focus fire safety in areas of high risk and thence match cover to any subsequent changes in risk.

MANAGEMENT OF LOCAL LIABILITY RISKS

The application of risk assessment to the determination of pre-determined responses to AFAs and malicious false alarms, particularly in assessing where and how to modify a PDA, would minimise the risk associated with a blanket reduction in the PDA to such calls. A risk assessment should help identify premises and areas where a reduced PDA can be enacted without incurring a significant risk of under-response, i.e PDAs are only reduced to AFAs from low risk properties and where malicious calls can confidently be identified.

5.3 TARGETING LOCAL FIRE SAFETY EDUCATION

Brigades consulted during this study suggested that local fire safety education of the public and local authorities and other local preventive initiatives, such as advisory visits to local non-domestic properties, offered the best means of reducing losses. The envisaged toolkit includes service planning guidelines for focusing fire safety education on areas of high risk and methods for identifying local target groups, premises and issues.

It is not within the remit of this report to provide conclusive evidence of the relative merits of national versus local fire safety education and lobbying of local authorities, Environmental Health Officers, Building Control officers and other agencies. However, it is suggested that locally targeted fire safety education campaigns may offer a way of cost-effectively increasing the uptake of fire safety measures, such as smoke detectors, amongst the minority of the population who have yet to, for example, install a smoke detector. This is suggested for a number of reasons.

The number of deaths has fallen by about 20% since 1988, in which time the rate of smoke detectors installation has increased from 15 to 70%. The rate of smoke alarm ownership plateaued in 1994 at about 74%. This suggests that the number of deaths fell by 20% over a period where the rate of smoke alarm installation rose by 55%. If this rate of decline in fatalities continued with the remaining 30% of households installing smoke alarms, this would give a further 10% fall in deaths, i.e. about 60 fewer deaths per year in the UK. However, this may underestimate the benefits of a further increase in smoke alarm installation, as:

- at least 57% of dwelling fatal fires lacked a smoke detector against a rate of installation of about 70% across the general population, according to research commissioned by the Fire Research and Development Group (1996),

- the British Crime Survey found that the rate of uptake of smoke detectors is lowest amongst elderly, single parents, council tenants and Afro-Caribbean's, i.e. those groups most likely to experience fires or be injured by fires.

- that the benefits of smoke alarms is disproportionate to the rate of fires detected by smoke detectors, in that the ratio of fatal to non-fatal injuries is 1 to 60 for fires detected by alarms and 1 to 19 for other fires. (Home Office Fire Statistics, 1994)

Hence a further increase in the rate of installation of detectors and other fire safety measures may have a disproportionate effect on the fatality rate. Whilst there is limited research on the effectiveness of locally targeted fire safety campaigns, some research has found that national TV campaigns are less effective than local interventions. For example, 60% of a target group made some physical change to make their homes safer compared with 9% of a control group who only watched the TV campaign, subsequent to a targeted mass media and health visitor home visits campaign in Newcastle in early 1980s (Colver et al 1982). Also, it is pertinent to note the reported rate of fault correction subsequent to property visits by firefighters in Buckinghamshire shown in Table 5.1.

Table 5.1 Identifying and correcting hazards (% of premises) (Dugdale and Draper 1993)

	Single occupancy		HMOs	
	Premises with faults on 1st visit	Success rate in correcting faults	Premises with faults on 1st visit	Success rate in correcting faults
Property faults	67	72	65	45
Human faults	33	67	35	38

It is also interesting to note that whilst the rate of smoke alarm installation in the West Midlands does not exceed the national average of about 70%, the rate of deaths per occupied dwelling fire is about 1 in 200 (20 deaths in about 4000 dwelling fires in 1993) instead of the average for the UK of 1 in 160 per dwelling fire. If the rate of fatalities per dwelling fire in the West Midlands was repeated across the UK this would give a further 20% reduction in the number of deaths, i.e. 100 fewer deaths per year. As previously noted, West Midlands fire service is renowned for the emphasis it has placed on locally targeted fire safety education. The suggestion that the observed fall in fatality rates did not occur solely due to increased smoke alarm ownership is supported by the observation that only 7% of fires in 1994 were discovered by smoke alarms.

Table 5.2 and Figure 5.1 show the number of deaths from fire in dwellings for the UK including Scotland) and West Midlands. It is interesting to note that:

- the number of fatalities in West Midlands in 1993-1994 is about 40% less than the number in 1991-1992. West Midlands initiated a fire safety education campaign and lobbying of local building control officers in 1991 to 1992.

- the number of fatalities in the UK in 1993-94 is about 15% less than the number in 1991-1992.

- the number of deaths in Scotland in 1993-94 is about 18% less than in 1991-1992. Locally driven fire safety education work was initiated in Scotland in the early 1990's

Further research is required to establish the extent to which local fire safety education initiatives reduce casualty rates. However, evidence such as the above does suggest that local initiatives focused on areas of high risk may have reduced casualty rates over and above national trends. On the information given above, it can be suggested that a further increase in the uptake of smoke detectors plus the repetition of the fatality rates in the West Midlands across the UK offers the potential for reducing the number of deaths by at least 30%, i.e. about 200 averted deaths per year with a nominal value of £150,000,000 per year at £750,000 per averted death. A 30% reduction in fatality rates would bring the UK rate of fire death to a level equivalent to those in Australia and Germany, but still higher than in Holland, Switzerland and Austria.

Note: £750,000 is the value used by the DoT for a statistical life and was used in In The Line of Fire to cost current fire deaths.

Figure 5.1: Deaths in dwellings (index 1985 = 100)

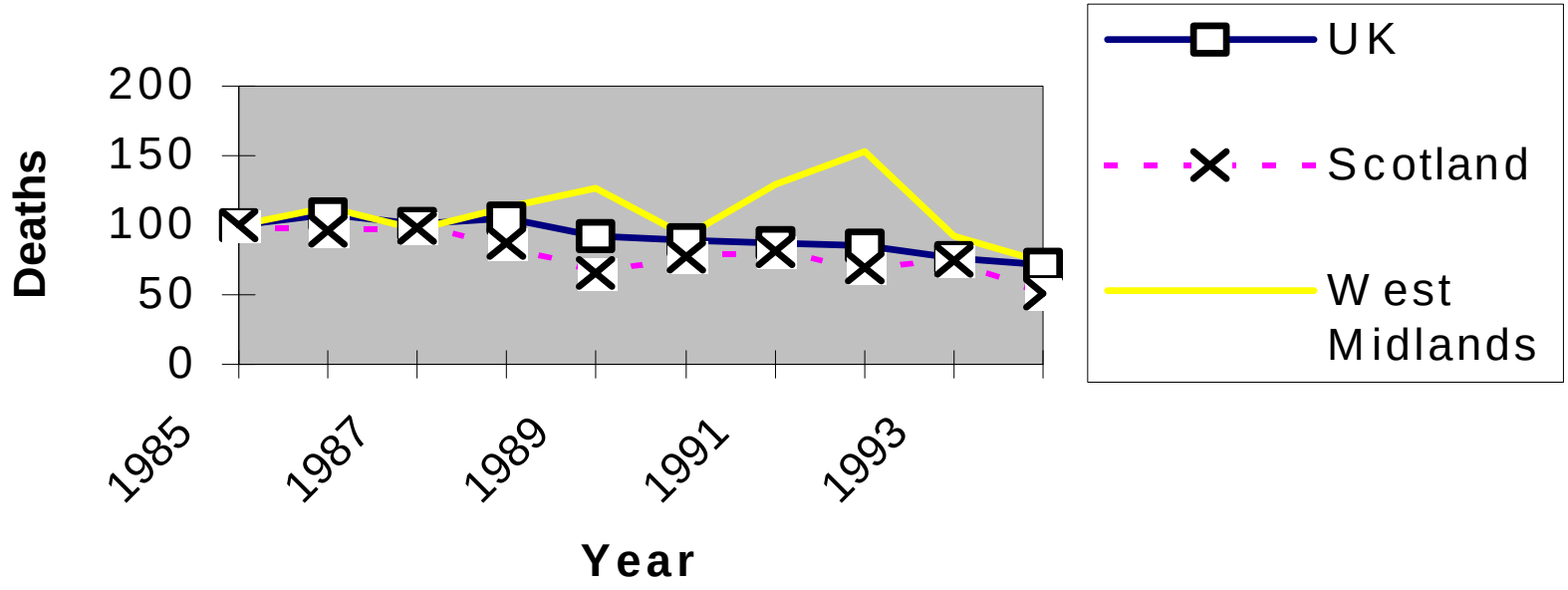


TABLE 5.2: FATAL FIRE DEATH TRENDS

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
UK	700	753	710	732	642	627	608	594	533	477-502
Scotland	171	165	168	150	113	133	139	119	127	87
West Midlands	38	43	37	43	48	35	49	58	35	28

5.4 REDUCTION IN LIFE LOSS AND INJURY BY CHANGING RESPONSE STANDARDS

Consultation with fire brigades during this study suggested that:

- the ability of brigades to make a significant impact in the short to medium term on the loss of life, injury and property by the redeployment of appliances is limited due to the capital cost implications of relocating stations, lengthy consultation process for changing station crewing arrangements and natural limits to sitting of stations in rural areas (i.e stations have to be located in centres of habitation), and;

- the majority of brigades already dispatch 2 or 3 appliances to dwelling fires.

Clearly these are generalisation and there may well be exceptions. Moreover, brigades have the option of changing crewing arrangements and appliance locations, such as;

- moving appliances out of commercial centres which operate predominantly during working week day to residential areas at night and at weekends,

- creating night crewed stations for “dormitory” areas instead of day crewed stations,

- developing new stations on a very selective basis, i.e areas with very high risk occupied dwellings.

Consultation with brigades also suggested that a faster response time is unlikely to reduce life loss in many incidents, where occupants have died or are severely injured before or shortly after the fire is reported. Two examples in the southern command area of Mid and West Wales illustrate this point:

- 6 adults died in a single occupancy fire despite the brigade attending within about 4 minutes of receipt of the call. On arrival a severe fire was in progress with flames visible in all parts of the house. One victim was rescued alive but subsequently died. All six victims were found to have high blood alcohol levels. The fire was believed to have started in the lounge and progressed up an open stair case, trapping the majority of victims upstairs. The smoke alarm lacked a battery.

- 4 children died from smoke inhalation, 2 dead on arrival and 2 died later. The children had been locked into their bedroom by their parents whilst they visited a pub. The fire was believed to have been started by the children playing with a lighter.

In each of these cases the fire would need to have been reported earlier for the fire brigade to have been able to attend in time to avert casualties.

However, it is also possible to cite examples of where a successful rescue was mounted after a fast attendance. Again, West and Mid Wales cite an example of where an unconscious occupant was rescued with an arrival time of 4 minutes in Llanelli.

Two estimates of the potential for a faster response to reduce losses can be cited:

- The 1980 Home Office Review of Future Fire Policy suggested that a more rapid response has a capacity to significantly reduce casualties which occur away from the source of ignition. This capacity was estimated at 100 deaths (11% of total) and 500 non-fatal (8% of total) casualties, mostly in B and C dwellings. If it is assumed that this reduction holds true today, this would give a potential for about 65 fewer deaths and about 1000 fewer injuries per year.

- More recent data (1989-92) on the percentage of deaths beyond the room of origin suggest that 47%, 44% and 41% of deaths in single occupancies, HMOs and flats/maisonettes occur outside the room of origin, representing about 250 deaths per annum. In 1992 376 out of 658 deaths involved persons “trapped”, of which 185 were asleep and 191 were “other”. Clearly, the ability to rescue these persons is strongly influenced by the time taken for the fire to be reported.

It has been suggested that the activation of smoke detectors may alert sleeping occupants to a fire, allowing them to make an emergency call in time for the fire brigade to mount a rescue where such occupants would otherwise die in their sleep or be trapped upstairs with insufficient time for the fire brigade to attend. Accordingly, with the increased uptake of smoke detectors since 1980, the potential for a faster response to avert casualties may have changed since 1980.

Assuming a nominal value of averted deaths of £750,000 per death, these two estimates give a range of “value of averted deaths” of between £49,000,000 to £187,500,000. The nominal value of averted non-fatal injuries should be added to these estimates. Clearly, a more detailed

assessment of the circumstances of deaths and injuries is required to establish the potential to reduce losses by modifying response times.

6. INSPECTION

Consultation with HMFSI during this study suggested that the introduction of a risk assessment toolkit would not affect the principle of the Inspectorate's role or their approach to the inspection of brigades, i.e. they would still inspect the process of fire cover reviews and examine the professional judgements offered in support of variations from national minimum standards with occasional spot checks of risk categories.

It is suggested though that a more flexible process of risk categorisation has the potential to inevitably lead to a more in-depth process of review, particularly if a brigade drew on fire statistics on the size of fires, time of day variations in risk and social-demographic features. Also, brigades may use different combinations of risk categorisation and local risk assessment methods. Consequently, the work required to inspect the process of fire cover review has the potential to increase.

Consideration could be given to minimising the onus placed on the Inspectorate by:

1. setting up an “approval process” whereby risk assessment and categorisation methods are reviewed, approved and validated before application, with criteria designed to:

    - assure a minimum level of inter-assessment consistency between brigades,
    - prompt empirical validation of risk categorisation.

    Thus limiting the subsequent inspection task to one of verifying correct application of methods, rather than exhaustive validation of the method and results.

2. placing onus of responsibility on brigades to demonstrate their process of assessment and decision making. This could include seeking production of a standardised risk assessment report by brigades, which would then comprise the entry point for inspection as well as being the subject of inspection itself. This could include development by the Home Office of:

    - a risk assessment reporting template, and:
    - example risk assessment reports.

3. varying frequency of inspection of fire cover across brigades to match predicted changes in risk, such as annual checks in metropolitan areas and less frequent checks on risk categories in other areas.

7. CONCLUDING STATEMENT

The risk assessment toolkit described in this document has been designed to be:

- flexible,
- empirically driven,
- focus on life risk,
- emphasise fire safety education, and;
- applicable within the resources of UK fire brigades.

Hence meeting the recommendations on risk assessment of the In The Line of Fire report.

It is suggested that a pilot national risk assessment study be carried out of a representative sample of fire calls from a single type of occupied dwellings, such as single occupancy dwellings, with a remit to:

- distinguish high versus low risk single occupancies,
- determine an optimal mix of fire safety education, building regulations and response,
- define the design tasks and operational capacity response planning guidelines,
- define the risk category proses and/or quantitative criterion for designating areas under these categories,
- review the quality of information available to undertake such a risk assessment,
- produce a points based scheme for distinguishing high risk from lower risk residential areas,
- survey a sample of areas using the new categories and associated methods, and determine the impact on fire cover,
- specify in detail the work required to designate area using the new prose and/or quantitative means of categorisation.

Given that the effects of any additional fire safety education or regulations would not be immediate the response would be based on the current risk.

Further complementary research: fire safety education

It is clear that further research on the effectiveness of local fire safety education initiatives would be an essential compliment to the envisaged toolkit. Again as stated by the HEA:

> "The whole area of injury prevention is still at an early stage of development and there is an urgent need for well designed and evaluated studies to underpin the priority attached to this area..."

This is particularly true for fire safety education, as in contrast to single measures which can demonstrate positive results fairly quickly, community wide measures need a much longer time scale to show effects ...(p 2, HEA 1993).

Such research could usefully focus on:

- the circumstances in which different fire safety education initiatives were effective or ineffective. This would allow such initiatives to be matched with target groups and issues generated by the risk assessment, and allow a more sophisticated cost:benefit assessment of such initiatives to be completed.
- the relationship between cost of initiatives and their measured effect on fire spread and casualties in dwellings.

Such work would assist in the assessment of the potential for fire safety education to reduce the severity of fires and thence provide a firmer basis for considering the respective roles of fire safety education and response in reducing losses. It would also provide a basis for developing guidelines on the "fire safety educational capacity" which should be sought for areas of high risk.

PART TWO

SCHEMATIC EXAMPLES OF METHODS

This section of the report provides an illustration of the form and application of methods within a risk assessment toolkit. This is achieved by providing outlines of each part of the toolkit, with illustrative examples of data, proforma and flow charts as appropriate. It should be noted that the example methods and information shown here are illustrative only and are neither complete nor validated.

8. SCHEMATIC EXAMPLES OF METHODS

8.1 DEFINING "HIGH", "MEDIUM" AND "LOW" RISK

Quantitative definitions of High, Medium and Low risk could be used for a variety of purposes, as illustrated in Table 4.1, including:

1. Designation of where likelihood of large fires and/or persons reported warrants additional weight of response, i.e. definition of risk categories and verification of area categorisation.

2. Designation of where fire education and safety should be targeted, such as prioritisation for:-

    - school based fire education,
    - areas of housing for smoke detector campaigns, and;
    - increased frequency of inspection of non-domestic premises.

3. Review of balance between fire education/safety and response, i.e. reviewing whether a higher level of risk assessment and focus on fire education/prevention is necessary and whether fire service strategy needs to be reviewed. For example, a high rate of reported fires escaping beyond the room of origin may suggest that greater attention should be given to fire education, hence reducing (over time) demand for larger attendances.

Such definition of High, Medium and Low risk could be used:

- at a national level when reviewing the formulation of risk categories, response standards and role of fire education/safety,
- at a local level by brigades when reviewing area risk categories and balance of fire education and response,
- parts of a brigade's area or;

The level of risk can be defined in a variety of terms of, for example:

1. the rate of deaths and injuries per head of population.

2. the rate of fires and/or a criteria based judgement of the risk for a defined area, type of premise or group of people.

3. the rate of persons reported, deaths, injuries and fires beyond a certain size (such as beyond the room of origin) per reported fire.

4. the frequency of life threatening special service incidents in an area.

5. the predicted frequency of major disasters in an area.

Whilst item 1, 3 and 4 are demonstrable and empirically driven, certain areas may have pockets of high risk which, due to their limited size and numbers of people, do not have a statistically reliable record of casualties. Hence, the second approach to denoting High Risk would allow pockets of high risk in otherwise low risk areas to be identified. Examples of each of these approaches to defining risk levels are given below. Similarly, some low frequency high consequence events, such as aircraft disasters, may not appear in brigade records, demanding a prediction be made of their likelihood.

8.1.1 Dwelling fire risk

PER REPORTED FIRE DEFINITIONS OF RISK

Table 8.1 provides illustrative examples of definition of High, Medium and Low risk for dwellings and the (hypothetical) implications for fire cover and education.

TABLE 8.1 ILLUSTRATIVE EXAMPLES OF PER REPORTED FIRE DEFINITIONS OF RISK

Risk level	Quantitative definition (per reported occupied dwelling fire)			Implication	
	Deaths	Rescues by brigade	Fire beyond room of origin	Fire education	Fire cover
High	>1 in 100	>1 in 15	>1 in 20	Priority area to reduce fire size, rate of persons reported and injured	Additional crews and appliances to attack fire and rescue occupants
Medium	1 in 150 to 100	1 in 15 to 20	1 in 20 to 40	Second priority	Additional crew and appliances to attack fire or rescue occupant
Low	<1in 150	<1 in 20	<1 in 40	Third priority	No additional crews/appliances

Note: The Chief Medical Officer for England recently suggested that a risk of greater than 1:100 be defined as High, such as a 1 in 6 chance of transmission of HIV from mother to child. source Department of Health

RATES OF CASUALTIES AND FIRE PER HEAD OF POPULATION

Criteria for designating rates of fire casualties in dwellings, other premises and open spaces as High, Medium or Low could be used for assessing:

- at a national level the progress made in reducing fire risk,
- whether the level of risk, taking a brigade as a whole, justifies the application of risk assessment on a widespread basis,
- at a brigade level or major part thereof, whether the level of risk is high or low, and hence whether the strategy for high risk areas and/or groups of people and premises need to be reviewed.

An illustrative risk criteria is shown in Figure 8.1. The actual values used are for the purpose of illustration only and need further research. In particular, the reliability of reported injury rates would need to be established. The values have been conceived as follow:

- the level of risk defined as Intolerable is approximately equivalent to the rate of deaths in Scotland in the early 1990's, which has subsequently been reduced on the grounds that this level of risk was higher than elsewhere in the UK.
- the level of risk defined as Very Low is the level of risk deemed by the Health and Safety Executive and other authorities such as the US Food and Drug Agency, to constitute a negligible risk, i.e. less than 1 death per million people (and its equivalent of less than 5 injuries per million persons per year).
- risk in the region of 11 to 15 deaths per million head of population covers the average risk of death from fire in the UK of about 12 to 14 per million in the early 1990's. This region is not defined as high or low, and is instead proposed as an intermediate area of risk which brigades define on the basis of year on year trends in casualty rates. The case for treating an intermediate area as a high risk area could be greater where the number of fires, deaths and injuries is unchanging or is increasing.
- any risk significantly above the UK average is defined as High, i.e. 16 or more deaths per million persons per year.
- any risk significantly below the UK average is defined as Low, i.e. between 1 and 10 deaths per million and 5 to 100 injuries per million people.

The lowest level of risk in the UK, based on 1993 data, is about 90 injuries per 1 million people in Warwickshire. Based on 1993 data the rate of casualties in a number of UK brigades could currently be in the Intolerable region, as illustrated in Figure 8.2. It is also

possible that the rates of deaths and injuries for certain discernible groups of people, such as people over 80 years of age, and types of dwellings, such as multi-occupancy dwellings, also fall in the Intolerable region.

Note: An alternative approach to designation of high versus low would be to develop criteria by comparison with other comparable countries. A selection of rates of fire death per 1,000,000 persons in other countries is shown below, based on 1992/93 data published by the Queensland fire service:

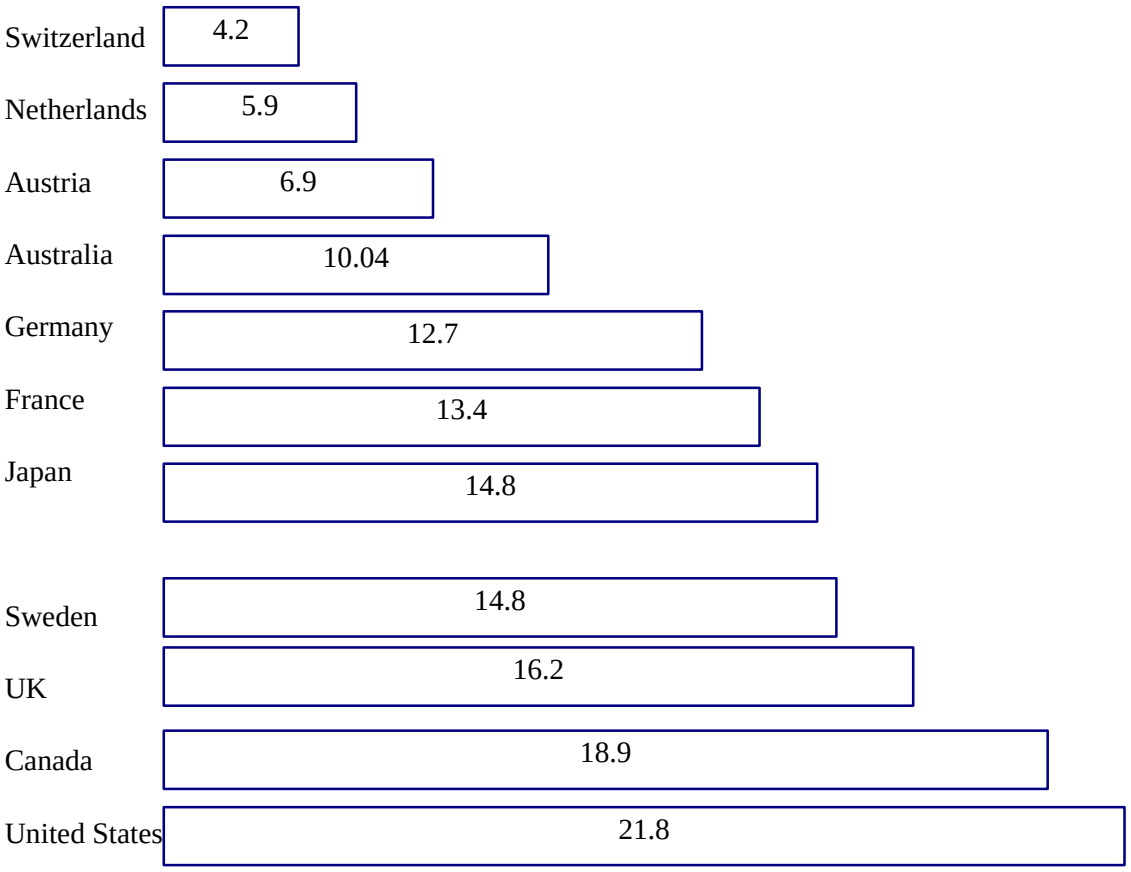
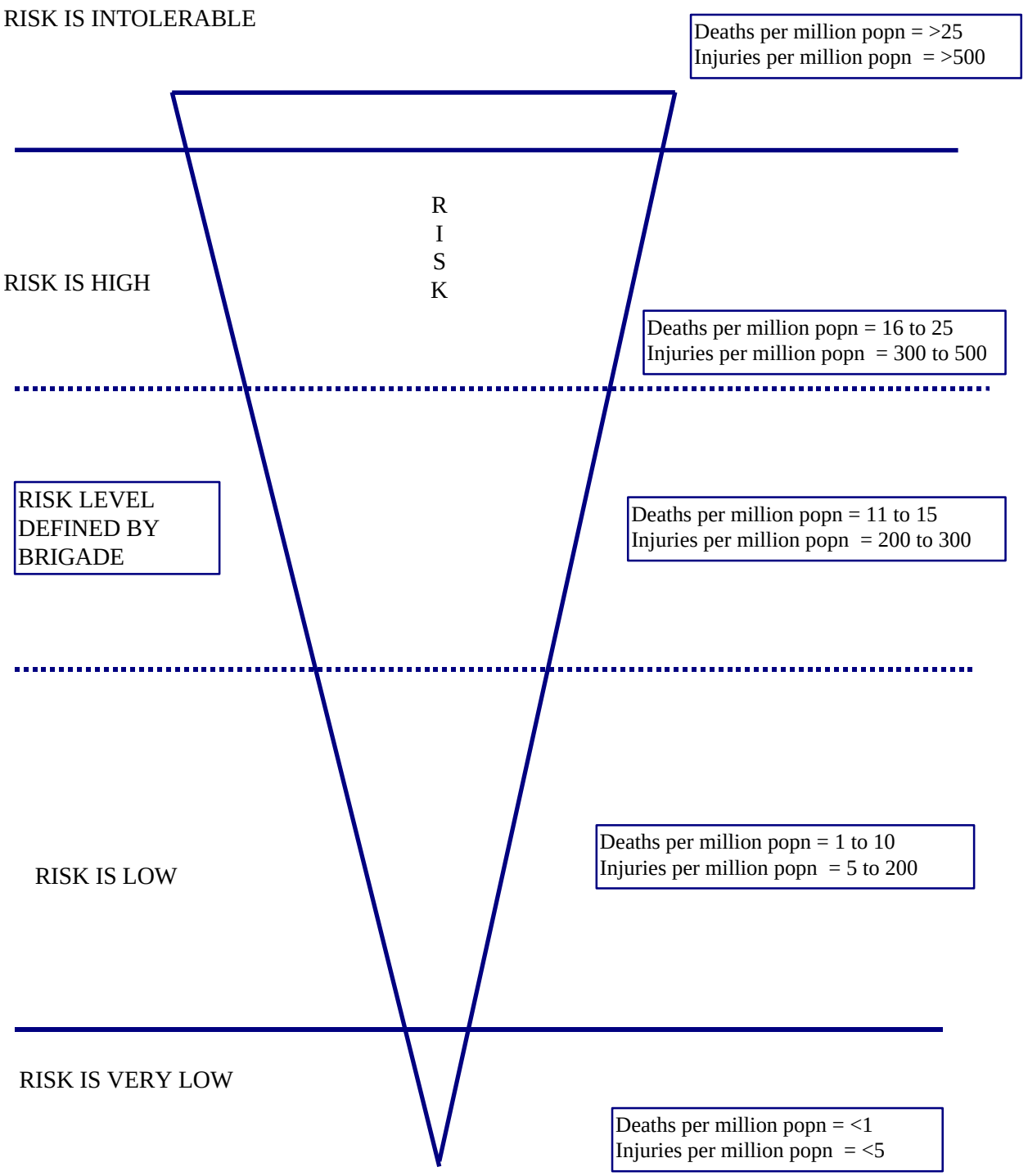


FIGURE 8.1 ILLUSTRATIVE RISK CRITERIA



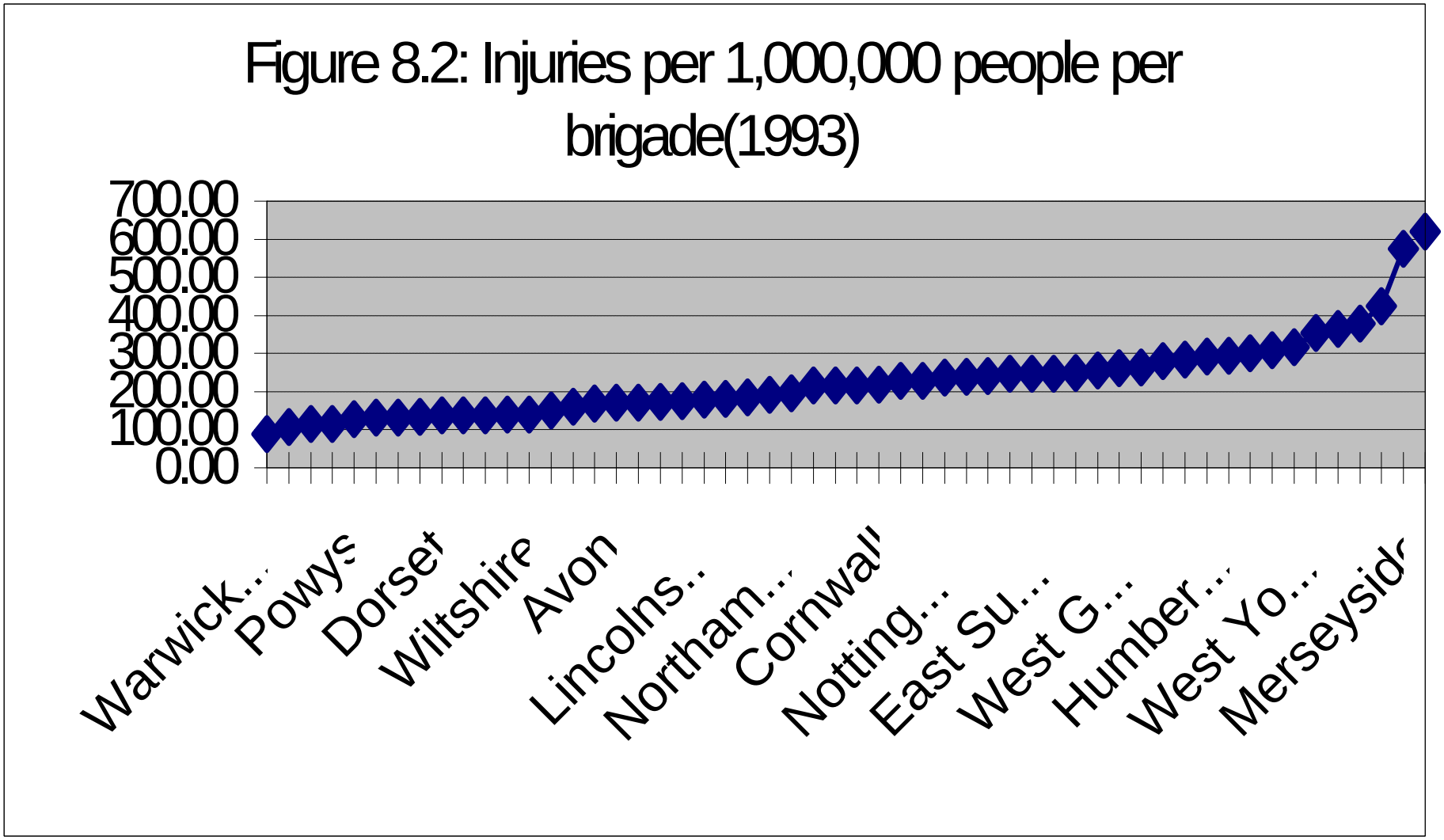


Figure 8.2: Injuries per 1,000,000 people per brigade(1993)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Warwick...
Powys
Dorset
Wiltshire
Avon
Lincolns..
Northam...
Cornwall
Notting...
East Su...
West G...
Humber...
West Yo...
Merseysid

Similarly risk could be defined in terms of the rate of reported fires per household, such as:

High	=	Over 1 reported fire per 150 households per annum.
Medium	=	1 reported per 200 to 150 households per annum.
Low	=	Less than 1 reported fire per 200 households per annum.

and thence used to target fire education work and/or fire cover.

JUDGEMENT AND FIRE INCIDENCE BASED DESIGNATION

For small areas and areas of low population with an accordingly low number of casualties, pockets of high risk could be designated by use of prose based criteria and fire incidence criteria. Taking a station ground by itself, risk could be classified in relative terms, as:

- whole time stations with 25% more than the national average number of primary fires for whole time stations,
- day crewed stations with 25% more than the national average number of primary fires for day crewed stations,
- retained stations with 25% more than the national average number of primary fires for retained stations.

and/or requiring these areas to have two or more of the following features:

- a high level of deprivation and/or crime rate,
- a high proportion of elderly, mentally impaired, disabled or children.
- multi-occupancy dwellings of poor construction,
- predominance of highly flammable materials, such as old foam filled furniture,
- predominance of properties without smoke alarms or other fire safety features.

8.1.2 RTAs, emergency special service incidents and major disasters

It should be possible to define “criteria” for special service incidents and “special” fire risks, such as disasters. The Fire Service has a lower level of influence over the frequency of such incidents, particularly special services. Accordingly, the criteria might be used primarily to discriminate low versus high risk areas for the sake of planning the sitting and level of any special resources required to **Respond** to such events, with less emphasis placed on their use in decisions on the prevention of such incidents. High risk could be defined in relative or

absolute terms. For example, a high risk special service area could be defined in the following types of terms:

- station grounds experiencing (over a 3 year period) three times more than the national average number of a designated type of life threatening special service incident, such as three times the number of RTA calls than the national average, or;

- station grounds with more than 40 RTA calls per year.

Similarly, high special fire risk could be defined in terms such as:

- areas where designated events with a potential for 10 to 100 fatal/serious casualties or over £10m in damage, such as CIMAH site disasters, could occur once every 25 years or more.

- areas where events with a potential for 100 or more fatal or serious injuries or over £100m in damage, such as schedule passenger jet aircraft disasters, could occur once a century or more often.

8.2 NATIONAL LEVEL RISK ASSESSMENT

POINTS COVERED HERE

- define sub-divisions of risk categories through a process of risk assessment reflecting occupant and fire safety factors as well as occupancy and construction,
- simultaneously assess role of fire safety education, fire safety regulations and response when developing risk categories,
- base response standards on current situation,
- vary weight of response noted in categories according to likelihood of larger scale incidents, such that weight will change over time in response to changes in scale of incidents,
- include reference to targeting of fire safety education and fire safety enforcement in guidelines,
- select initial attendance "design task" on basis of likelihood of fire size(s) on arrival.

8.2.1 Scope of national level risk assessment

The toolkit could include a risk assessment method for defining, on an occasional basis at a national level, the wording of Risk Categories, the sub-division of categories and associated minimum response standards. *The form of this assessment has yet to be developed.* An illustration is given below of one version of a risk assessment approach to defining risk categories and associated service planning guidelines. The scope of such assessment would include:

(1) Assessment of the risk in terms of:

- categories of premises and incidents which present broadly comparable life, property and other risks,
- the likelihood of each size of fire, outcome (such as deaths and persons reported) and time course of events for each category of premise or incident,
- the scenarios which each size of fire or incident will present.

(2) Evaluate likely impact of alternative mixes of preventive and response options on risk levels, including:

- changes in fire safety and building control legislation,
- changes in fire safety education,

- changes in response standards. This would involve determining the speed and type of emergency response which, given the frequency incidents in an area, will minimise life and other losses without incurring a disproportionate cost or diversion of resources from other emergency duties.

- combinations of the above.

(3) Compare relative costs and benefits of each mix of preventive and response options.

The latter scope of assessment would require an assessment of :

- the rate of life loss and injury, rescues and size of fires in each category of property, such as a 1 in 100 rate of death in dwelling fires vs a 1 in 1000 rate of death in industrial fires.

- the time course of events in such a way that the impact of faster detection, response etc on the likelihood and number of deaths and size of fire can be determined.

- the number of fires and other incidents which, given a certain rate of death injury or loss, warrants a greater or faster response or higher/lower level of fire safety.

- the costs of alternative mixes of response and preventive options.

- estimates of the effect of alternative responses and preventive options on losses.

The latter scope of assessment would allow an assessment to be completed of the relative merits of preventive and response options. For example, an assessment may conclude that;

- where the interval between ignition and harm is minimal, such as under 5 minutes, it is unlikely that a response based strategy would reduce the incidence of such injuries, especially where the interval between ignition and emergency call exceeds 5 minutes.

- where there is a high number of incidents where the interval between ignition and harm is greater and a high proportion of these fires are detected and reported to the fire service quickly, a swift emergency response could comprise a cost-effective means of reducing the incidence of losses.

- where there is a predominance of small fires with very occasional large fires, neither of which present a high risk to life, it could be cost-effective to provide an initial which is capable of suppressing fires confined to the room of origin, but which depends on make-up to contain larger fires.

The assessment would collate information on the time course of fires, sizes of fire, operation of detectors and extent of smoke logging, casualty rates, rescue rates etc. Such information would be drawn from fire reports and fire research. For example, fire reports provide indications of the estimated time between death and call to the fire brigade, operation of detectors, occupant characteristics, time to structural collapse and extent of fire and smoke spread on arrival, whilst fire research provides information on fire and smoke growth rates for different types of fires in buildings. Whilst fire research could be used to augment information contained in fire reports, assessment would draw on reports of actual fires to ensure due account is taken of the impact of occupant behaviour. For example, fire reports should provide information on the incidence of:

- the duration of fire protection offered by fire resistant structures being reduced due to poor fire safety management, such as unsealed ducts and stacking of plastic materials against walls,

- inadequate water pressure reducing effectiveness of sprinklers and lack of detector maintenance reducing reliability of smoke detectors,

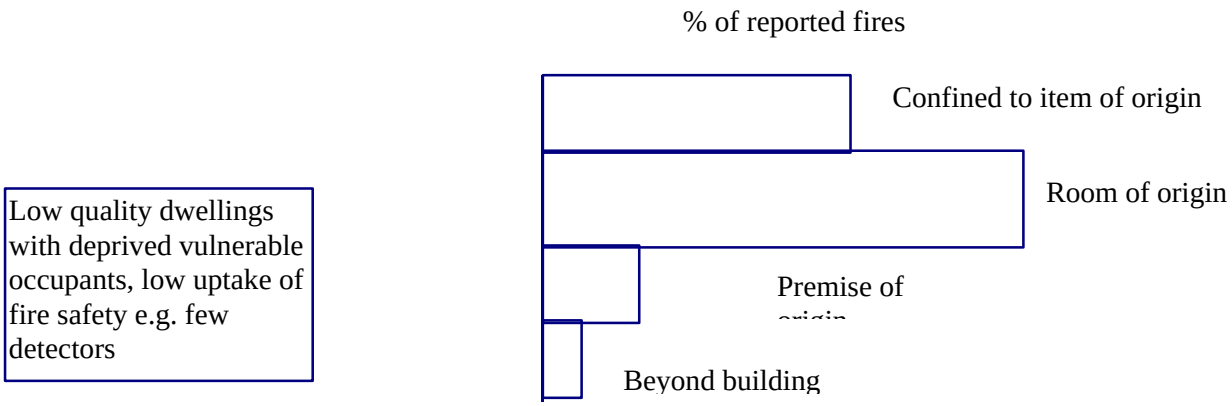
- the effect of arson and vandalism on the operation of fire safety features, such as vandalism of fire doors, switching off sprinkler supplies, multi-seated fires and use of accelerants,

- inappropriate occupant behaviour, such as failing to respond to fire alarms, collecting belongings before evacuating etc.

Gaps in information supplied by fire reports could be addressed by completion of fire research, such as surveys of occupant behaviour in fires.

The latter principles of risk assessment are illustrated in figures 8.3 and 8.4. Thus, the speed and weight of response would be based on the likelihood of fires reaching a certain size and the rate of fire growth, i.e. what sizes of fire are likely to be encountered on arrival. This is likely to vary between types of premises, with fewer fires spreading beyond the room of origin where early detection occurs and more fires spreading beyond room of origin where detection is slower. Thus, the design task in high quality occupancies with high rates of “early” detection could be based on a “confined to room” fire scenario whilst the response to lower quality occupancies might be based on a “fire spread beyond room of origin” scenario, depending on the balance of cost of response and level of averted loss and injury.

Figure 8.3 Illustration of hypothetical match of risk to initial response "design task".



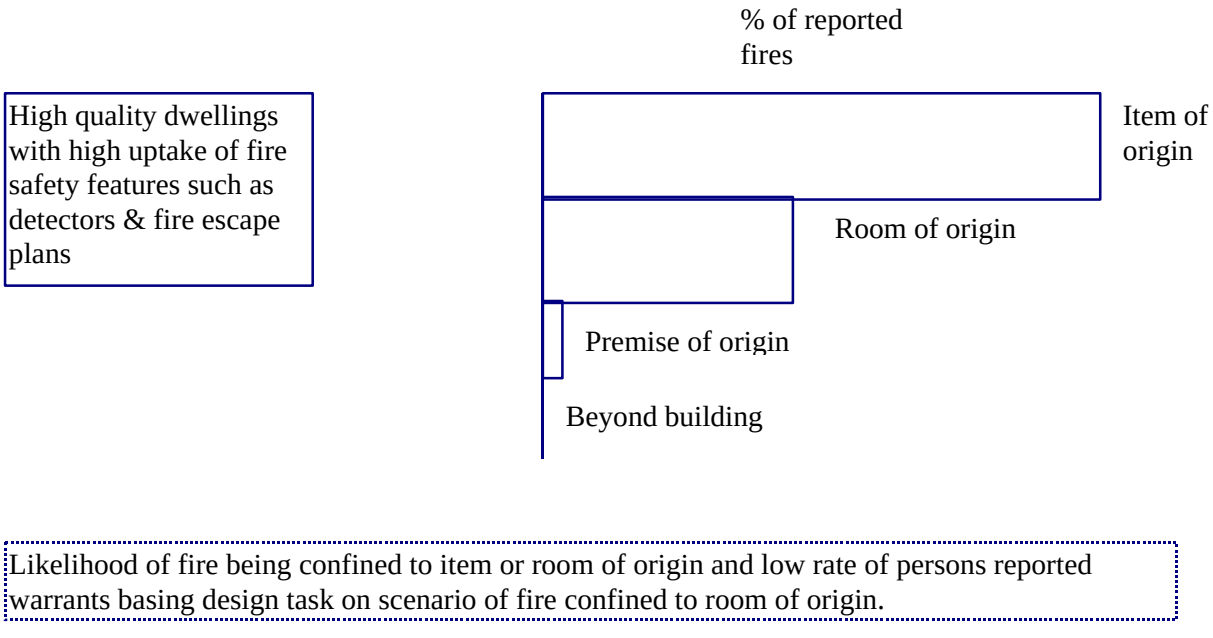
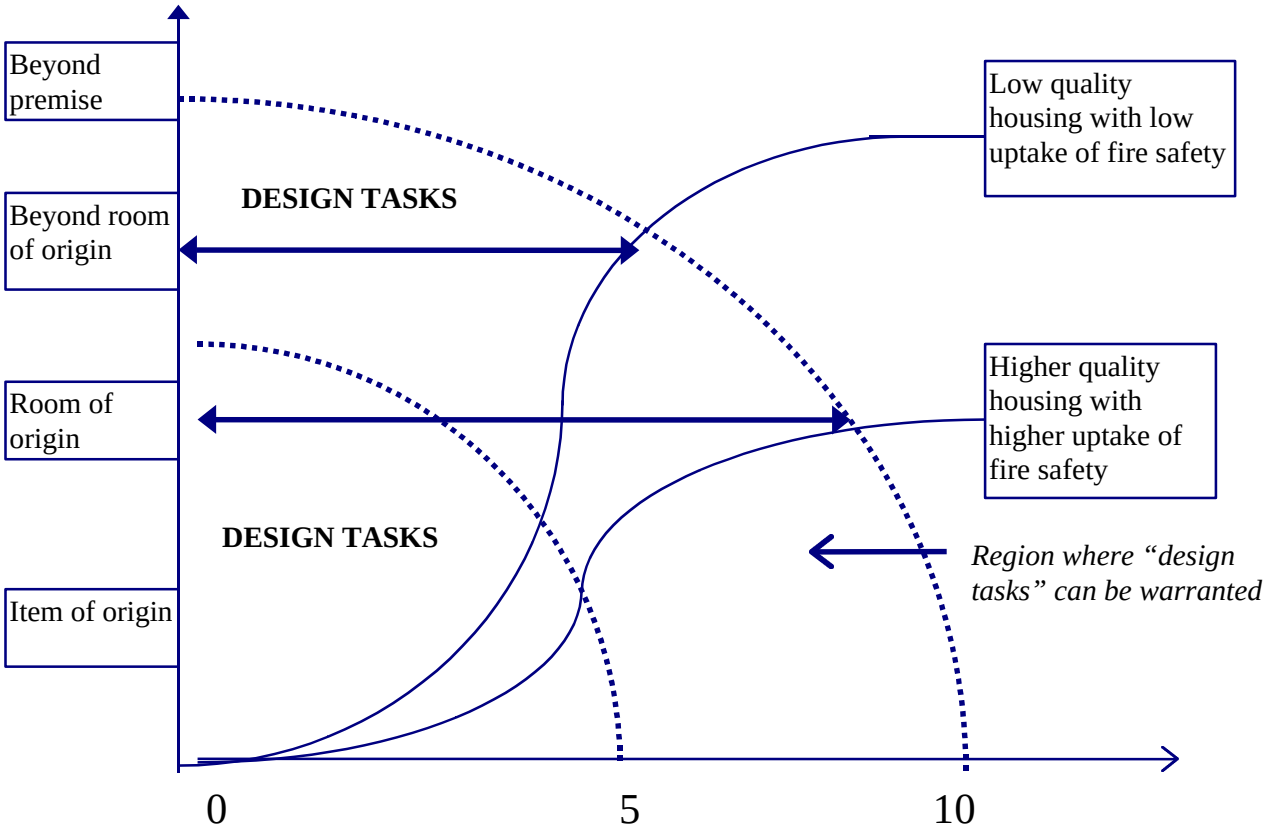


Figure 8.4 Further illustration of matching initial attendance design task to varying likelihood of fire growth and spread.



8.2.2 Exemplar method of assessment

Risk assessment would be carried out for discernible categories of properties and incidents, such as HMOs versus well protected commercial properties. The risk assessment could be based on samples of (say) 1000 incidents involving a certain category of property, such as 1000 fires in poorly maintained HMOs versus 1000 fires in well maintained single occupancy dwelling.

(1) Assessment of risk.

The assessment would first determine the approximate time course and consequence of fires for each category of premise, such as estimating the:

(i) The proportion of injuries which occur:

- through direct contact with source of ignition, such as clothing catches alight, with death or injury occurring upon contact or immediately thereafter.

- within (say) 5 minutes of ignition, with a further distinction between occasions where calls are or are not made to a brigade within this period.

- in 5 to 10 minutes of ignition, with a further distinction between occasions where calls are or are not made to a brigade within this period.

- between 10 and 30 minutes after ignition, with a further distinction between occasions where calls are or are not made to a brigade within this period.

- occurs 30 minutes after ignition, with a further distinction between occasions where calls are or are not made to a brigade within this period.

(ii) The proportion of fires which are:

- confined to room of origin,

- confined to floor of origin,

- confined to premise of origin.

(iii) The cross referencing of the location of casualties/rescued occupants, with the point of fire origin and extent of fire/smoke spread.

The information noted above could be represented in the form of a Fire Event Tree, as shown in Figure 4.5 using hypothetical data. The figure shows the initial stages (up to and including initial brigade attendance) of fires in single occupancy occupancy dwellings with a 5 to 10 minute attendance time. A fire event tree plots the sequence of events which can follow on from a fire, the combination of these events and their outcome. Thus, for example, smoke could spread from the room of origin but be confined to the floor of origin on some occasions but could spread to other floors on other occasions.

A nominal number of 1000 serious dwelling fires is shown in Figure 8.5, multiplied by the likelihood of each subsequent event, using hypothetical data. The number of deaths, injuries and rescues would be taken from fire reports. Similar fire event trees would be developed for other attendance times and weights of initial attendance, such as less than 5 minute and over 10 minute attendance times, for the same category of premise.

(2) Assessment of the contributors to risk:

The results of each Fire Event Tree could be used to determine the likely benefits of alternative response times and weights of attack as well as increased fire prevention, such as increased uptake of smoke detectors.

The impact of alternative response times could be examined in two ways, namely:

(i) by logical examination of the potential for alternative emergency responses to avert casualties. For example, it may be judged that any credible speed of attendance would not avert casualties arising from direct contact with the source of ignition, such as an elderly persons clothing being ignited by smoking materials.

(ii) by comparing the levels of deaths, injuries and rescues of different attendance times for the same category of premise, and then re-calculating casualty rates accordingly for a general revision of attendance times. For example, with a current arrival time of 1 appliance in 5 minutes;

- if it is accepted that an initial attendance of 5 crew and 1 pumping appliance cannot effectively suppress larger fires at the same time as mounting a rescue of occupants, and;
- if it is also accepted that an initial attendance of 9 crew can more effectively contain a fire which has spread from the room of origin and mount an effective rescue of occupants,
- then a heavier initial attendance should reduce the number of casualties in fires which have spread from the room of origin, as noted in Figure 4.5.

The actual level of risk reduction could be estimated by considering the levels of life loss and injury for the same category of property with heavier initial attendance. Thus, for example, a Fire Event Tree for 1000 dwelling fires attended in 5 minutes by 2 appliances may show that there are (say) 20% fewer casualties, i.e. 7 deaths and 72 injuries per 1000 fires rather than 9 deaths and 90 injuries per 1000, with a proportionate increase in rescues.

(3) Cost-benefit

The cost-benefit should compare the benefits of alternative mixes of changes, as illustrated below using hypothetical data:

1. **changed response times alone.** For example, assuming the heavier attendance required provision of one additional whole time pump, the cost of an upgraded standard from 1 to 2 can be stated (at £625,000 according to the In The Line of Fire). This would allow an assessment to be made of the cost of reducing losses, i.e. 2 fewer deaths and 18 fewer injuries at a cost of £625,000 p.a. less averted damage.

2. **changed levels of fire safety education.** For example, work by Dugdale and Draper (1993) of Buckingham Fire and Rescue Service found a fall from 40% to 10% in fire safety faults after visits by fire brigade personnel in single occupancy dwellings. Assuming that further research showed that this translated into a 75% fall in deaths this would give about 6 to 7 fewer deaths and about 70 fewer injuries.

3. **changes levels of fire prevention and/or building control.** For example, assuming a cost of (say) £75 per dwelling to retrofit mains supplied smoke detectors to all dwellings, a rate of 1 fire per 200 households per year, and a 50% reduction in fatal fires this would give a cost of about £3333 per averted death for legislatively required fire detection.

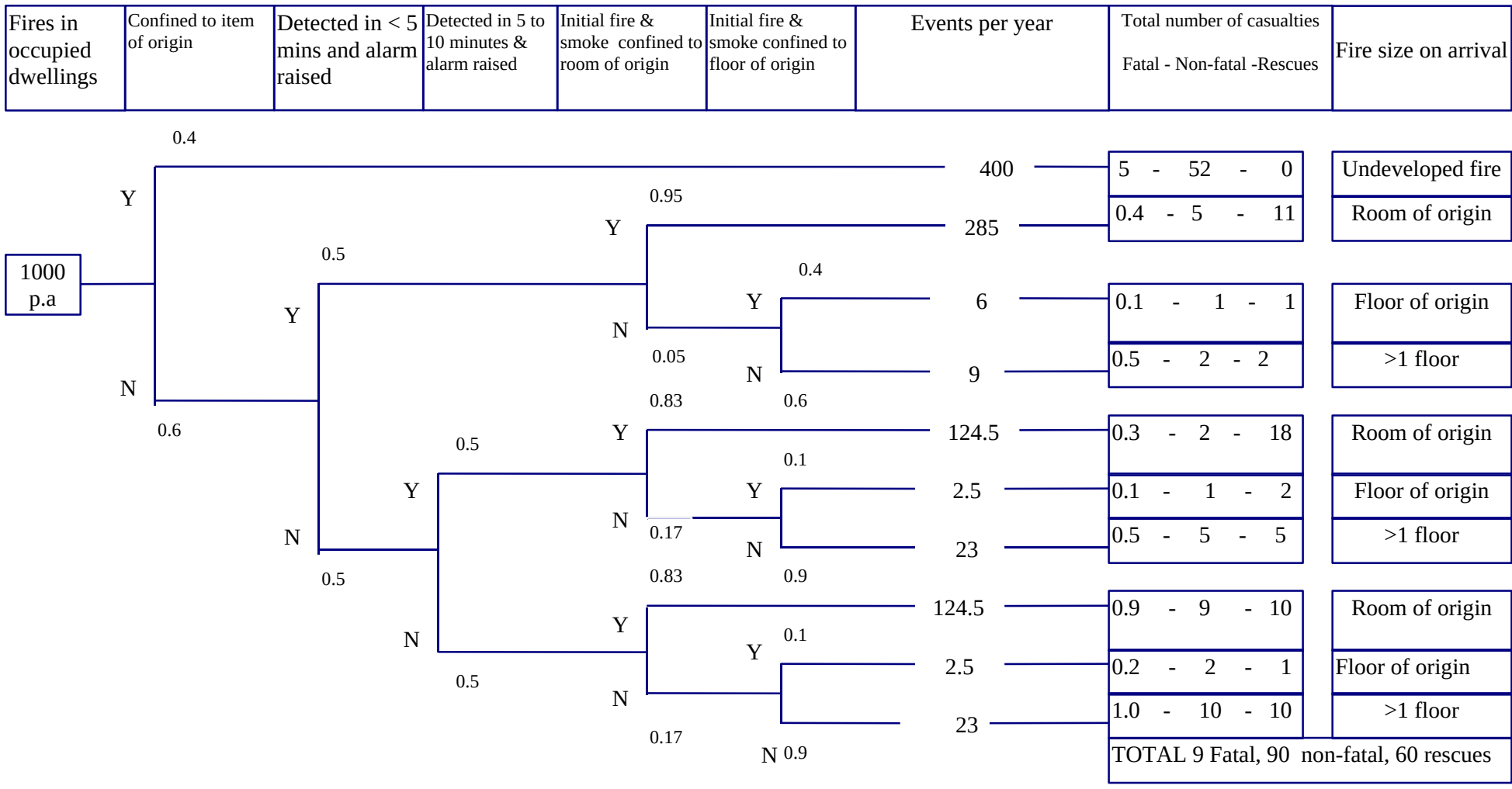
4. **combinations of the latter.** For example, a combination of new building controls as above and changed response time, as above, could in combination reduce number of deaths per 100 fires from 9 to 3.5, as opposed to 7 in case of faster response and 4.5 in case of new building regulations alone.

An informed review of the response standard, level of fire safety education and building controls, according to what ever policy is operational, could then be undertaken. Clearly, if a decision is taken to maintain a 1 pump attendance, this would imply that the policy is one of confining the task of the initial attendance to the suppression of small confined fires or rescue of no more than 1 or 2 persons involved in small confined fires. Alternatively it could be concluded that a faster or heavier response is either ineffective or uneconomic, hence highlighting the need to review fire safety strategy if the level of losses are significant.

Implicit in this approach is the idea that the pre-determined attendance is based on an assessment of the risk associated with the full range of fire sizes in a particular category of property rather than on an examination of the percentage of incidents for which the PDA was adequate. For example, the assessment may reveal that a PDA which is more than adequate on 80% of occasions is justified on the grounds of averting losses on the other 20% of occasions.

Finally, it is suggested that the response standard be based on the “as is” situation given that the benefits of fire safety improvements may not be manifested and that they may take time to occur. However, if the risk category is phrased to reflect the incidence of fires and persons reported, the designated risk category of an area should change in response to changes in risk.

FIGURE 8.5 FIRE EVENT TREE FOR HIGH RISK SINGLE OCCUPANCY DWELLINGS WITH 1 PUMP IN 5 MINUTES



8.3 RISK BASED RISK CATEGORIES

POINTS COVERED HERE

- comparison of envisaged risk categories with current risk categories,
- revision of form of response standards into “design tasks” and “response planning guidelines”,
- varying weight of response according to “design task”,
- link of design task to operational capacity,
- establishing predominance,
- reference to fire safety education and fire safety inspection in service planning guidelines.

8.3.1 Comparison with current risk categories

Tables 8.2 to 8.5 presents a set of prose based RISK CATEGORIES which could be applied to areas in the same manner as the current risk categories***. The prose and standards shown in Tables 8.2 to 8.5 are for the purposes of illustration only and are neither validated nor recommended for actual use.*** The prose shown in Table 4.8 to 8.5 differs from the current categories in a number of respects, as outlined below.

(1) FIRE DEMAND AND LIFE RISK

The prose has been worded so as to:

- take account of the frequency of incidents,
- take account of the effect of fire safety and protection in commercial, industrial and service sector premises,
- focus on life risk, taking account of occupant characteristics, types of dwelling occupancy etc

(2) NON-PREMISE RELATED RISKS

New categories have been included for:

- life threatening RTA and other special service incidents,

- non-premise fire and hazardous material incidents.

(3) LINKAGE TO FIRE SAFETY AND FIRE EDUCATION

A prompt for targeting fire education and safety work on high risk properties is included for high risk areas

8.3.2 Predominance

A number of approaches to the issue of predominating risk can be considered:

(i) As with the current points based system, an area could be surveyed using either risk categories and/or one or more of the risk assessment methods to develop a profile of the risk. A single initial response standard could thence be designated for the area for planning purposes on the basis of predominance, as at present. Predominance could be based on:

- the percentage of ground area covered by each type of premise,
- the percentage of households falling into each risk category within an area, and the percentage of floor space falling into each risk category for non-domestic premises,
- the percentage of each type of call in an area, (or the per centage of calls to confirmed fires from each type of occupied premises).

(ii) Alternatively, planning could be carried out on the basis of being able to meet a range of response standard in the area as per the risk category of each premise. Again, this could involve either:

- seeking achievement of each response standard on each call excluding 2nd and other calls in an area or;
- meeting the response standard on a set per centage of occasions. This would also allow account to be taken of the impact of 2nd and 3rd calls on station grounds, periods of peak loads and major incidents on the standard of fire cover and allow a common response standard to be set for (eg) dwellings regardless of location, as discussed in Appendix A.

Similarly, mobilisation could be managed on an address/locality/incident basis, as opposed to district based mobilisation, to a greater extent than at present.

8.3.3 Task based response planning guidelines

Response planning guidelines are presented in two parts, namely:

- the tasks which the INITIAL RESPONSE is "designed" to achieve and the scenarios in which these tasks are determined to be achievable. For example for example, containing a fire confined to the room of origin in a dwelling whilst also carrying out a limited search and rescue operation for occupants without incurring undue risks, and subsequent in situ first aid treatment of fire related injuries. Clearly a response designed to achieve this task would also be able to handle less onerous fire scenarios.

- an **operational capacity planning guideline** for the latter design task could be deemed to require a minimum of (say) 1 high pressure hose team, 1 BA search and rescue team, an OIC trained in command and control capable of commanding such a scenario, with 1 team member capable of rendering in situ emergency medical treatment, with attendance in X minutes. Thus, the guideline explicitly differentiates between fire fighting and rescue resources, without prescribing the exact number of personnel, means of conveyance or appliance design.

Given that the design task might vary between premises, between inhabited and uninhabited premises and incidents according to their respective likelihood of fire size(s), a range of design tasks would be developed which brigades would match against types of premise and incidents in their area. Hence, the design task may vary between:

- premises presenting risk of large fire versus smaller fires,
- AFAs from well protected versus poorly protected properties,
- periods of habitation versus non-habitation of commercial, service sector and industrial premises,
- isolated secondary fires versus secondary fires near residential areas or involving high value forest,
- special service incidents which have a minimal potential to threaten life or injury versus special services with an imminent life threat.

Clearly, the tasks and resources called on for non-fire incidents may differ in type from those called on for fire incidents.

A comparable approach could be used to define, for planning purposes, second and subsequent response tasks and hence second response operational capacity needs. For example, with an initial response task of assessing risk of contaminated fire water run-off, the second response task could be to contain such run-off and/or forewarn local organisations, such as water companies, of impending pollution of waterways.

TABLE 8.2 ILLUSTRATIVE COMMERCIAL, INDUSTRIAL AND SERVICE SECTOR RISK CATEGORIES

Commercial, industrial and service sector premises.	Quantitative measures of risk	Initial response design tasks	Operational capacity response planning guideline	Fire safety service planning guideline
Areas dominated by (commercial, retail, industrial & recreational) buildings which by virtue of their very high level of fire protection, security & safety or small size and low risk occupancy are likely to present a risk of small confined fires or are likely to be detected before escalation to a serious fire.	Less than 1 death per 1000 fires. Fires beyond room <1 in 60 99% automatic suppression success rate.	Suppress a small confined fire within a few minutes of arrival and verify no persons reported in room of origin.	1 hose team & OIC in: - 8 minutes during periods of habitation.	Low priority
Periods of known uninhabitation.		Suppress small confined fires within a few minutes of arrival.	1 hose team & OIC in: - 10 to 20 minutes during periods of habitation.	
Properties where reliable confirmation of false AFA can be obtained and/or low ratio of fire to false alarms:	Less than 1 in 100 conversion of AFA to fires	Investigate fire call and need for full response.	- 1in 10 mins in periods of habitation. - discretionary attendance time standard in other periods	
Areas dominated by medium sized commercial, retail, industrial and recreational buildings which by virtue of either their moderate size and high level of fire protection, security and safety or low occupancy present a risk of moderate fires only. Such as $100m^2$ engineering works & offices.	1 death per 500 to 1000 fires Fires beyond room <1 in 30	Effect suppression of small fires, containment of medium sized fires involving room of origin & capacity to carry out a limited search for occupants.	2 hose teams, 1 BA team & OIC in: - 10 minutes	Medium priority **CONT'D**

Commercial, industrial and service sector premises.	Quantitative measures of risk	Initial response design tasks	Operational capacity response planning guideline	Fire safety service planning guideline
Areas dominated by large (commercial, retail, recreational and industrial buildings) for which life risk either cannot be forecast or which are forecast to pose a high life, property or heritage risk due to a significant possibility of an unconfined fire, minimal fire safety, with potential for incapacitation of occupants (due to either large number of occupants, impaired occupants or people who are otherwise likely to require assistance), or damage to a property of high economic or cultural value.	1 death per 100 to 500 fires Fires beyond room >1 in 30 Fires beyond premise >1 in 20	Containment of unconfined fires and simoultaneous evacuation of occupants in large premises. Assess risk of contaminated fire water run-off, evacuation of adjacent buildings and need for salvage.	3 hose teams, 2 search & rescue teams & OIC, in - 5 minutes during periods of habitation. 3 hose teams plus OIC in 5 minutes during other periods (plus aerial & crew as necessary in 10 mins)	Fire safety and education to be targeted here.

TABLE 8.3 ILLUSTRATIVE DWELLING RISK CATEGORIES

		Dwellings			
	Quantitative definition (per reported fire)	Qualitative examples	Initial response design task	Response planning guideline	Fire safety service planning guideline
Remote rural			None	None	None
Areas presenting low risk of fire spread beyond room of origin or persons reported	Deaths <1 in 200 Rescues <1 in 30 Fires beyond room <1 in 30	Non-family residential areas, modern family housing.	Suppression of a fire confined to item or room of origin.	1 hose team in 20 minutes.	
Areas presenting high risk of larger scale incidents (high life and fire risk)	Deaths >1 in 100 Rescues >1 in 15 Fires beyond room >1 in 20	Low quality HMOs, council estates and older terraced housing.	Simultaneous control of fire beyond room of origin and limited search and rescue for 1 or more occupants without incurring undue risk.	2 BA search teams and 2 fire fighting teams in 10 minutes.	Highest priority
Areas presenting medium risk of larger scale incidents. (medium life and fire risk)	Deaths 1 in 150 to 100 Rescues 1 in 15 to 20 Fires beyond room 1 in 20 to 40	Affluent suburban housing, mixed inner metropolitan areas, better off retirement areas.	Simultaneous control of fire confined to room of origin and limited search and rescue for occupant without incurring undue risk.	2 BA teams and hose team in 10 minutes	Second priority
Areas of medium fire risk	Fires beyond room 1 in 20 to 40	Agricultural areas, modern family housing, high status non-family areas.	Control of a fire beyond room of origin, no persons reported.	2 fire fighting hose teams within 20 minutes	Focus on early detection and door closure

TABLE 8.4 ILLUSTRATIVE SECONDARY FIRE RISK CATEGORIES

Secondary fires	Quantitative measures of risk	Initial response design tasks	Operational capacity response planning guideline	Fire safety service planning guideline
Isolated rubbish, grass, heathland and forest fires in areas lacking sites of commercial, recreational, heritage of environmental value.		Suppress a small slowly developing fire.	1 hose team & OIC in: - 20 minutes	Low priority
Areas where there is a significant possibility of fires in open areas, such as heathland and forestry, which have a high environmental, cultural, social or commercial value, or are near to transport routes or occupied buildings.	High value acreage to exceed X hectares.	Verify extent of fire and risk to nearby premises/forest etc, and initiate containment.	2 hose teams & OIC in: - 20 minutes	Medium priority

TABLE 8.5 ILLUSTRATIVE LIFE RISK SPECIAL SERVICE RISK CATEGORIES

Special services, including RTAs	Quantitative measures of risk	Initial response design tasks	Operational capacity response planning guideline	Fire safety service planning guideline
Areas where there is a significant possibility of life threatening special service incidents involving persons trapped in machinery, tunnels, compartments etc or imminently threatened by unsafe structures.	More than 6 cases per year in station ground.	Effect stabilisation of machinery/structures, medical access to casaulties and/or immobilisation of casaulties at risk from movement in time to avert escalation of injuries.	Stabilisation & extraction equipment plus crew trained in extraction and casaulty care in: - 5 to 10 minutes	Low priority
Areas with a high risk of life threatening Road Traffic or other transport Accidents requiring rapid extraction of casaulties, or clearance to avoid major traffic congestion.	Rate of RTAs in station ground with persons trapped to exceed 6 per year. Or: Volume of traffic to exceed X per hour.	Effect extraction of 1 or 2 casaulties in time (in 60 minutes from accident) to avert injury escalation, avoid harm from delay in medical intervention & major traffic congestion.	Extraction & other equipment & crew trained in use of equipment and casualty care in 5 to 10 minutes for life threatening incidents involving 1 or 2 vehicles.	High priority lobby issue.
RTAs without person reported trapped		Ensure risk of ignition is minimised, any fires extinguished and area made safe.	1 hose team in 20 minutes.	
Areas where there is a significant likelihood of chemical spills which could pose a threat to life or the environment.		Safely contain hazardous material and minimise traffic holdup.	Response varied according to caller information on type and location of spill.	Medium priority

8.3.4 Linking response guidelines on operational capacity to training etc

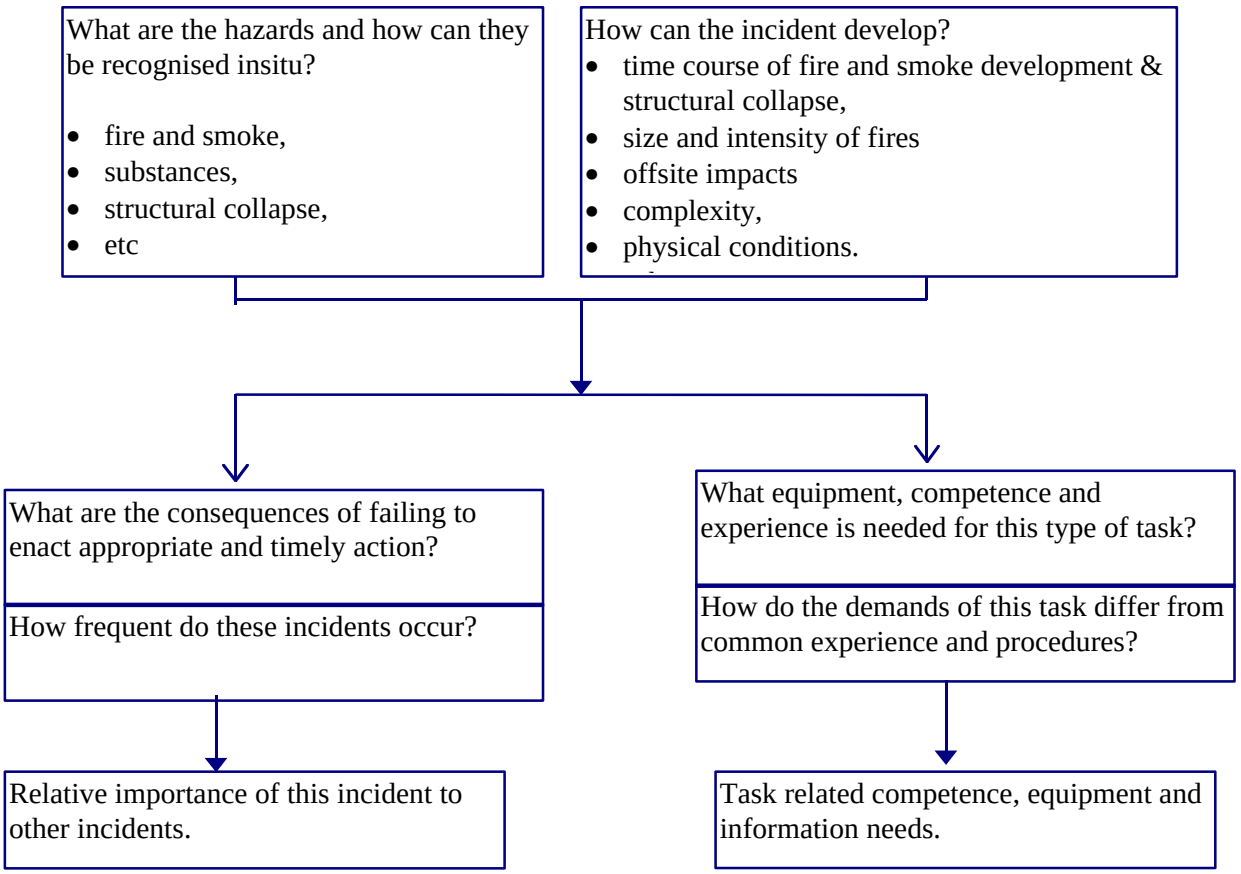
An illustration of the process of linking operational capacity guidelines to training etc is illustrated in Figure 8.6 The links between risk assessment and fire fighter safety have already been elaborated by CACFOA. The form of linkage is likely to rely on qualitative assessment to a greater extent than fire cover assessments, to produce a profile of the hazards and tasks upon which to specify training, equipment, personnel and procedural needs. Given a reference to operational capacity in a standard, the assessment could focus on:

- identifying the dominant and significant hazards and detailing the tasks in "design tasks" and scoping training, equipment etc to assure competent performance of pertinent "design tasks", as well as supporting activities,

- identifying the generic competencies all personnel need for certain design tasks and the specialists needed for supporting tasks.

With competence needs driven by risk assessment of those incidents attended by brigades, rather than being driven by an interpretation of statutory duty, such needs are likely to cover special service and special fire activities as well as normal fires.

FIGURE 8.6 LINKING DESIGN TASKS TO OPERATIONAL CAPACITY



8.3.5 Application of risk categories

In considering the work required to apply the envisaged form of risk categories account should be given to:

- the reference to social-demographic characteristics of areas,
- the reference to the incidence of large fires and persons reported,
- the reference to the installation and judged effectiveness of engineered fire safety systems such as sprinklers**.**

These references suggest that a brigade could approach risk categorisation in a number of alternative or complimentary ways, as illustrated in Figures 8.7 and 8.8 for dwellings and commercial premises. Thus, in the case of residential areas a brigade could assign risk categories by one or more of the following means:

1. judgement of types of dwellings and frequency of fires with persons reported or beyond room of origin,
2. survey of a sample of households to determine households types, uptake of smoke detectors, use of space heaters etc,
3. application of census information and ACORN typology,
4. analysis of local fire reports for occupied dwellings, such as rate of fires confined to room versus beyond room of origin on arrival and rate of persons reported per reported fire.

These approaches can be seen as complimentary with one method verifying (or not as the case may be) the conclusions of another approach.

In the case of commercial, service sector etc premises, categorisation could be approached by one or more of:

1. judgement using risk category prose,
2. survey of premises via 1iD and fire safety inspections,
3. acquisition of information held by other agencies such as Building Control, Environment Agency and the Health and Safety Executive.
4. review of fire reports (both local reports and reports from other brigades) relating to types of premises in area**,** particularly regarding size(s) of fire on arrival, effectiveness of engineered fire protection etc**.**

In addition, the identification of time of day, time of week and time of year variations in the incidence of fire, persons reported and/or habitation would necessitate examination of fire reports and/or survey of local time related variations in habitation and traffic.

Figure 8.7 Approaches to application of envisaged dwelling risk categories

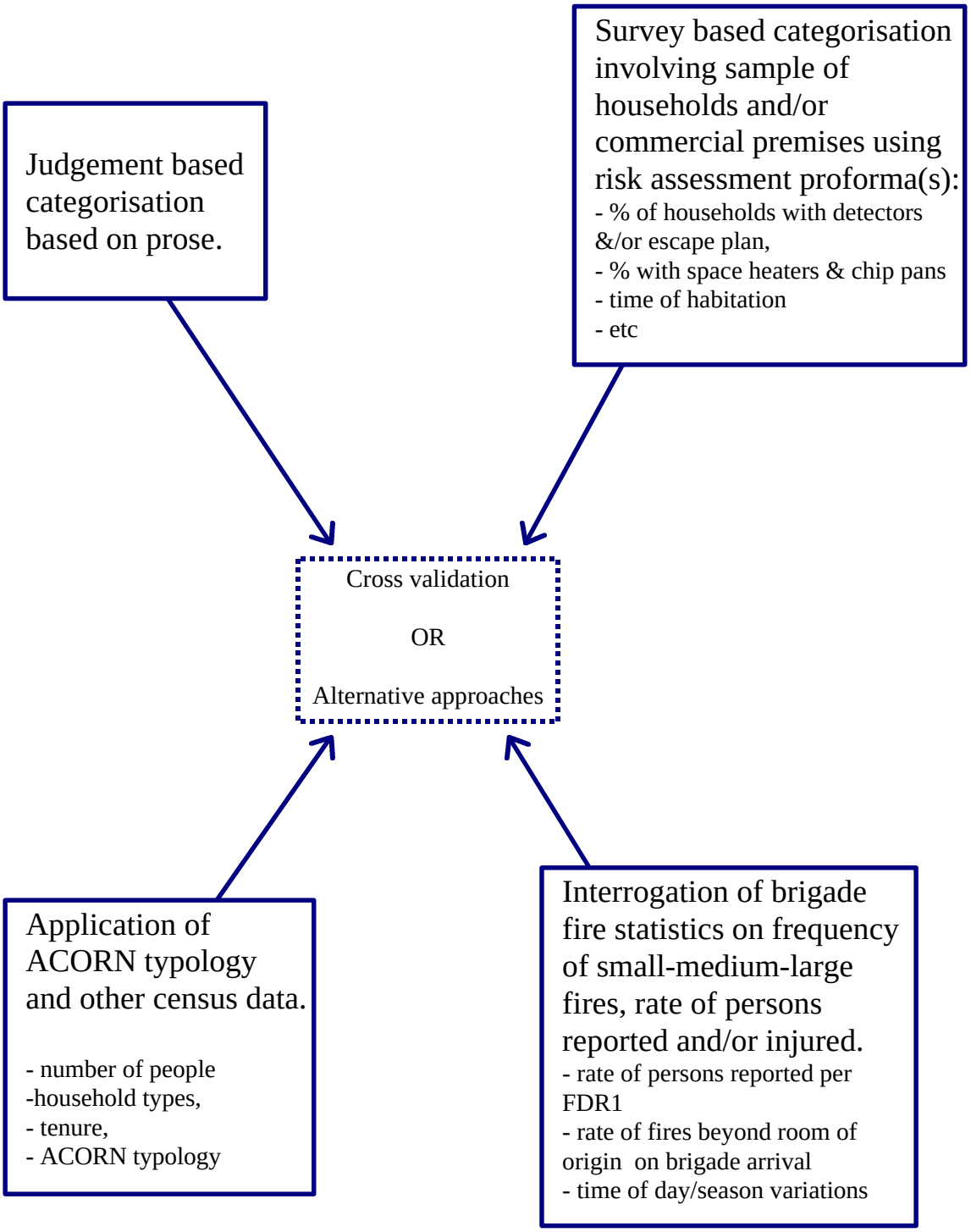
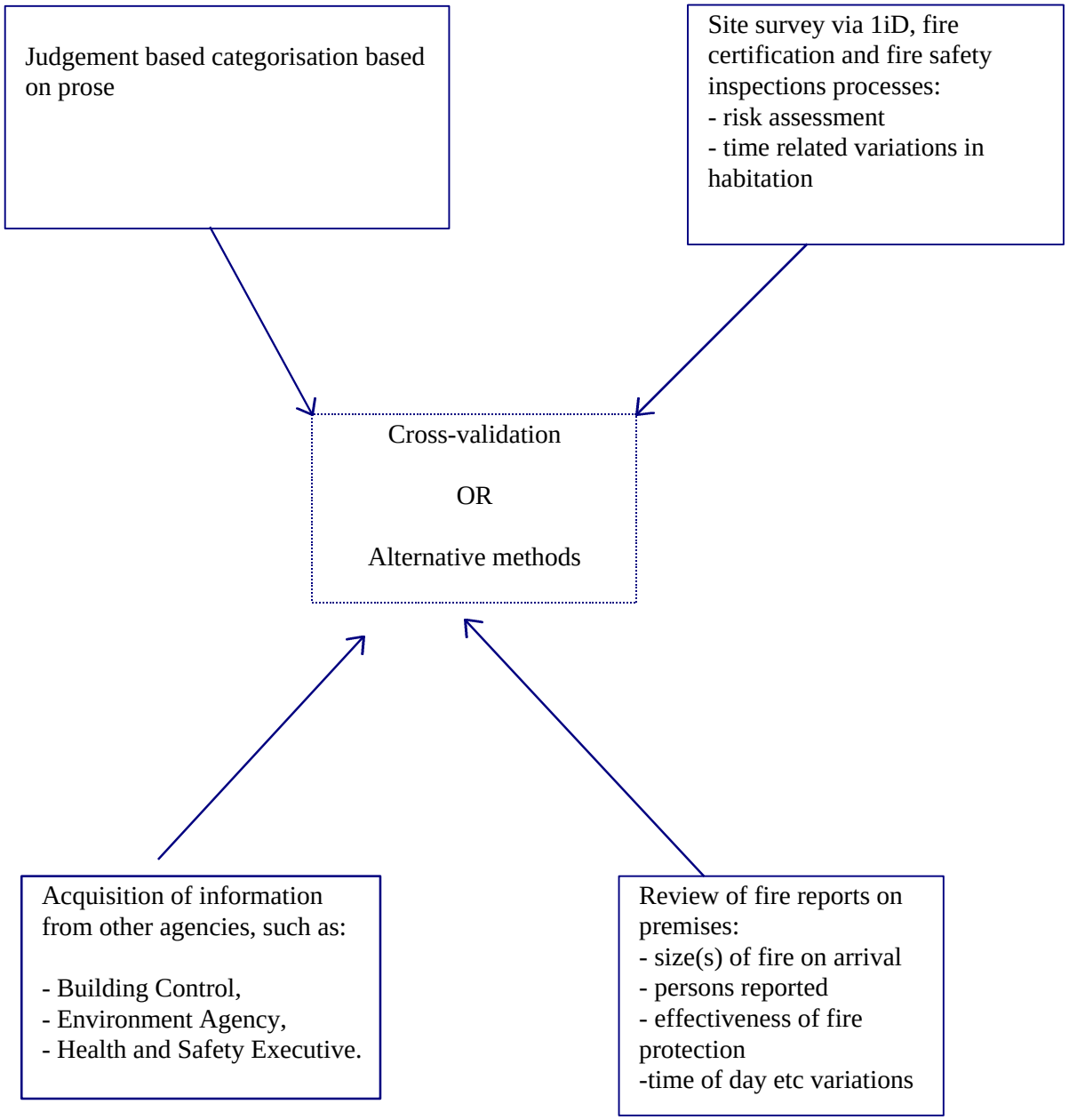


Figure 4.8 Approaches to categorisation of commercial, educational, retail etc premises using envisaged risk categories.



OTHER FIRE RISKS

The risk associated with sites and incidents that have the potential for major disasters, such as rail systems and CIMAH sites, could be determined by:

- analysis of record of calls to such incidents, and;
- drawing on predictions of accident likelihood developed within quantitative risk assessments carried out in relation to major hazards in the UK.

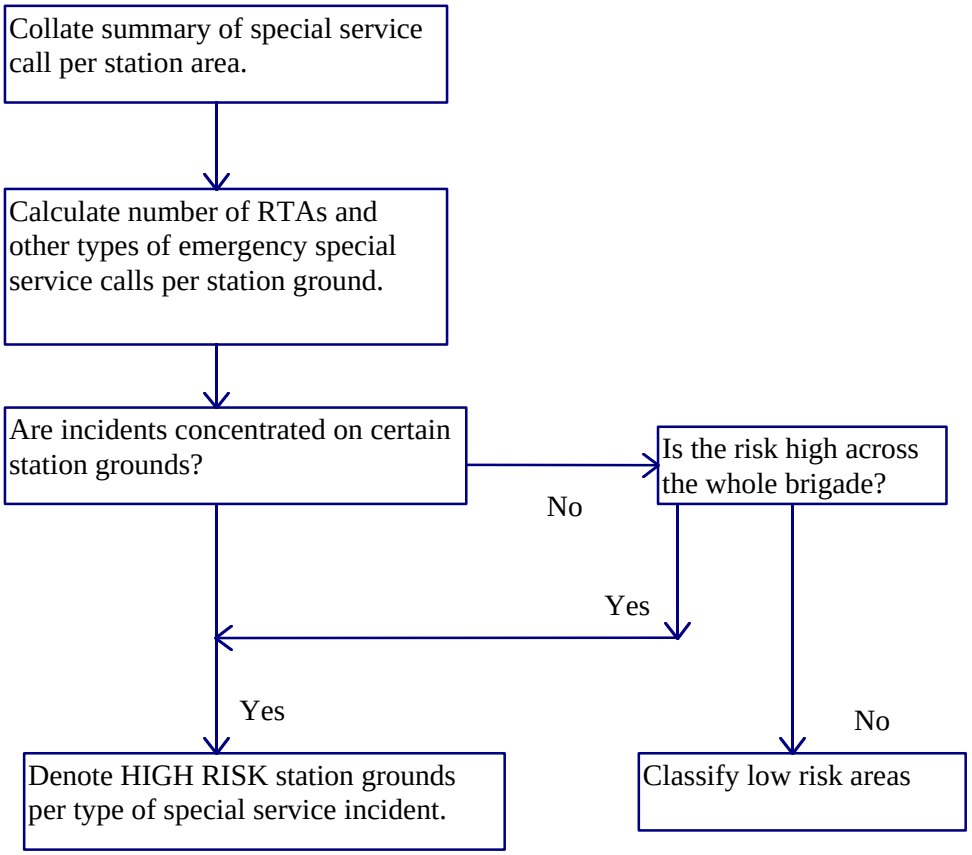
RTA AND OTHER SPECIAL SERVICE LIFE RISKS

As with fire related fatalities examples can be found of fire brigades identifying “clusters” of RTAs and other life threatening special service incidents, such as persons stranded in unsafe locations. Such analysis, as illustrated in Figure 8.9, is largely completed by examination of brigade records of special services, with a breakdown of calls per station ground according to:

- RTAs,
- hazardous materials and pollution incidents,
- rescues and extractions, such as from machinery (other than lifts)
- making safe

For example, about 50% of Hereford and Worcester’s RTAs in 1994 occurred on 6 out of 34 (18%) station grounds, and about 60% of other special service emergency calls occurred on just 4 out of 34 station grounds. An area would be classified as high risk if the number of calls exceeds a certain defined level, as per the risk category.

FIGURE 8.9 DEFINING AREAS OF HIGH SPECIAL SERVICE AND RTA RISK



8.4 LOCAL TARGETING OF FIRE SAFETY EDUCATION

POINTS COVERED HERE

- targeting of fire safety education within high risk areas,
- identifying high risk groups and issues,
- linking fire safety education strategy to target groups and issues.

8.4.1 Identifying high risk groups and premises

The risk categories would suggest that brigades should develop fire safety education programmes targeted on high risk groups and premises in areas assigned a high risk category. Examples of this type of analysis are already available within the UK fire service as noted in Entec's earlier report (Entec, 1996, a) and the "In the Line of Fire Report" (p25). This could comprise

- brigades reviewing whole authority area to develop area wide fire education and safety strategy, and/or:
- individual stations identifying high risk groups and premises for local station led fire education and safety work.

As previously noted, the number of fire related casualties in a station's ground may not provide a statistically reliable indicator of fire risk, due simply to the low number of casualties in any single station ground. Accordingly, any station level analysis of risk is likely to be limited to determining whether fires are concentrated in certain parts of the station ground, whether the number of fires exceeds the norm for that type of station, and whether certain types of occupants and occupancies are predominant.

An overview of the steps in the type of analysis which could be carried out at brigade level is shown in Figure 8.10. The method involves collating and then analysing fire reports. To allow "at risk" groups and areas to be discerned the analysis first classifies fires and casualties according to one or more of the following, cross-referencing as appropriate:

- occupant age,
- sex,
- individuals socio-economic class,

- area of residence and socio-economic classification of the area,
- type of premise (age of premise, owner occupied, rented vs local authority ownership, multi vs single occupancy, materials and form of construction),
- ethnic group,
- physical and mental capability, i.e. able bodied versus physically or mentally impaired.

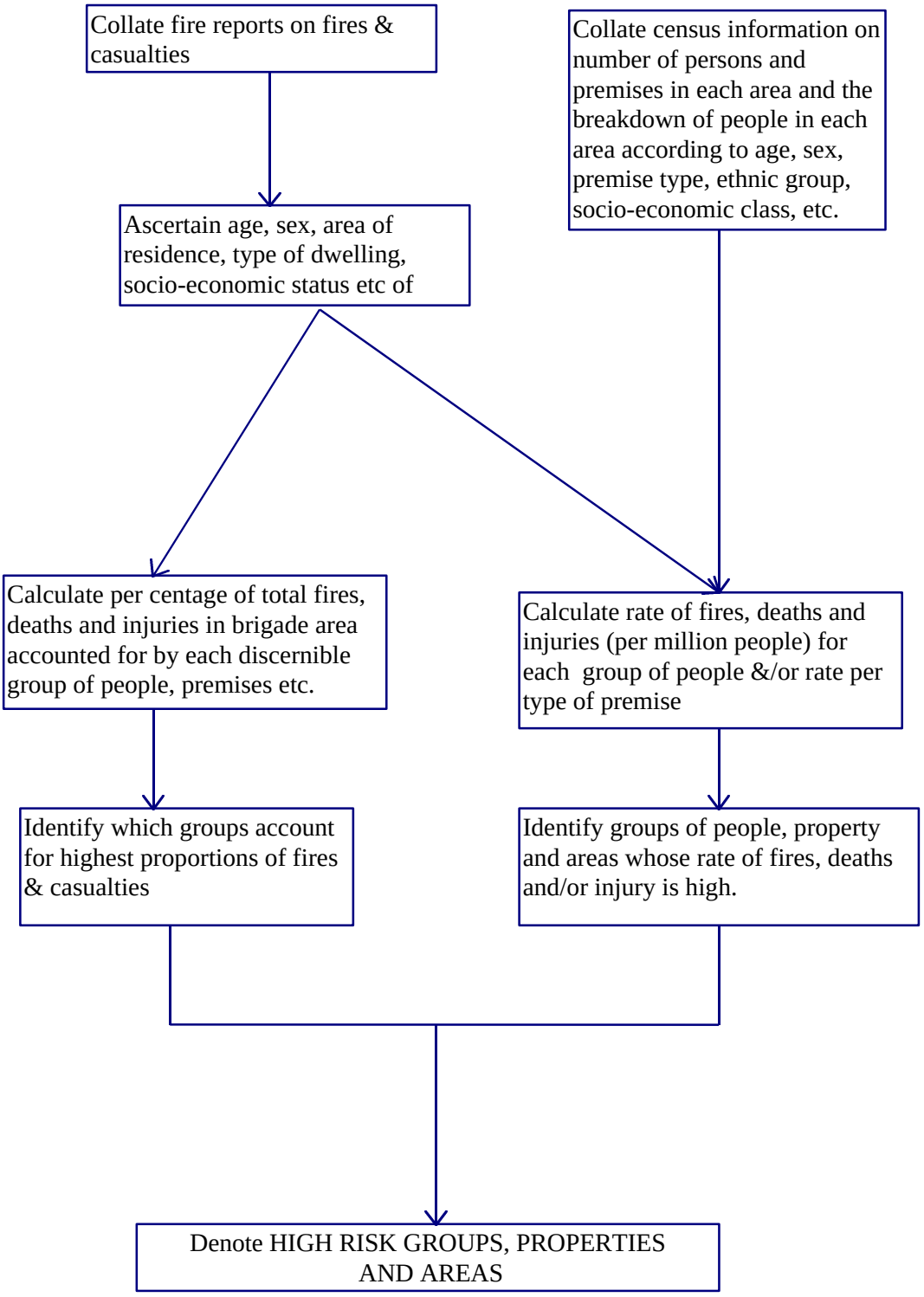
A high risk group, type of premise or area could be defined using the type of risk criteria shown in Figure 8.1, and/or as one where:

1. the rate of deaths and injuries for a defined group of people significantly exceeds the average rate for the UK population, or:
2. one which comprises the largest single grouping of casualties in an area.
3. the area shares two or more of the features of areas elsewhere known to have a high risk of life loss, as noted in section 8.2.3

The contribution of a group to the total number of casualties can be estimated by use of fire and casualty statistics alone, i.e. what per centage of casualties come from each group. For the rate of deaths and injuries to be estimated it would be necessary to draw on census information regarding breakdown of population in the area of interest in terms of age, sex, ethnicity, socio-economic status, etc.

Whilst either of these forms of analysis can identify “at risk” groups, it is possible that a class of casualties which does not contribute greatly to the total number, such as casualties of a particular ethnic group, could nevertheless have a rate of injury which exceeds that of other groups. The low contribution of a class of people to casualty numbers could simply be a result of the relatively small numbers of such people. Accordingly, it is possible that both forms of analysis would be needed. In addition, it is possible that the persons involved in fatal fires may differ from those injured in fires. Hence, a check should be made as to whether the defined groups of people contribute equally to both fatalities and injuries.

FIGURE 8.10 IDENTIFYING HIGH RISK GROUPS AND PREMISES



EXAMPLES OF AT RISK GROUPS

1. FRDG analysis of causes of fire death which showed that whilst about 42% of a sample of 392 fatalities in 1994/95 involved people over 65 years of age, persons over 65 comprise about 16% of the total population.

2. The same FRDG analysis found that 9% of fatalities were physically disabled in some way and 3.6% were mentally ill or suffered from senile dementia, i.e. 12.6% were physically or mentally impaired.

3. The 1980 Home Office review of future fire policy found that persons under 5 and over 60 are 50% more likely to be fatally injured per fire, as opposed to injured only, than other age groups, as well as finding that the likelihood per year of being fatally injured by fire for children under 5 and people over 60 is twice that for other individuals.

4. The 1994/95 review of fire risk by Merseyside Fire & Civil Defence Authority found that 95% of recorded fire deaths over a five year period occurred in 'C' risk areas, which accounts for about 45% of the brigade's area.

5. According to work completed by Buckingham Fire and Rescue Service, occupants of HMOs are 4.5 times more likely to die in a fire than those living in single family dwellings.

8.4.2 Identifying dominant issues

The aim here is to focus fire safety and education work on causes of fires as well as fire safety features and occupant behaviours which impact the consequences of fires. Such an assessment would comprise an analysis of factors which contribute to fires:

- the causes of fires, such as chip pans fires, arson, smokers materials,
- poor housekeeping and fire safety management, such as storing flammable materials against doors and walls, careless disposal of hot materials, allowing dirt and grease to accumulate,
- impact of occupant characteristics on outcome of fires, such as physical impairment,

- the existence, operation and effect of fire safety systems such as detectors, fire exits, sprinklers etc,

- occupant behaviour, such as closure of lounge doors at night, moving burning chip pans, attempting to re-enter burning houses etc.

Examples of this type of assessment can already be found in the UK Fire Service, as noted in both the In the Line of Fire Report and Entec's earlier report. Ideally such analysis is carried out for each discernible group of people (as designated by the analysis described in section 8.5.1), such as elderly vs mobile occupants vs HMOs, given that the causes and circumstances of fires differ between these groups.

8.5 LOCAL RISK ASSESSMENT

POINTS COVERED HERE

- use of risk assessment methods locally by brigades in place of prose based risk categories,
- suite of methods to be supplied instead of a single points based system,
- suite of methods matched to complexity and type of risk,
- common methods used for fire cover, fire safety and operational capacity purposes,
- consistency between risk assessment methods and risk categorisation,
- central approval of risk assessment methods.

8.5.1 Overview

A suite of risk assessment methods ranging in rigour and scope are illustrated here, including:

- A series of interlinked points based risk assessment schemes are shown in section 8.5.2 for use in PDAs, fire safety and competence.
- a template for assessing a common type of property, for the purpose of defining PDAs.
- proformas for special service incidents of low complexity,
- Fire Risk Assessment and Quantitative Risk Assessment methods for occasional assessment of complex, high risk, new types of sites for sake of fire cover, and supporting fire safety advice.

The role of these methods would be comparable with the existing points based scheme for risk categorisation and the designation of special risks. However, the methods described here would give due account to the likelihood of events and their severity in terms of life and property risk, taking account of engineered fire safety and occupant characteristics. Also, methods of assessment would be supplied for special risks, AFAs and special service incidents, which are not currently covered by the existing points based risk categorisation scheme. Finally, methods would be included to examine competence, procedures and equipment issues as well as support fire safety work, which again are not covered by the current risk categorisation system.

The toolkit could also include points-based systems for assessment of site which present a significant environmental risk in the event of a fire, such as the risk of contaminated fire water run-off from warehouse fires, and systems for assessing sites which have a heritage value.

It is suggested that inter-assessment consistency could be achieved by:

- issuing guidance on the form of local risk assessment, such that methods developed by brigades fulfil certain minimum requirements, and/or;
- requiring a central body, such as CFBAC sub-committee to review and approve methods prior to application, and/or;
- including review of local risk assessment methods within the remit of HMFSI inspections.

8.5.2 Points based fire risk assessment schemes

Examples of points based schemes for assessing fire risk in premises are shown in Exhibits 8.1 to 8.5. It is envisaged that a brigade might use one or more of these depending on its circumstances. Each scheme would be developed through a process of Risk Assessment drawing on fire reports, fire and smoke development models and fire reports, with the results of schemes validated against actual experience as recorded in fire reports.

Each scheme designates risk as being High, Medium or Low. Example guidance on the implications of risk assessment results for PDAs, 1iDs and fire safety inspections is given in Table 8.6.

Exhibit 8.1 Exhibit 8.1 is designed to give a risk rating of low-medium-high for individual domestic dwellings. The suggestion is that brigades survey a sample of dwellings in areas where the overall risk category is not clear cut.

Exhibit 8.2 Exhibit 8.2 is designed to give risk ratings of High, Medium or Low for the Fire and Life risk in certain types of commercial premises, such as retail outlets and offices. It is envisaged in this example that a premise could present a High fire risk but only a Low life risk, such as large poorly protected storage units staffed by a single employee. Alternatively a premise could present a high life risk, such as large numbers of physically impaired persons, but a moderate fire risk due to a low fire loading.

Similar schemes could be developed for other types of premises such as:

- care homes, hotels, flatlets, hostels and HMOs,
- industrial,
- educational,
- small retail outlets,
- etc

Exhibit 8.3 A points-based scheme is shown in Exhibit 4.3 for determining, from a survey of individual sites, the potential to have a reduced PDA for AFAs from such sites. This example envisages alternative discretionary PDAs for AFAs from lower risk premises where it is possible to gain a reliable corroboration of the AFA in a defined interval. The results of exhibit 8.2 are drawn on to provide the fire and life risk ratings.

Exhibit 8.4 A points-based scheme for suggesting 1iD, information and training priorities, based on a fire fighter risk rating. (An example of a more detailed points based scheme for generating special site related training, information and equipment needs is already available from Hereford and Worcester Fire Brigade).

Exhibit 8.5 A points-based scheme is shown in Exhibit 8.5 for scheduling of fire safety inspections, again drawing on results of exhibit 8.2. An alternative system has also been developed by West Midlands Fire Service entitled Qualitative Re-Inspection Review.

The example guidance in Table 8.6 suggests:

- faster and heavier PDAs for higher risk premises,
- alternative PDAs for AFAs received from lower risk premises from which it is possible to gain a reliable corroboration of an alarm and which have a low ratio of confirmed fires to false alarms,
- more frequent fire safety inspections for higher risk premises and premises where it is judged that there is a risk of fire safety standards rapidly falling due to either a change in occupancy or decline in standards of fire safety management,
- more frequent 1iDs, site specific training and more specific information for premises which pose a higher risk to fire fighters.

TABLE 8.6: EXEMPLAR LINKAGE OF RISK RATINGS TO PDA, COMPETENCE AND FIRE SAFETY INESPECTIONS

RISK RATING	PDA		AFA PDA	1iDs & site specific information/ training needs	Fire safety inspection schedule
	Firefighting	Search & rescue			
High	3 or more hose teams in 5 mins	2 search & rescue teams in 5 minutes when inhabited	Full PDA	Annual 1iD, detailed site specific tactical & strategic information, specialist training etc	Annual or more
Medium	2 hose teams in 8 mins	2 search & rescue teams in 8 mins when inhabited	Investigatory PDA in 8 minutes (weight depending on size & complexity of site)	Bi-annual 1iD, tactical information & building plans.	2 to 3 years
Low	1 hose team in 10 to 20 mins	1 search & rescue teams in 10 to 20 mins when inhabited	Investigatory PDA in 10 to 20 - (discretionary attendance time when uninhabited)	1iDs every 3 years or less. Key information on Central Risk Register. Standard procedures apply.	4 to 5 years

EXHIBIT 8.1:DWELLING RISK ASSESSMENT					
Tenure		Accommodation		Age of household head	
Local authority	3	Flat/other	3	16-35	3
Other	2	Multi-occupancy	2	36-59	2
Owner occupied	1	House	1	60+	1
Family type		ACORN typology		Smoke detectors	
Single parent	6	G	6	1 or 2 mains	0
With children	3	D, F, E	3	2 battery	1
No children	1	J, K, A, H, I, B & C	1	1 battery	2
				None/inoperable	6
Fire safety			Yes	No	
Doors shut at night			1	0	
Doors absent/obstructed			1	0	
Chip pans used			1	0	
Space heaters used			1	0	
Poor disposal of smokers materials?			1	0	
Fire escape plan			1	0	
Dilapidated			1	0	
Correct response to chip pan fire?			1	0	
Bedroom windows do not allow escape?			1	0	
Common roof void?			1	0	

Points	>25	High risk
	12 to 24	Medium risk
	<12	Norm

EXHIBIT 8.2: NON-DOMESTIC PREMISE FIRE RISK ASSESSMENT

Address

Description

LIKELIHOOD OF SERIOUS FIRE

Ignition risk		Fire safety management		Ignition suppression		SERIOUS FIRE RATING	
High	3	Poor	3	Minimal	3	High	12 +
Medium	2	Average	2	Average	2	Medium	8 or 9
Low	1	Good	1	Good	1	Low	<8

TOXICITY RISK

Generation rate		Confinement		Occupant sensitivity		TOXICITY RATING	
Rapid	3	Minimal	3	Aged, sick	3	High	12+
Moderate	2		2	General popn	2	Medium	8 or 9
Slow	1	Some High	1	Adults only	1	Low	<8

ESCAPE

Initiation		Exit design		Occupant mobility		ESCAPE RATING	
Slow	3	Poor	3	Slow	3	Slow	12+
Moderate	2	Average	2	Mixed	2	Medium	8 or 9
Fast	1	Good	1	Mobile	1	Fast	<8

INITIAL FIRE DEVELOPMENT

Fire load		Confinement		Suppression		FIRE SIZE RATING	
High	3	Minimal	3	Minimal	3	Large	12+
Low	2		2	Some	2	Medium	8 or 9
Medium	1	Some High	1	High	1	Small	<8

LIFE RISK

Serious fire rating	Toxicity 12+ 8 to 12	Escape 1 to 27 <8	Toxicity 8 or 9 4 to 6	Escape 8 or 9 8 +	Toxicity 1 to 6	Escape 8 +	No° of people
High	HIGH RISK		MEDIUM RISK		LOW RISK		Day -------- Night
Medium							
Low							

INITIAL FIRE SIZE

Serious fire rating	FIRE SIZE RATING Large	FIRE SIZE RATING Medium	FIRE SIZE RATING Small	Fire size
High	HIGH RISK		LOW RISK	
Medium		MEDIUM RISK		
Low				

SPECIAL FACTORS

External access	Internal access & layout	Water supplies	Smoke logging	Other

EXHIBIT 8.2: PREMISE RISK ASSESSMENT GUIDANCE

For retail outlets, offices, above ground railway premises, recreational & storage premises > 100m^2 (excluding residential, care, hotel, hostel, HMO industrial, defence and educational premises).

LIKELIHOOD OF SERIOUS FIRE

Ignition Risk		Fire safety management		Ignition suppression	
High	Commercial cooking, numerous electrical appliances, heat sources such as motors, poor security in high risk arson area, smoking permitted, frequent hot work. Highly flammable materials, eg paper & wood.	Poor	Minimal. Flammable materials stacked against doors, walls, etc. Doors left open and unsecured. High % of alarms points inoperative. No control of hot work.	Minimal	Legal minimum hand held extinguishers. Few staff trained in use of extinguishers
Medium	Smoking restricted to designated areas, just electrical appliances. Day security. Low risk arson area.	Average	Patrolled, day staff only, no CCTV, nominated fire officer.	Average	Auto-sprinklers in some areas. Some staff trained in use of extinguishers. Unsecured sprinklers.
Low	No heat sources. All points of entry controlled 24 hrs.	Good	24 hr trained staff, dedicated on site fire officers, hot work permits, CCTV,	Good	Auto-sprinklers in all areas. Some staff trained in use of hoses. Secure sprinklers

TOXICITY RISK

Generation rate		Confinement		Occupant sensitivity	
Rapid	Foam filled articles, plastics, vinyl, highly flammable materials.	Minimal	Single compartment, open access between compartments. Segregated floor connected by open doors with low ceiling (<11 foot). Open access between floors.	Aged, sick	Predominantly elderly, sick and infirm persons.
Moderate	Predominance of carbon based contents. of moderate flammability.	Some	Segregated floors with rooms protected by fire doors. Voids have smoke blocks,	General popn	Mix of all ages, predominantly able bodied.
Slow	Contents comprise fire retardent products only.	High	Segregated floor space, auto smoke control, HVAC shutdown, smoke blocks in ventilation, no cavities.	Adults only	People aged 16 to 65, predominantly able bodied.

EXHIBIT 8.2: PREMISE RISK ASSESSMENT GUIDANCE

For retail outlets, offices, above ground railway premises, recreational & storage premises > 100m^2 (excluding residential, care, hotel, hostel, HMO industrial, defence and educational premises).

cont'd

ESCAPE					
Initiation		Exit design		Mobility	
Slow	Either no alarms or traditional bell alarm only, occupants unfamiliar with building. No uniformed staff or fire officers. No smoke detectors.	Poor	Unprotected stairwells, over 100 feet to safe air, must circumvent objects, single door to stairwells, no emergency lighting or floor lights to exits, obscured exit signs,	Slow	Predominantly elderly, disabled, sick, mentally impaired.
Medium	Alarms bells only with people familiar with site and practised in evacuation. Detectors in high risk areas only.	Average	Double doors to stairwells, less than 100 feet to safe air, few objects to circumvent, clear exit signs.	Mixed	Mixed general population, including family groups, children and some elderly persons. Variable familiarity with building layout.
Fast	Alarm plus automatic voice instruction to evacuate plus uniformed staff when occupied. Detectors in all rooms with a fire load. or all areas occupied.	Good	Stairwells are positively pressured, double doors to stairwells, or less than 100 feet to safe air, floor lighting to exits.	Mobile	Adult population 16 to 65 with few infirm or disabled persons., familiar with building layout, practised in fire drill.
INITIAL FIRE DEVELOPMENT					
Fire Load		Confinement		Suppression	
High	Flammable materials of construction. Densely packed flammable materials (< 4 foot separation), eg warehouses, carpet shops.	Minimal	Single compartment or rooms connected by open space. Connecting ceiling voids. Cavities in walls, ducts etc. No fire separation from other buildings.	Minimal	No sprinklers or detectors.
Medium	Mix of flammable materials as found in offices and hotels rooms.	Some	Compartments connected by manual fire doors or shutters.	Some	Main areas of occupation and areas containing flammable materials sprinklered. & detectors. Mains water only.
Low	Large proportion of floor space vacant. Eg foyers and concourses. Minimal inward air flow, eg bonded enclosed storage.	High	30 to 60 minute fire rating of floors, stairwells, doors and ceiling of a compartmented floor. Voids and ceilings have fire rated fire breaks.	High	All areas containing flammable materials sprinklered. Controlled sprinkler maintenance, standby pumps. Detectors in all areas with brigade auto-call.

EXHIBIT 8.3 AFA RISK ASSESSMENT

Property address or definition of type of premise:

INITIAL FIRE SIZE RISK
(take risk rating from exhibit 8.2)

HIGH	MEDIUM	LOW

LIFE RISK ASSESSMENT
(take risk rating from exhibit 8.2)

HIGH	MEDIUM	LOW

POTENTIAL FOR AFA VERIFICATION

Opportunity to gain reliable corroboration of AFA (CO)		Ratio of confirmed fires to false alarms (medium if unknown) (RF)		VERIFICATION POTENTIAL (VP = CO X RF)	
Low	3	High	3	6+	Poor
Medium	2	Medium	2	4	Average
High	1	Low	1	<4	Good

AFA RISK

Verification potential	HIGH FIRE OR HIGH LIFE RISK	MEDIUM FIRE OR LIFE RISK	LOW FIRE & LOW LIFE RISK
Poor	HIGH AFA RISK		MEDIUM AFA RISK
Average			
Good		MEDIUM AFA RISK	LOW AFA RISK

Opportunity to gain reliable corroboration of AFA:

Low: Premise unoccupied for some periods. Security desk unstaffed at times.
Medium: 1 staff on duty at all times, lacking CCTV.
High: 24 hour staffed office with oversight of alarm system faults and CCTV of occupied areas. Direct dial to/from fire service. Extensive smoke detector system. 2 or more staff on duty at all times.

Ratio of confirmed fires to false alarms:

Low: Less than 1 in 100.
Medium: Between 1 in 10 to 1 in 100
High: More than 1 in 10

EXHIBIT 8.4: FIRE FIGHTER RISK			
	Rate potential for each risk at site		
RISK	**HIGH**	**MEDIUM**	**LOW**
Rapid structural collapse			
Backdraught			
Flashover			
Explosion			
Air exhaustion			
Rapid fire spread			
Contamination			
Other			
	Overall risk rating =		

EXHIBIT 8.5: FIRE SAFETY RISK ASSESSMENT							
Premise address:							
INITIAL FIRE SIZE RISK (take risk rating from exhibit 8.2)							
HIGH		**MEDIUM**		**LOW**			
LIFE RISK ASSESSMENT (take risk rating from exhibit 8.2)							
HIGH		**MEDIUM**		**LOW**			
FIRE SAFETY DEGRADATION RISK							
Potential for rapid change in occupancy (O)		Potential for rapid degradation of fire safety (FS)		Dependence on engineered systems and staff actions (EFS)		SAFETY DEGRADATION RISK 0 x FS x EFS	
High	3	High	3	High	3	High	12+
Medium	2	Medium	2	Medium	2	Medium	8 to 11
Low	1	Low	1	Low	1	Low	<8
FIRE SAFETY RISK							
Safety degradation risk		High fire or life risk		Medium fire & life risk		Low fire & life risk	
High		HIGH				MEDIUM	
Medium				MEDIUM		LOW	
Low							

8.5.3 Premise fire risk templates

It is common practice in many industries to develop “template” risk assessment where there are large numbers of sites or operations which present the same type and level of risk. Such templates are typically developed through the detailed risk assessment of the types of sites or operations in question. Template provides a prose description of the site or operation to a sufficient level of detail to ensure the user can judge whether the site or operation in question is broadly comparable with the template. Quantitative criteria can be included in templates, as appropriate, to aid judgement of whether the site is comparable with those upon which the template is based. The template would include guidance on response for those occasions where the site or operation in question matches the template.

Exhibit 8.6 shows a template which could be used for a class of site which has already been assessed in detail. For example, an assessment of single compartment unsprinklered retail outlets could be generalised through use of a template such as in Exhibit 8.6.

EXHIBIT 8.6: EXAMPLE TEMPLATE	
1 to 4 storey uncompartmented industrial and storage units 100m^2 to 10,000 m^2 **TREAT AS HIGH RISK PREMISE** Minimum PDA of 43 hose & 2 search teams with option of >3 if caller information indicates flames are visible from exterior. (or PDA of 2 appliances for isolated buildings)	High fire loading, such as: • stacked with textiles, paper, wood, aerosols, plastics etc. • over 1 cu.m^3 of flammable liquid stored inside, High ignition risk, such as: • no hot work permit process, • high arson rate in area, • uninhabited at night. Security restricted to padlocked doors, wire fence and possibly a conventional burglar alarm. No night security. • rubbish and flammable waste materials stored against side of premise, • motorised and/or electrical equipment, • exposed element heaters, industrial cooking. No smoke detectors, or no auto-call to brigade in day staffed unit. Unsprinklered and unprotected steel frame or brick shrouded steel supports. At least 1 uncompartmented room over 75m^2, or a series of smaller compartments connected by open access routes, non-fire braked ceiling cavities or ducts, unsealed penetrations into sandwich panels or wall cavities. Isolated buildings or building less than 10m from adjacent building, or no fire resistant walls between adjoining buildings. Few means of access into building, such as less than 4 doorways and windowless (or windows on small percentage of 1 side only.
Industrial and storage units 100m^2 to 10,000m^2, excluding chemicals plants. **TREAT AS LOW RISK PREMISE** Minimum PDA of 1 hose team (with option of 2 or more appliances for sites over 1000 m^2).	Good fire safety management demonstrated by lack of flammable materials stored against walls etc, operative smoke detectors, hot work permit to work system, staff trained in fire safety. 24 hours staffing and/or on-site security with CCTV, secure fencing and controlled entry to site, eg by gate staff. Flammable liquid stores etc are segregated from building. CO_2 etc in electrical and/or other process areas involving flammable liquids. Smoke detectors in all areas containing flammable materials with AFA, or 24 hour occupancy in all areas. Premise is compartmented (max size of 250m^2) by fire rated doors, shutters, walls etc of 60 or more minutes fire rating. Fire breaks in ceiling voids, ducts etc. No wall cavities. Support structure 60 or more minutes fire rated. All areas with flammable materials are sprinklered.

8.5.4 Special service risk assessment proforma

A proforma based risk assessment is shown in Exhibit 8.7 for special service incidents.

EXHIBIT 8.7 SPECIAL SERVICE INCIDENT RISK ASSESSMENT

Definition of incident:			
Areas where incident risk is designated as high:			
Average number of incidents per year across the brigade for the last 3 years?	**How imminent is the threat to life or the threat of escalated injuries?**	**Very imminent** **Imminent** **Not imminent**	
How would a faster or slower emergency intervention influence the degree of harm?			
Can this type of incident be handled in a safe & efficient manner using standard procedures, equipment, common experience and know-how?			
In what ways do the demands of this incident differ from those of "normal fire" incidents?			

RECOMMENDATIONS

Special resource & training needs	**Siting of special resources**	**Response time in high risk areas**

Cost per response		**Assessed by:**	
Cost per averted death/serious injury.		**Date**	

8.5.5 Fire and quantitative risk assessment

Fire and Quantitative Risk Assessment (QRA) methods discussed and illustrated in Entec's earlier report (1996, a) could be used for:

1. assessment of complex, new, low frequency, very high risk sites and special incidents, such as aircraft crashes, and;

2. assessment of more common sites such as common retail outlets, with the results used to design points based schemes and templates for broader application, and;

3. substantive changes to procedures, equipment, mobilisation arrangements, appliances and competencies.

4. generating information on the level of risk and cost-benefit of improvements in support of fire safety advice.

Examples of the first and third applications can already be found in the UK Fire service, as noted in Entec's previous report. Also, as previously noted, QRA studies have already been completed for the majority of major hazard industries in the UK. The results of these studies could be drawn on selectively for the fire services purposes.

QRA tends to involve detailed quantitative assessment of the likelihood and consequences of events, often using Fault and Event Trees to represent complex events such as fires in very large buildings with complex geometry and a number of interacting fire safety and protection systems. An example of a Fault Tree is shown in Figure 8.11.

However, QRA can involve less complex assessments where the dynamics of an event are simpler. For example, the assessment of aircraft crashes around Heathrow Airport simply noted:

- the frequency of crashes in and around the airport,
- the likelihood of a crash on site versus offsite, and;
- the likelihood of crashes occurring to the east, south, north or west of the airport,
- with the consequences expressed in terms of ratio of deaths to survivors, and likely number of persons involved.

This was achieved without recourse to fault or event trees.

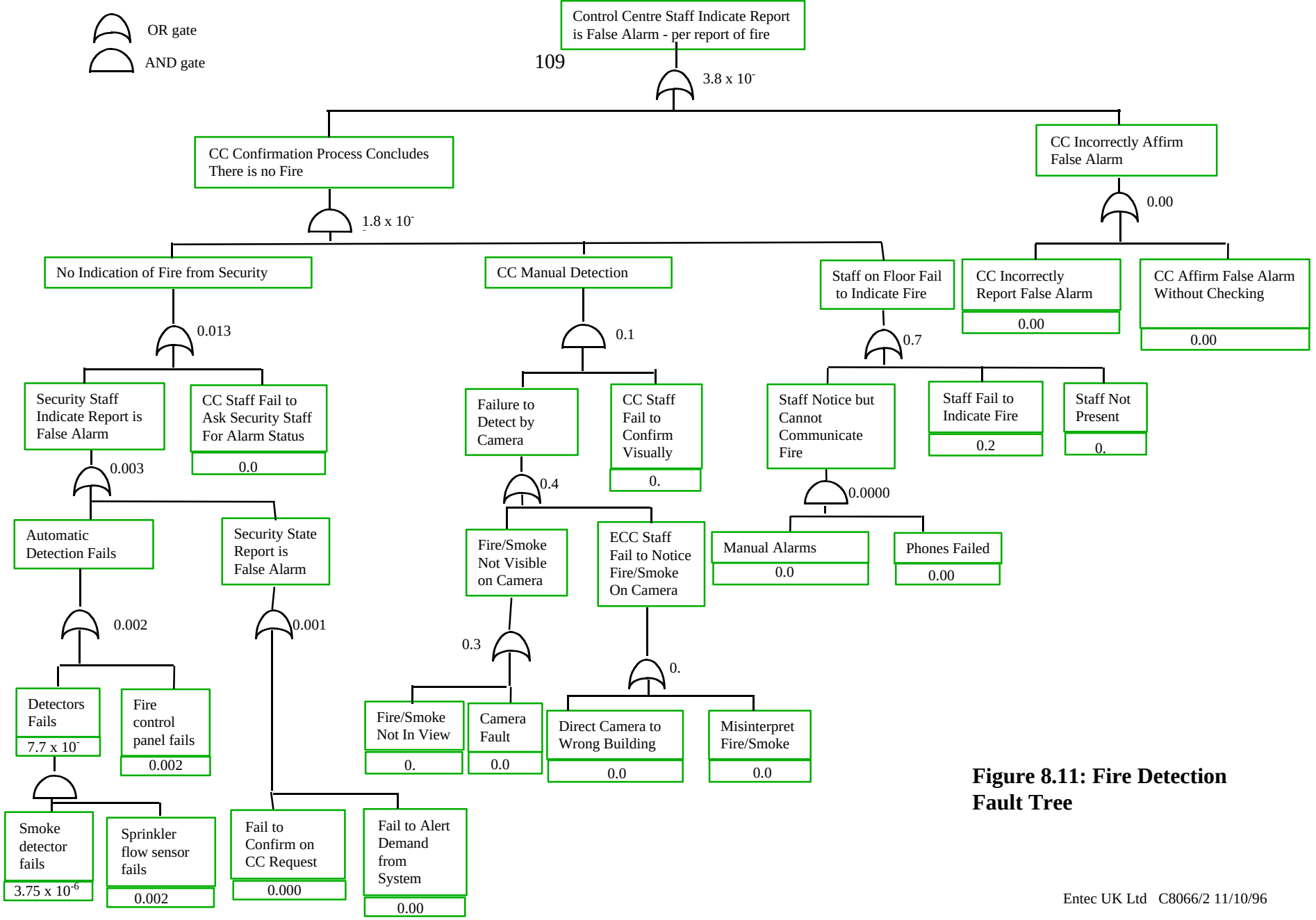


Figure 8.11: Fire Detection Fault Tree

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REFERENCES

Audit Commission. In The Line of Fire. HMSO, 1995.

A. Colver, P. Hutchinson and E. Judson. Promoting children's home safety. British Medical Journal. 285: 1177. 1982

B. Dugdale and B. Draper. Fire safety in HMOs. Environmental Health, April 1993, p 117-121.

Fire Research and Development Group. Study into the causes of fire deaths. Home Office 1996.

Fire Statistics, United Kingdom, 1992. Home Office 1994.

Future Fire Policy: A Consultative Document. Home Office. HMSO, 1980.

I. Roberts and C. Power. Does the decline in child injury mortality vary by social class? A comparison of class specific mortality in 1981 and 1991. British Medical Journal, vol 313, 28th September 1996.

E.Towner, T. Dowswell and S. Jarvis. Reducing Childhood Accidents. The effectiveness of health promotion interventions: a literature review. Health Education Authority, 1993.

APPENDIX A

ALTERNATIVE FORM OF RESPONSE STANDARD

An alternative form of risk categories and response planning guidelines are illustrated in Table A.1. Key points are that:

- the national minimum response standard operates across the whole UK, excepting remote rural areas (perhaps defined as 100^2 mile areas with less than [say] 0.5 person per hectare), regardless of variations in the incidence of fires.

- greater weights of response are suggested for areas, excepting sparsely populated areas (perhaps defined as 100^2 mile areas with less than [say] 1 person per hectare), where there is a higher risk of larger scale incidents, ie where there is a higher than average rate of persons reported, fire deaths or fires escaping beyond room of origin on arrival of the brigade,

- the standard is expressed in terms of attending a per centage of reported occupied dwelling fires in 5 to 10 minutes rather than be able to attend any location within a defined area in this period,

- measure achievement of standard across the whole fire authority area and/or major divisions thereof, rather than on a station by station basis.

Such a formulation of standards presents the advantages of:

- matching the public expectation that a common minimum standard will be set for all residents regardless of social status or area of residence,

- having greater weights of response where higher incidence of larger scale incidents, ie persons reported or larger fires,

- allowing account to be taken of 2nd and 3rd calls,

- prompting a strategic review of fire cover across a whole fire authority area and divisions thereof,

- being comparable with ambulance service response standards, namely of 90% of all high risk calls (irrespective of location) being attended in 8 minutes.

It should be noted that the 1985 review reported the following attendances times:

Area	Response times	
A	90% of 1st in 5 mins	
B	74% of 1st in 5	90% of 2nd in 8 mins
C	89% of 1st in 8 mins 95% of 1st in 10 mins	91% of 2nd in 10 mins
D	Average attendance of 1st in less than 10 mins Average for first 3 all in less than 15 mins.	

Hence, the achievement of a target of attending (say) 90% of fires in occupied dwellings in 5 to 10 minutes in all parts of the country, except remote rural, may not be an unreasonable expectation although the costs of achieving such a standard would clearly need to be determined for a cost-benefit assessment to be carried out.

	National minimum response standard: 90% of reported fires to be attended by a BA equipped fire fighting team & OIC in 8 minutes, and 100% in 20 minutes, measured across a fire authority area and/or command divisions.			
Higher risk areas	Quantitative definition (per reported fire)	Qualitative examples	Design task	Response planning guideline
Areas presenting high risk of larger scale incidents (high life and fire risk)	Deaths >1 in 100 Rescues >1 in 15 Fires beyond room >1 in 20	Low quality HMOs, council estates and older terraced housing.	Simultaneous control of fire beyond room of origin and limited search and rescue for 1 or more occupants.	1 additional BA search teams and 1 additional fire fighting team in 8 minutes.
Areas presenting medium risk of larger scale incidents. (medium life and fire risk)	Deaths 1 in 150 to 100 Rescues 1 in 15 to 20 Fires beyond room 1 in 20 to 40	Affluent suburban housing, mixed inner metropolitan areas, better off retirement areas.	Simultaneous control of fire confined to room of origin and limited search and rescue for occupant.	1 additional BA team in 8 minutes
Areas of medium fire risk	Fires beyond room 1 in 20 to 40	Agricultural areas, modern family housing, high status non-family areas.	Control of a fire beyond room of origin, no persons reported.	1 additional fire fighting team within 10 to 20 minutes

APPENDIX B

RISK ASSESSMENT EXAMPLE

The work completed by Buckingham Fire and Rescue Service and Wycombe District Council (SO Bryan Dugdale and EHO Bob Draper) in 1993 is an example of the type of analysis which can be completed using current data and an example of how an empirical risk assessment can confound common perceptions.

This work was completed as part of a review of fire safety requirements rather than a review of fire cover needs, with a recommendation to increase EHO and Fire Prevention Officer co-operation. Consequently information is not presented on the likelihood of non-fatal injuries outside of the room of origin or the number and location of rescues per fire in HMOs, single occupancies and flats, information which is required to review response needs. Clearly, if there is a higher rate of rescues from floors above the outbreak and/or on the floor of outbreak in HMOs than in single occupancies this would indicate that resources are required to enact such rescues. The finding that about 40% of HMO victims are above the ground floor, compared with only about 22% of single occupancy victims, adds weight to the suggestion that a response needs to gain swift access to higher floors in HMOs. In addition, the analysis does not differentiate between high and low quality dwellings, such as those with and without smoke detectors, the presence of which other research has indicated can be related to social class and hence geographic location. Given that the proportion of fires spreading from the room of origin is about 6 times higher for fires not discovered by smoke alarms than for fires discovered by smoke alarms, there may be sub-categories of single occupancies and HMOs (ie ones lacking detectors etc) which present a much higher risk of fire spread than indicated by the aggregated data used by Dugdale and Draper.

However, and notwithstanding the need for a more complete risk assessment tailored to emergency response issues, the findings outlined below would suggest that a greater weight of response cannot be warranted on the grounds that there is a higher rate of fatalities outside of the room of outbreak for HMOs than for single occupancies, as the data indicates that this is not the case. Moreover, the information would suggest that there is even less of a case to increase the weight of response for flats and maisonettes (over and above that for single occupancies) due to the rate of fatalities occurring on floors above the outbreak, as again the data indicates that fatalities are less likely to occur above the floor of outbreak in flats than in single occupancies.

Summary of findings

“The risk of injury for an HMO occupant was four and a half times greater than for the occupant of a single dwelling. Additionally, fire was five times more likely to occur, and 14 times more likely to constitute a dangerous situation. The main reason for additional danger were identified as relating to separate cooking and heating appliances and their misuse. Other factors include inadequate means of escape ....

The HMO population is estimated at 5% of the total population but account for 11% of all domestic fires.

> "From Home Office statistics, it can be seen that HMO occupants are at greater risk from their own actions than from those of their fellow occupants and are most likely to die in the room where the outbreak occurs. Other occupants are less likely to be victims of fire spread to other floors. These figures reflect the nature of bedsit accommodation, where each tenant has the use of only one room, with the door likely to be kept shut. Even a conventional door will offer some protection against fire spread, provided it is properly closed."

In contrast, occupants of single household dwellings are (in 1985-88) twice as likely as HMO residents to die within a floor above that on which the fire started. Flats appear to offer the safest conditions, due to a higher likelihood of built-in fire resistance.

...HMO residents are more likely to suffer a fire and be injured but their premises have the potential to be safer in terms of fire spread prevention and early detection."

Table B.1 Summary of rates of deaths and location of victims in HMOs, single occupancies and flats/maisonettes.

	Single occupancies	HMOs	Flats & maisonettes
Number of deaths	383	70	162
Number of fatal fires	331	65	146
Total number of fires	34,241	6036	18,604
Ratio deaths:fires	1 in 89	1 in 86	1 in 115
Ratio fatal fires; Fires	1 in 103	1 in 92	1 in 127
Location of victims (%)			
In room of origin	53.5 %	56.0 %	59.0 %
On same floor	19.0 %	24.0 %	32.0 %
Floor above outbreak	22.5 %	14.0 %	6.0 %
Two or more floors above	4.5 %	Not stated	Not stated
Other locations/ unspecified	0.5 %	5.0 %	3.0 %