Communities and Local Government

Risk assessment tools, techniques and data for the Civil Contingencies Act and Integrated Risk Management Planning

Fire Research Series 5/2008

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Department for Communities and Local Government

The findings in this report are those of the authors and do not necessarily represent those of the Department for Communities and Local Government.

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Executive Summary

Background

The Civil Contingencies Act 2004 was introduced to provide a framework for civil protection and defines organisations into Category 1 (such as fire, police and ambulance) and Category 2 responders such as the Health and Safety Executive. Category 1 responders "assess the risk of emergencies occurring and use this to inform contingency planning". Local Resilience Forums (LRFs) were created to bring together all the Category 1 and 2 organisations who have a duty to co-operate under the Civil Contingencies Act. There are 43 LRFs within England. Amongst other tasks, LRFs complete risk assessment of civil contingencies within their areas, produce Community Risk Registers and ensure multi-agency plans, procedures, training and exercises exist. The UK Resilience website, developed by the Cabinet Office's Civil Contingencies Secretariat, provides a standard approach to Local Responder risk assessment, as carried out by Category 1 responders within LRFs.

Integrated Risk Management Plans (IRMPs) were introduced in 2004/05 for every Fire and Rescue Service (FRS) as part of the FRS modernisation process. The Audit Commission's Operational Assessment of Service Delivery (OASD) guide lays out short statements that encapsulate expectations of FRSs, including on risk analysis. The Civil Contingencies Act 2004 and IRMPs are both focused on integrated emergency management, which require effective risk analysis. Whilst they are supported by underpinning advice it was thought by Communities and Local Government that there was a lack of clarity of what risk assessment tools, techniques and data are (a) available, (b) appropriate and effective, (c) required and (d) already used.

Aims of this work

The aims of the project were to research and produce advice on the availability, selection and use of risk assessment tools, techniques, data and guidance to support the obligations of the LRFs under the Civil Contingencies Act 2004 and risk analysis for IRMPs.

Phases of work

The research had four main phases.

1. A review of what tools and data are available to conduct risk analysis of the probabilities and consequences of emergencies by LRFs and FRSs. This has been achieved by consulting a sample of 10 LRFs, 14 FRSs and 8 Category 2 responders in England. We also reviewed the results of the OASD review of IRMPs conducted as part of the Audit Commission's Comprehensive Performance Assessment (CPA) and a sample of Community Risk Registers (CRRs). As we used a sample of LRFs and FRSs the findings are indicative rather than exhaustive.
2. A gap analysis to identify any shortfalls in risk assessment tools, techniques and data that are available and used, as well as identifying good practice in current use of data and tools.
3. Identification of other data, tools and techniques that would further support the risk analysis of the LRFs and IRMPs.
4. Recommendations were provided for the Operational Assessment of Service Delivery toolkit regarding the selection and use of risk assessment tools, techniques and data by FRSs.

Key findings regarding LRF risk assessment

Benefits of the LRAG process

LRFs risk assessments are led by the Category 1 responders with input and support from Category 2 responders. The Local Risk Assessment Guide (2006), as developed by the Civil Contingencies Secretariat (CCS), provides guidance to LRFs on likelihoods and impacts of national and regional scale emergencies, and for some localised events. The LRFs interviewed all employ the process set out in LRAG and consider it an adequate basis for high level risk assessments and emergency preparedness. The incident likelihood assessment and impact values in LRAG and those provided by Category 2 responders were used as a starting point. In some cases LRAG stipulates that its likelihood and impact values are not expected to be changed by LRFs. In other cases it stipulates a range of values from which LRFs should select specific values based on their local assessment.

The LRF respondents raised no significant criticisms of the LRAG process, which was viewed as:

- Clear and simple
- Providing rules that are useable
- Relatively easy to maintain although with a moderately heavy initial effort
- Providing a more traceable and robust basis for prioritising contingency planning
- Helping to minimise LRF liability, by following 'official guidance'.

Some LRFs indicated that the results have been used to check:

- If there any gaps in the portfolio of emergency plans
- If the prioritisation of plans is appropriate.

The LRFs indicated that their risk assessments added value to these decisions and there was value in adopting a consistent approach across LRFs in England.

Support for each risk category

The feedback from LRFs regarding the extent to which data and analysis tools were available to support risk assessment varied across the risk categories; from well to less well supported. The categories suggested by LRFs as having less support were:

- Localised industrial fire and explosions
- Aviation accidents
- Industrial technical failures
- Shipping accidents
- Land movements
- Public protest
- Mass gatherings
- Animal health
- Terrorist
- Storms and gales (smaller scale events).

The gaps included issues such as lack of access to lists of installations and lack of data on past incidents.

In many cases LRFs referred to local incident experience. Where the local experience differed from the LRAG values this was considered by the LRFs to cast doubt on the validity of the LRAG value. However, as the LRAG indicated specific likelihoods for many risks, the LRFs tended to constrain their likelihood assessments to the values presented in LRAG regardless of their own local data.

Need for more support on assessment of localised event frequencies

A recurring point from LRFs was that they wished to include a wider range of 'localised' events (ones that can be handled using the resources within the LRF's area) in their risk assessment, for which LRAG provides limited support. Feedback from LRFs was that the LRAG event descriptions and the likelihoods did not correspond to the 'localised' events that they wished to include. In a number of cases the LRF contained unique features such as the Channel Tunnel and key sites, which were difficult to assess using the generic guidance in LRAG. They felt that the limited support and focus on localised events reduces the practical value of the process.

Many of the respondents stated that:

- No specific tools or techniques were used to assess localised events
- They relied on "professional judgement" and local data to assess localised events.

They said that there was:

- Limited support to assess likelihoods of 'localised' events in the form of data or tools
- Limited knowledge of sources of data and analyses
- An element of 'do not know what we do not know' regarding what data and tools were available.

The restricted internal (not published) versions of the Community Risk Registers did not disaggregate the risk assessment geographically.

Developing scenarios and predicting impacts

The feedback from LRFs was mixed. Some LRFs developed local scenarios that, in their opinion, reflected the scale and nature of events that may occur in their area. This was typically achieved by review of local events and from first principle, such as by considering the size of towns that may be subject to coastal flooding.

The researchers' observation was that in some cases the review of local events was limited and may not have provided a robust basis on which to identify and define scenarios. In particular:

- The period of time from which local incidents were drawn was, in our opinion, short, namely 5 to 10 years. This does not provide a sufficient period of experience to assess likelihoods of local frequency events in the order of one every hundreds or thousands of years
- The historical incidents in the local area may not represent the full spectrum of events that could occur.

On the other hand, in some cases the LRFs applied the LRAG outcome description 'without question' as fulfilment of the risk assessment exercise. Moreover, there was common feedback that:

- The LRAG outcome descriptions did not 'help' with emergency planning as they did not provide sufficient detail on the nature and features of the event
- The outcome descriptions (and associated likelihoods) focus on the very large-scale national and regional events. This did not support assessment and planning of more localised events such as motorway closures, cylinder explosions etc
- It was noted that it was difficult to agree on a single event description where the outcome of an incident can vary across an LRF, such as where the outcome of a gas pipeline incident varied according to the population density along the pipeline route.

There was an expressed need to include assessment and planning for more localised (but still significant) events, which is consistent with the requirements of CCA. There was an expressed wish from some LRFs for ready access to information on events that would help:

- Identify the types of incidents that could occur
- Conceptualise incidents, such as defining their characteristics (eg impact and outcome descriptions)
- Understand the circumstances in which such incidents could occur and therefore whether they could occur in the local area.

Assessment of knock on effects and outcome descriptions

There was mixed feedback on the extent to which 'knock on effects' of the primary risk were considered. In some cases the LRFs indicated that they should consider 'domino effects'. They cited the example of the Bunsfield incident, which impacted the road network and disrupted local business as well as posing an industrial fire and pollution risk. In the case of flooding, one LRF's assessment identified how flooding may impact COMAH sites (as part of the site's own emergency plan) and reception centres. However, this was not cited as a common practice because:

- 'Mixing up' risk categories may lead to overly complicated and erroneous risk analysis
- Emergency plans should focus on the primary risk, such as evacuating vulnerable people
- Responsibility for looking at knock on effects lies with other parties, such as the utilities, whom it was assumed by LRFs have considered eventualities such as of flooding of a sewage plant.

There was no evidence that it was right to assume that utilities will have assessed the civil contingencies eventualities of flooding. Moreover, the researchers judged that LRF emergency plans should identify this eventuality and include it within their plans.

Risk prioritisation

Feedback from LRFs indicated that some look to include additional factors in the prioritisation of risks and that there were some queries regarding the risk rating process. The factors included:

- Public risk perception and expectations
- Whether the risk is considered to be well managed and planned for already.

It has also been argued that:

- Some risk categories share similar 'scenarios' and would have similar 'generic' contingency plans, such as aviation accidents, chemical leaks and a terrorist 'dirty' bomb

- There is operational value in having a small set of generic emergency plans (where appropriate), as this (in their opinion) facilitates a more effective response.

This raised the question of whether the prioritisation of activities such as emergency exercises should be based on the risk rating of individual risk categories or of 'groups' of risk categories that share similar emergency planning scenarios. The researchers' review suggested that there is danger that the sub-division of risk categories may lead to the risk assessment for some categories, those that are sub-divided into many sub-categories, being artificially lower than for those risk categories that are less sub-divided. Those risks with similar consequences and response plans could benefit from being assessed as a whole, at least at the point of risk prioritisation.

Also, whilst LRFs accepted that priority should be awarded to the higher risks, concern was expressed by LRFs about the application of this principle. In particular, whether in practice this was interpreted to mean that emergency exercises are only completed for the Very High risks. Finally, given that there was wide uncertainty in the risk assessment, especially likelihoods, the results should not be used in a literal way to decide for or against emergency planning and exercises but a degree of judgement was needed based on professional experience.

Competence of LRFs

LRFs were confident with regard to the way in which their risk assessments support activity to control and treat risk. A number of concerns were expressed, including:

- Experience of local risk assessors
- Uncertainty regarding the competence and risk assessment processes used by some Category 2 responders
- Lack of clear competence requirements for LRFs' Risk Assessment Working Group (RAWG) chairs and members.

There were some concerns that responsibility for leading the assessment of some risks was allocated (or falls upon) an agency or individual who lacks suitable knowledge and experience of the risk category. The limited experience of Category 1 LRFs' members in assessing specific risks contributes to a limited ability to scrutinise, validate or challenge the estimates provided by other organisations.

Limits on sharing of data

Feedback indicated that FRSs and LRFs share data willingly, and that the LRF was a very useful forum for sharing information. There were three concerns though:

- Examples were cited of where the sharing of data by Category 2 assessors was limited by security and commercial factors

- Examples were cited where effective contact could not be established with Category 2 organisations due to the LRF lacking any suitable point of contact with them
- Many people who hold key risk assessment positions within LRF RAWG did not possess security clearance and that this limits the acquisition and use of sensitive information.

Findings regarding IRMPs completed by FRSs

Overall

The general view was that FRSs were well supported with respect to strategic planning, tactical decisions, operational planning and occupational health and safety. As regards strategic risk assessment FRSs have been supplied with Fire Service Emergency Cover (FSEC) toolit which the vast majority of FRSs have used. However, the adoption of additional tools and data by FRSs to augment FSEC, and feedback from FRSs, highlighted a series of specific limitations of risk analysis tools and a requirement for additional risk assessment functionality.

Matching IRMP risk assessment to changing FRS roles

The need to adapt to changes in the role of the FRS was suggested to have prompted new developments, including:

- The focus on community fire safety (shifting away from a focus on statutory fire inspections as part of the Regulatory Reform Order) requires predictive assessment, including assessment of the socio-demographic risk, using current and predictive information
- The shift towards partnership working requires a wider view to be taken of risk – beyond dwelling fires and towards wider community safety issues
- The increased importance of FRSs involvement in Road Traffic Collisions prevention (directly through FRS driver education schemes and through community safety partnerships) increases the demand for quality data on and assessment of RTCs
- The recognition of wider social responsibilities requires further account to be taken of the impact of activities, such as fire fighting, on the environment and society.

These emergent needs were prompting the development of tools and data sources by FRSs.

Workload modelling

A number of FRSs have developed or acquired tools to explore workload and resource utilisation issues, again highlighted a gap in the suite of tools provided nationally. This extended to modelling the resource implications of prevention work in addition to response activities.

Major incidents

There was mixed opinion on the need for additional data and tools for use by FRSs to risk assess major incidents within their FRS areas. On the one hand, as decisions were already made using qualitative information, it was doubted whether further 'data driven' risk analysis would add value to decisions. On the other hand, it was expressed that there was very little local data on major incidents and that it was questionable how assessments can be completed by any one FRS if they have not experienced a particular type of incident. It was also questioned whether a review of (say) five years of operational experience in any one FRS provides a valid basis on which to gauge the likelihood of low frequency major incidents. Accordingly there was some support for providing additional data and risk analysis of major incidents. Two specific areas of concern related to:

- Chemical incidents. It was suggested that as the majority of industrial chemical incidents occur at non-COMAH sites that the risk assessment process needs to extend beyond COMAH to include sub-COMAH sites and the transport of chemicals
- Simultaneous incidents: Could a tool be developed or made available to provide predictions of simultaneous major incidents?

The study also noted gaps in the risk assessment of flooding, including the assessment of transient populations and caravans, risk of dam/reservoir failure and inundation flooding. Given the important role of the FRS in rescue and recovery from flooding, this suggested to the researchers that consideration needs to be given to further development of FRS flood risk assessment.

Wildfire

There was growing interest in the assessment of wildfire for a number of reasons, including:

- The potential for large scale forest fires as well as lowland heath land fires
- More remote locations need better prevention because it is difficult for fire appliances to arrive in time to extinguish fires
- Recognition that wildfires can have a significant impact, particularly where there are consequential impacts such as closure of motorways
- Climate change may lead to longer and dryer summers (hence more fires and larger fires)
- The potential for increased cost of retained fire cover and demand for permanent fire cover in the event that climate change leads to more fires.

These developments indicate a need for further development of wildfire risk assessment.

Dynamic risk assessment

The general view of FRS respondents was that established processes were in place for the fire fighting response to 'traditional' events such as COMAH site incidents and incidents with potential for industrial pollution, such as through the use of site specific risk assessments, wind sensors and pre-attack plans. It was also noted that a number of FRSs have developed and operate mobile data systems that provide information to support dynamic decision-making for building fires. However, there was a need for considering further the wider impacts of incidents such as the environmental and social impacts of major fires. It was suggested that tactical deployment plans focus on fire fighter safety and fire fighting rather than other impacts, and that higher risk sites may justify plans that cover societal and environmental impacts.

Findings regarding the interplay of IRMPs and LRFs

Benefit of Community Risk Registers to IRMPs

It was stated by respondents that the first round of IRMPs was produced before LRFs were implemented. Any use of the Community Risk Registers occurred after the first IRMPs were produced. This was presented by FRSs as one of the reasons why FRSs have made limited use of CRRs, ie they had already completed their own risk assessments.

Some FRSs were exploring the value of the LRF risk assessments and were identifying some points of cross over. There were examples of FRSs reviewing their IRMP against the CRR and expressing the view that the LRF assessment did assist, to a limited extent, with prioritising risks. The review of their IRMP against the CRR indicated that they had covered the vast majority of their risks but had decided to include some additional risks after the review of the CRR. Some examples of where CRRs did help FRSs included:

- Identifying flooding as a key risk and that some fire stations are in flood areas and would be impacted in the event of a flood
- Identifying severe weather (storms) and a local airport as a high risk;
- Raising the question of whether the FRS has sufficient resources to handle major incidents
- Helping identify some scenarios for training purposes
- FRSs also said that LRFs usefully acted as conduits between the FRS and other agencies for identifying and sharing data and information for use in IRMPs.

Moreover, review of the CRRs highlighted to some FRSs a number of issues that may benefit from further review, including:

- Does further consideration need to be awarded to the impact of civil contingencies on FRSs' 'reserve' resources?

- IRMPs tend to focus on local events. The CRR process may help identify regional and national events that could impact them.

In some cases the FRSs explicitly checked fire cover decisions against the CRR to check resourcing decisions. However, it was queried whether current assessment of 'reserves' by FRSs was entirely sufficient. It was common practice to assess the availability of 'over the border' resources to assist in the event of a major incident in an FRS. However, in the event of a national or regional incident (that affects many FRSs) these 'over the border' resources may not be available.

Limitations of CRRs for IRMPs

It was suggested that the risk assessments completed by LRFs would be of greater value to IRMPs if there was a greater element of spatial (geographic) assessment and if they addressed more localised incidents. A number of FRS respondents indicated that:

- They have made very limited (if any) use (to date) of the LRF risk assessments or CRR
- The LRF assessments have not (to date) helped FRSs assess likelihoods of lower frequency incidents such as aircraft crashes
- FRSs have not (on the basis of CRRs) retained 'reserve' resources to handle major civil contingencies or the impact of (for example) pandemic flu on FRS operational capability – relying instead on regional and national arrangements and contingency planning already completed within IRMPs.

None of the FRSs indicated that they had changed their resources due to LRF risk assessments.

This was indicated to be due to a variety of reasons, including:

- IRMPs pre-dated the assessments completed for the 2004 Civil Contingencies Act
- The roll out of New Dimensions assets prompted FRS to review their CBRN, urban search and rescue and flooding risks independently of the CRR;
- The roll out of New Dimensions assets already prompted examination of what level of resources was needed to achieve 'resilience' in the event of civil contingencies
- IRMPs initially focused, in accordance with Communities and Local Government guidance, on dwelling, RTC and other building risks
- The local Community Risk Register was a 'drill down' of regional events that provided county level assessments – which were too high level to add value to IRMPs
- The CRR and LRAG scenario descriptions were too high level to be of practical value
- FRSs wished to consider smaller scale events that were not captured by current CRRs

- FRSs had already assessed a range of major incidents and had established contingency planning processes for many risks, such as COMAH sites
- As FRSs have generic business continuity contingency plans for attrition of resources, the assessments of individual risk categories within CRR did not necessarily add value.

The need to assure business continuity had already been highlighted by events such as the 2002 industrial action and the promulgation of flu pandemic plans to local authorities. These 'degradation' plans cover (in a generic way) all causes of loss of resources, such as pandemic flu, industrial action, foot and mouth, flooding of fire stations etc. The use of generic plans was reported by FRSs to mean that business continuity plans per risk category were unnecessary. The FRSs indicated they have made some, limited, use of the CRR to check they have addressed all risks to business continuity.

Conclusions

It was concluded that:

- There was significant scope to further develop the risk assessment tools and techniques used by LRFs for assessing more 'localised' events, to model knock on effects, factor in public risk perceptions and to produce risk assessments of sub-areas within the LRF's area
- There were some aspects of FRS IRMP risk assessment that could benefit from further development, such as wildfire, RTCs, workload modelling and major incidents (including flooding).

A search for risk analysis data, tools and techniques found:

- In most risk categories these were specialist techniques and data. LRFs and FRSs may benefit from the results produced by these techniques, but would need assistance in sourcing and interpreting the results
- There were no 'off the shelf' tools available that would help LRFs assess more localised events, to disaggregate risk assessments geographically or to assess knock on effects of risks, although many generic consequences modelling techniques existed
- There was no common format or tool for tabulating LRF risk assessments although there was one example of a database developed by Cheshire LRF that could be used by other LRFs to support the current scope of LRF assessment
- Internal versions of CRRs did not disaggregate risk geographically or extend the scope of LRF assessment to localised events, and therefore did not address the LRFs expressed need for a more localised risk assessment.

Options for way ahead

Facilitating localised event risk assessment by LRFs

Some options for facilitating localisation (disaggregation) of risk assessments and modelling of knock on effects included:

- Providing a bespoke tool (either as a simple GIS or database) that supports LRFs assessment of localised events and knock on effects
- Advising LRFs of databases, tools and techniques that they could draw results from with the help of Category 2 responders.

As most risk analysis tools identified in this study required specialist expertise to operate and interpret, the principle of providing LRFs with simplified results or locally applicable metrics appeared to be appropriate. However, the simplified metrics could usefully extend to support assessment local scale events. A specific option was to use the proposed Resilience Extranet to meet the needs of LRFs, such as by adding a risk analysis module and a GIS module to it. A GIS tool may offer the opportunity for LRFs to identify potential knock on effects of events, such as by identifying infrastructure that would be impacted by floods. A GIS tool can map infrastructure and, using overlays of the event, allow users to identify what structures are in the potentially affected area.

LRAG would need to be amended in the event that the LRF risk assessment process is extended to cover local scale events, knock on effects and risk assessments of sub-areas within LRFs.

The risk assessments completed by FRSs could be further communicated to LRFs, especially if the FSEC major incident module is upgraded and applied by FRSs. However, as FRSs assess only a minority of the risk categories assessed by LRFs, IRMPs can only provide limited support to LRFs.

Incorporating risk perceptions and adequacy of plans into LRF prioritisation

The approach adopted by Cleveland LRF to including a public risk perception rating into their risk prioritisation may be of value to LRFs. Our review identified a number of techniques that could be used by LRFs to assess societal concerns, and thereby provide a more robust basis for the rating of risk perceptions. In addition, a factor can be included in risk prioritisation that captures the current adequacy and level of contingency plans.

LRF and FRS risk assessment competence and support

The feedback from LRFs indicated a need for:

- A forum to share lessons, experience and ideas between LRFs
- Advice on sources of data and tools including a central and/or local approved "yellow pages"

- Advice on competence standards for LRFs.

There was also some evidence of a need to support FRS risk assessment competence, in context of IRMPs, due to the limited appreciation of how to assess likelihood of low frequency events and reliance on tools that do not provide risk measures in a small minority of cases. Whilst there is training available on the operation of FSEC, there is no training available on IRMP related risk analysis. Therefore, consideration could be given to reviewing IRMP risk analysis training.

Security classification

It was suggested that consideration is given to:

- Clarifying with Category 2 responders that LRFs do not publish sensitive information, as a way of encouraging greater sharing of information
- Identifying the minimum information that organisations need, and where possible deleting restricted or confidential information, to reduce security related restrictions in data sharing
- Increasing the level of security clearance of LRFs and FRSs staff, to facilitate their use of such data
- Developing standard data sharing protocols for exchange of information between LRFs, FRSs and other Category 2 responders, including system protocols to ensure data remains secure and guidance that helps organisations recognise when their data should be restricted.

It was noted that FRSs may need to be provided with advice on what information they collect should be classed as restricted or confidential. This included where information becomes restricted due to the combination of data rather than due to the security classification of any one body of data.

The latter protocols may benefit from being produced centrally, such as by Communities and Local Government or CCS, so that they have an appropriate level of authority. The protocols could be applied locally by LRFs and FRSs.

IRMP risk analysis tools

Options regarding the further development of IRMP risk assessment tools included:

- Upgrading FSEC to better assess major incidents and workload modelling
- Identifying complimentary tools used by FRSs to assess FRS specific issues, such as tools that assess the overlap of dwelling fire and crime
- Developing an approach for use of FDR1 (to be replaced by the Incident Recording System) and other FRS fire data for outdoor fires

- Providing guidance and tools to support assessment of resource implications of regional and national scale events as well as simultaneous large-scale events – this could be linked to the scenarios identified by LRFs and Regional Resilience Forums
- Addressing concerns about arrangements for weather-related incidents and the potential impact of climate change
- Facilitating assessment of wider environmental and social impacts of major incidents within dynamic risk assessment.

Interplay of LRFs and IRMP

There did appear to be value in more co-ordination between LRFs and IRMPs, in respect of:

- LRFs identifying the national and regional scenarios that FRSs need to assess (in respect of resilience of FRSs resources and operational continuity)
- FRSs checking that they have included all relevant types of major incidents in their IRMPs and assigning them proportionate weighting.

LRFs indicated that FRSs already provide useful input to LRFs. Accordingly; guidance could be given to FRSs to refer to LRF risk assessments (and RRT risk assessments) in their preparation of IRMPs.

The benefit to IRMPs of the risk assessment carried out by LRFs would be increased if the LRF assessment was further developed to provide more disaggregated forms of risk analysis and assessment of more 'localised' events. FRSs may also benefit from advice on how to determine scenarios for use in assessing resilience, especially those FRSs that do not operate New Dimensions assets.

National and regional IRMPs

LRFs indicated that FRSs already provide useful input to LRFs. In addition, respondents indicated that LRFs are already useful forums for identifying and sharing data and information. This led to the suggestion that FRSs may benefit from further developing similar structures to review IRMPs at a regional level. As previously noted, some FRSs raised the question of how the development of regional control centres may affect IRMPs. This again led to the suggestion that consideration is given to the FRS developing a set of regional IRMPs, perhaps with regional IRMP forums, to mirror the LRFs. A regional IRMP forum could address issues such as:

- Liaison with LRFs, RRFs and RRTs
- Planning for regional scale events
- Agreeing 'over the border' co-operation for major events
- Co-ordinating the retention and use of 'reserve' resources.

It was also noted by the researchers that the summer 2007 flood events involved the use of FRS resource from across England and required national co-ordination of resources. This raised the question of whether some form of national IRMP and IRMP forum was needed to risk assess and plan for such large scale events.

If regional and/or national IRMPs were developed this was thought to lead to the need for software support for regional FRS risk assessment. Therefore, it was suggested that Communities and Local Government consider developing a national and regional version of FSEC, to support national and regional level IRMPs.

Implicit in these suggestions is the principle that FRSs should consider regional and national scale risks when making decisions about their own 'reserve' resources and resilience. This would require liaison between national, regional and FRS specific IRMPs.

Contents

List of acronyms

ART	Area Risk Team
ASBO	Anti-Social Behaviour Order
BCM	Business Continuity Management
BCP	Business Continuity Planning
BERR	Department for Business, Enterprise and Regulatory Reform (formerly the DTI)
CAA	Civil Aviation Authority
CADDIE	Crime and Disorder Data Information Exchange
CAST	Critical Attendance Standard Model
CCA	Civil Contingencies Act
CCS	Civil Contingencies Secretariat
CDRP	Crime and Disorder Reduction Partnership
CLG	Communities and Local Government
CPA	Comprehensive Performance Assessment
CRAMM	Central Risk Analysis and Management Method
CRR	Community Risk Register
CS	Community Safety
Defra	Department for Environment, Food and Rural Affairs
DETAM	Dynamic Event Tree Analysis Method
DfT	Department for Transport
DH	Department of Health
DTI	Department of Trade and Industry
FCO	Foreign and Commonwealth Office
FBU	Fire Brigade Union
FDR1	Fire Damage Report 1
FDR3	Fire Damage Report 3
FEMA	United States Federal Emergency Management Agency
FRS	Fire and Rescue Service
FSA	Food Standards Agency
FSEC	Fire Service Emergency Cover
GIS	Geographic Information Systems
HO	Home Office
HPA	Health Protection Agency

HSE	Health and Safety Executive
IMD	Indices of Multiple Deprivation
IPDS	Integrated Personal Development System
iRAT	Incident Risk Analysis Toolkit
IRMP	Integrated Risk Management Plan
IRR	Internal Risk Register
KSI	Killed or seriously injured
LEPC	Local Emergency Planning Committees
LOD	Lines of defence
LOP	Layers of protection
LRAG	Local Risk Assessment Guide
LRF	Local Resilience Forum
MCA	Maritime and Coastguard Agency
MIS	Management Information System
MORECS	Met Office Rainfall and Evaporation Calculation System
NaFRA	National Flood Risk Assessment
NATS	National Air Traffic Services
NIM	National Intelligence Model
ODPM	Office of the Deputy Prime Minister
OPRA	Operator and Pollution Risk Appraisal
PIU	Performance Information Unit
PPE	Personal protective equipment
RAWG	LRF Risk Assessment Working Group
RDBMS	Relational Database Management System
RMB	Regional Management Board
RRT	Regional Resilience Team
RSSB	Rail Safety and Standards Boards
RTC	Road Traffic Collision
R2P2	Reducing Risks and Protecting People
SCRIBE	Sharing Community Related Information in Bedfordshire Electronically
SEMD	Security & Emergency Measures Direction
SWIM	Severe Weather Impact Model
TOR	Tolerability of Risk

Chapter 1

Introduction

1.1 Background

The Civil Contingencies Act 2004 was introduced to provide a single framework for civil protection. The Act established a clear set of roles and responsibilities for those involved in emergency preparation and response at the local level. The Act divided local responders into two categories, imposing a different set of duties on each. Those in Category 1, which includes the Fire and Rescue Services (FRSs), are organisations at the core of the response to most emergencies (eg emergency services, local authorities, NHS bodies). Category 1 responders are subject to the full set of civil protection duties, including, amongst other duties the need to "assess the risk of emergencies occurring and use this to inform contingency planning".

The risk assessment and contingency planning is completed by a network of Local Resilience Forums (LRFs), Regional Resilience Teams (RRTs), Regional Resilience Forums (LRFs) and Regional Civil Contingencies Committees (RCCCs), as follows:

- RCCCs are a multi-agency group including representatives from across the region of the emergency services, local authorities, the Government Offices and others. They help to coordinate regional response and recovery to emergencies at a regional level, where this is needed (in exceptional circumstances)
- The nine RRFs (one per Government Office) have no role in response but focus on emergency planning – providing a forum for multi agency co-operation. RRFs include representatives of local public bodies; the emergency services; the Environment Agency; the voluntary sector; the armed forces; and the regional assembly. The RRF produce regional risk maps, consider policy initiatives, share information and helps produce Regional Capability Co-ordination Plans as well as co-ordinating multi agency emergency exercises
- Regional Resilience Teams (one per Government Office) role is to improve regional planning and preparation for large scale events and support the operation of RRFs
- LRFs are generally based on local police areas (with the exception of London), and bring together all the organisations who have a duty to co-operate under the Civil Contingencies Act, along with others who would be involved in the response. LRFs are not sub ordinate to RRFs. There are 43 LRFs outside within England. Amongst other tasks, LRFs complete risk assessment of civil contingencies within their areas, produce Community Risk Registers and ensure multi-agency plans, procedures, training and exercises exist.

This report only considers LRFs and the IRMP work of Fire and Rescue Services.

The UK Resilience website, developed by the Cabinet Office's Civil Contingencies Secretariat, provides a standard approach to risk assessments carried out by Local Resilience Forums. The Local Risk Assessment Guide (2006), as developed by the Civil Contingencies Secretariat (CCS), provides guidance to LRFs on likelihoods and impacts of national and regional scale emergencies, and for some localised events.

Integrated Risk Management Plans (IRMPs) were introduced in 2004/05 for every FRS as part of the Fire and Rescue Service modernisation process. All Fire and Rescue Services produce an IRMP. The IRMPs are local to the area served by each FRS. IRMPs replaced the previous national standards of fire cover and reflect local needs and set out plans to tackle effectively both existing and potential risks to communities, in partnership with neighbouring authorities and other agencies. The ODPM/Communities and Local Government has provided extensive guidance on data needs for IRMPs, assessment processes and approaches. At the same time the Fire Service Emergency Cover (FSEC) tool kit has been provided to enable integrated risk assessment (although it had limited major incident assessment capability at the time of this study).

After the 9/11 event, the New Dimension programme supplied equipment and procedures to enhance the capability of the FRS to respond to a range of incidents such as Chemical Biological Radiological and Nuclear (CBRN) attacks, floods and natural disasters. This equipment was positioned by Communities and Local Government based on defined incident scenarios and response time objectives.

These developments are in addition to the duties placed on emergency responders by the Management of Health and Safety at Work Regulations 1999, which require suitable and sufficient risk assessment, and apply equally to the emergency responders.

Auditing of FRSs is now completed by the National Audit Commission. The Operational Assessment of Service Delivery[1] was one of two aspects of the Audit Commission's comprehensive performance assessment of Fire and Rescue Authorities and will be undertaken by Communities and Local Government. The Operational Assessment takes the form of a self-assessment and covers risk analysis of hazards to FRSs and the community and can include environmental, socio-economic and statistical incident data. OASD also states that risk analysis may help define preventive and protective measures to remove, reduce and control hazards as well as emergency response options. This implies that the scope of risk analysis, and hence the scope of this study, should extend to issues such as socio-demographic risk analysis (of dwelling fires), perhaps using tools like MOSAIC and the Indices of Multiple Deprivation (IMD) as well as incident data, GIS tools and other types of risk analysis tools. The guide also makes it clear that risk analysis is intended to feed into and underpin IRMPs.

[1] www.communities.gov.uk/publications/fire/firerescue

1.2 Aims of this work

The Civil Contingencies Act 2004 and Integrated Risk Management Planning are both focused on integrated emergency management, which require effective risk analysis and planning for a range of defined emergencies. Whilst they are supported by underpinning advice and guidance it was thought by Communities and Local Government that there was a lack of clarity of what risk assessment tools, techniques and data were (a) available, (b) appropriate and effective, (c) required and (d) already used to support the respective risk analysis carried out by Local Resilience Forums (LRFs) and FRSs.

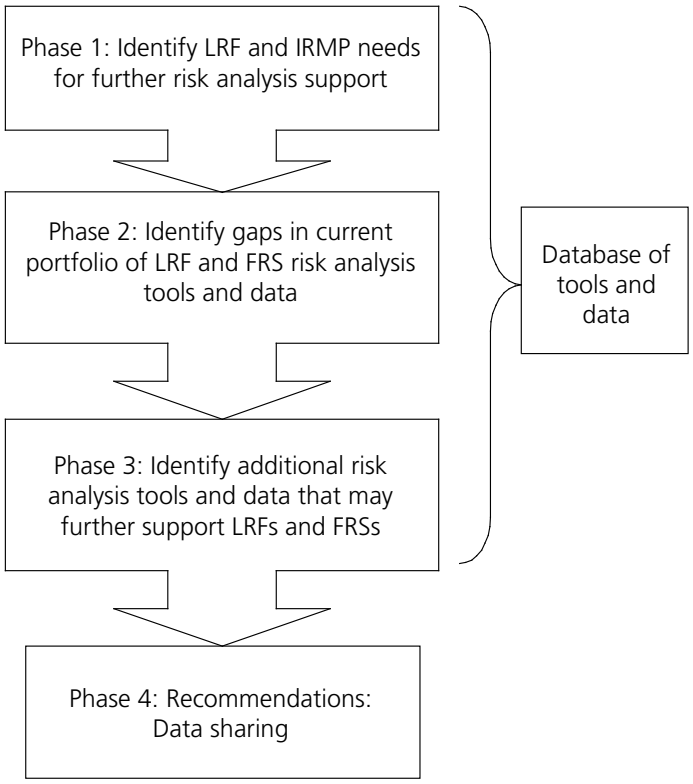
Therefore the aims of the project were to research and produce advice to Communities and Local Government and Civil Contingencies Secretariat on the availability, selection and use of risk assessment tools, techniques, data and guidance within FRSs and other Category 1 and 2 responders to support the obligations of the Civil Contingencies Act 2004 and risk analysis for IRMPs.

1.3 Approach to this work

1.3.1 Overview

The research had four main phases as per Figure 1. The work started by identifying any needs amongst LRFs and FRSs for further risk analysis support and then identified data and tools that may be available to meet these needs. In practice all phases of work were carried out in parallel.

Figure 1: **Overview of project method**



1.3.2 Phase 1: Consultation with LRFs and FRSs

The first stage of work reviewed:

- What risk assessment tools and data are ***available*** to conduct risk analysis of the probabilities and consequences of the types of emergencies defined within the Fire and Rescue Services Act (fire and road traffic collisions), the proposed Section 9 Emergency Services Order (CBRN, collapse of buildings or structures, train, tram and aircraft emergencies) and the Civil Contingency Act, and
- Across Category 1 and Category 2 responders what risk assessment tools and data are ***used*** for the Civil Contingencies Act?

The review of Category 1 and 2 responders specifically aimed to:

- Identify those aspects of LRF risk assessment and associated decision-making that would benefit from additional support in the form of tools, data and techniques
- Identify any tools, data or techniques that LRFs have developed to assist with local contingency risk assessment and associated decision-making
- Identify problems incurred by LRFs in applying the Local Risk Assessment Guide (LRAG) to their local risks and associated decision-making.

This was achieved by consulting a sample of LRFs, specifically by consulting the Category 1 responders who complete the local Community Risk Registers. As the work was based on a sample of LRFs the findings were indicative rather than exhaustive.

The LRFs indicated that in many cases they used information and data held by Category 2 organisations such as the Environment Agency, as well as advice and judgements from these organisations. Therefore, as part of the review of LRF assessment it was necessary to explore the data and tools provided by the Category 2 responders who provide support to the Category 1 responders. In addition, the Local Risk Assessment Guide has been developed by the Civil Contingencies Secretariat (CCS) to support risk assessment by LRFs. LRAG provides guidance on likelihoods and severities of national and regional scale emergencies, and some localised events. Therefore, we also explored the use of LRAG by LRFs and the interplay of LRAG and the information provided by Category 2 responders.

A similar approach was adopted for reviewing risk assessment within the context of IRMPs, namely consulting a sample of FRSs to identify those risks whose assessment would benefit from further support and identifying any tools and data that they have developed or acquired. Again, as the FRSs make use of information and tools from other organisations, such as the Health and Safety Executive, we also consulted some of these organisations. We have also reviewed the results of the Operational Assessment of Service Delivery conducted as part of the Audit Commission's Comprehensive Performance Assessment (CPA).

In the case of LRF and IRMP the review included:

- Identification of the risk assessment techniques used
- How the tools are validated and their evidence base
- Identification of the limits to the types of risks analysed completed by LRFs and FRS (as part of IRMPs) – such as whether they indicate likelihoods, how do they describe or quantify outcomes and what confidence can be placed in these analyses
- Competence requirements for their use – how competence requirements for the tools' use are met
- Any additional functionality that the LRFs and FRS would wish to have.

This phase of work also aimed to establish:

- What the barriers to using/sharing data, such as how the commercial value of GIS information influences information sharing
- What information could most effectively be made available and by which agencies or bodies
- What organisational protocols are needed for inter-agency information sharing
- How the validation of the accuracy of information (ownership of information items) is achieved
- What the relevant data standards are in relation to the capture, storage and management of information
- What optimum format information items should be provided to emergency responders (voice, text, image) within different contexts.

We consulted:

(a) Fire and Rescue Services:

1. Lancashire FRS
2. Greater Manchester FRS
3. London FRS
4. Cleveland FRS
5. Hereford and Worcester FRS
6. Essex FRS
7. Mid Bedfordshire FRS
8. Kent FRS
9. Tyne and Wear FRS
10. Norfolk FRS
11. West Midlands FRS
12. West Yorkshire FRS
13. Cambridgeshire FRS
14. Tyne & Weir FRS

(b) Local Resilience Forums:

1. Thames Valley LRF
2. Lancashire LRF
3. Cleveland LRF
4. Bedfordshire and Luton LRF
5. Kent LRF
6. Sussex LRF
7. West London LRF
8. Essex LRF
9. Cleveland LRF
10. Norfolk LRF

The LRFs were co-terminus with their respective FRS, except West London.

(c) Others:

1. Ambulance Association
2. Police Federation
3. Health and Safety Executive (HSE)
4. Maritime and Coastguard Agency (MCA)
5. Health Protection Agency (HPA)
6. Department for Environment Food and Rural Affairs (Defra)
7. Department for Transport (DfT)
8. Department for Trade and Industry (DTI)

1.3.3 Phase 2: Gap analysis

The next phase of work comprised a gap analysis to identify any shortfalls in risk assessment tools, techniques and data that were available and used, as well as identifying good practice in current use of data and tools.

1.3.4 Phase 3: Identify other data, tools and techniques

The third phase of work aimed to identify other data, tools and techniques that could further support the risk analysis and associated decision-making of the LRFs. The search included:

- Consultation with the LRFs, some of whom have identified or developed data and tools
- A desk top web based search for data and tools (UK and overseas)
- Consultation with some Category 2 organisations to identify data and tools they hold which may be of benefit to the LRFs.

The vast majority of these data, tools and techniques required specialist expertise to apply. Also as most of them were developed for reasons other than supporting LRFs, their results and outputs do not align with the LRAG process. A small number of tools, data and techniques were identified to be of direct value to LRFs and IRMPs. These were identified and profiled.

1.3.5 Phase 4: Advise on further advancement of risk assessment

Based upon the outcomes from the work, recommendations were been provided for:

- Further development of risk assessments completed by LRFs
- Further development of risk assessment completed by FRSs as part of IRMPs.

A database was produced to provide a searchable record of the data and tools identified here. This included:

- Name and scope of the tool or technique
- Data used
- Competence requirements for their use
- Confidence limits for application.

Chapter 2

LRF civil contingencies Risk Assessment

2.1 Introduction

The LRFs interviewed all employed the Six Step Local Risk Assessment Process set out in 'Emergency Preparedness'[2] and considered it an adequate basis for high level risk assessments and emergency preparedness. They all stated that they used the process to support risk reviews whereby Category 1 responders peer review the risk assessments provided by Category 2 organisations. The assessments were then further validated (by judgement) by circulation on a wider basis across the LRF partnerships. The LRF committees did not use any risk analysis tools themselves, relying instead on the Local Risk Assessment Guide and inputs from Category 2 responders. They expressed confidence in their own competence to use the process, with many LRFs led by emergency planners.

The respondents raised no significant criticisms of the Six Step Local Risk Assessment Process, which was viewed as:

- Clear and simple
- Deriving from an approved source
- Providing rules that are useable
- Relatively easy to maintain although with a moderately heavy initial effort.

Also, it was reported that by following 'official guidance' this helps to minimise LRF liability.

The process was considered adequate by LRFs where key assumptions are fulfilled, namely:

- That it is intelligently applied by experienced and knowledgeable Category 1 responders
- That they are in possession of reliable inputs from the Category 2 partners, and
- The LRF are working as a peer review group.

It was also clear, as elaborated further in section 2.2, that:

- The availability of data and tools to LRFs for carrying out risk assessment of localised emergencies varied between the risk categories, and was reported to be limited in some cases

[2] http://www.ukresilience.info/preparedness/risk.aspx

- Whilst LRAG provides support to LRFs for assessment of national and regional level events, LRFs encountered difficulty in assessing 'localised' emergencies
- They wanted to achieve greater confidence in (some of) the Category 2 inputs
- There were barriers to the sharing of data
- There were some concerns about meeting the competence needs of local risk assessment
- Some LRFs developed additional processes, indicating a potential need for additional functionality
- There were some concerns about the application of the LRF risk assessment results within local decision-making.

The process did not appear to constrain the development of locale specific risk assessments but LRFs did express concern about whether it achieves consistency across the country. On the other hand it was noted that whilst a consistent approach across LRFs was desirable, LRAG was thought to encourage a 'tick box' approach in some cases and restrained innovation.

Also, doubts were expressed as to whether the Six Step Local Risk Assessment Guide process could be applied with any reasonable degree of reliability by responders less well versed in emergency planning and response and in risk management. This consideration further emphasised the need to resolve uncertainties as to the quality of some of the Category 2 inputs to Risk Assessment Working Groups (RAWG) risk assessments.

2.2 Findings: LRF feedback

2.2.1 Hazard identification and contextualisation

The LRFs reported that the LRAG risk scenarios provided a basis from which to prepare a local hazard list, the FRS will then seek to enhance this either with local risk scenarios or by tailoring the scenarios to match local conditions. In these respects, the LRAG risk scenarios were a useful starting point in hazard identification.

A number of the LRFs elaborated how they contextualised the risk register using an array of locally held data on, for example, COMAH sites and airports, and how they viewed this as a practical part of the process. It was felt LRFs who had undertaken more robust contextualisation, such as by considering the attributes of local risks (eg size of chemical plants) were more confident in the subsequent stages of the risk assessment.

2.2.2 Identification and limits of the risk assessment techniques used

Validation of risk assessments provided to LRFs

Most LRFs utilised the generic risk analyses in the LRAG guide and liaised with the Category 2 risk assessors. The LRFs stated that they did not, and were unable, to audit the Category 2 risk assessment processes, the competence of the Category 2 risk assessors, or the integrity/quality of the data used.

The reasons cited for this were:

- As specialists, the Category 2 agencies are responsible for ensuring the quality and integrity of their own risk assessments
- That the LRF RAWG do not possess the expertise to audit risk assessments completed by specialist Category 2 responders.

From a governance standpoint, this meant that the Category 1 LRF responders were in a difficult position in which they were unable to establish whether or not the subordinate inputs to their own risk assessments were valid, robust and current.

The LRFs expressed greater confidence when assessing risks that were within their own areas of competence, or those of their Category 1 partners, and for which there is historical data and/or a precedent – preferably local in origin. They expressed less confidence in other areas of risk, particularly when the data and/or expertise derive from an agency other than a Category 1. A similar decrease in confidence was cited in some respects with regard to the national risk scenarios, especially when a risk, such as CBRN, was either relatively novel or is rare in historical terms.

Our own consultation with Category 2 responders indicated that whilst some use established and validated methods, other rely on judgement.

Information used in LRF risk assessments

The feedback from LRFs was mixed and varies across the risk categories. In most cases, the values supplied by the 2006 Local Risk Assessment Guidance[3] and from Category 2 responders were used as a starting point for local risk assessments. Where the risk was considered to be common to all areas the LRAG values were judged by LRFs to provide an adequate basis for risk assessment.

[3] Note: Although outside the direct scope of the project, some respondents expressed concern that the 2006 LRAG did not include tracked changes or a summary of the changes. This made reviewing and updating the risk registers more time consuming and more prone to error.

Where the risk was considered to vary between LRFs, or where the LRAG likelihoods did not appear to correspond to the risk of localised events, many of the respondents stated that:

- No specific tools or techniques were used to assess likelihoods
- They relied on "professional judgement", using local incident data and experience in deciding on the particular risk outcomes and probabilities.

A further issue noted was the reliance in some cases on Google and Wikipedia type sources including BBC historical archives in order to address the frequency aspect of the risk assessment. These sources may not be comprehensive or validated.

Assessing localised events

A recurring point from LRFs is that they wish to include a wider range of localised events in their risk assessment, for which LRAG provides limited support. The LRAG likelihoods relate to national and regional scale events. A recurring point of feedback from LRFs was that the LRAG event descriptions and therefore the corresponding likelihoods do not correspond to the relatively smaller scale 'localised' events that they also wished to include in their risk assessment. The limited support and focus on localised events was felt by LRFs to reduce the practical value of the process.

Use of local incident data and historical experience

As noted above, in many cases LRFs refer to local incident experience. Where this appeared to correspond to the LRAG likelihoods this gave confidence to the LRAG values. Where the local experience differs from the LRAG values this was considered to cast doubt on the validity of the LRAG value. However, as the LRAG indicated specific likelihoods for many risk categories the LRFs tended to constrain their likelihood assessments to the values presented in LRAG regardless of their own local data. Table 1 summarises for which LRAG risk categories the likelihood values are 'not expected' to vary between LRFs. In one case the LRF noted that they fitted their assessment to the LRAG guidance, as there was no scope for changes despite local data contradicting the LRAG values.

The outcome descriptors, variations and likelihood assessments were rarely challenged by LRFs, although individual LRFs did, on a case-by-case basis, challenge the data presented to them. One LRF noted that whilst consistency between LRFs was needed, the national LRAG may over simplify assessments and stifle innovation at a local level. In addition, whilst LRF RAWGs report that they endeavoured to seek supporting evidence, such as historical data to validate the assessment wherever possible, they also noted that they encountered difficulties in this.

Table 1: **Summary of lead organisations and LRAG likelihood guidance**			
	LRAG guide		
Risk category	**Lead agency**	**LRGA states that risk not expected to vary[4]**	**Likelihood range given**
Industrial accidents, fires/ explosions/biological release	HSE		0 to 1, 0 to 2, 0 to 3 (5 for legionella)
	Defra	H11 (radioactive material) – 1	
	FSA	Food contamination – 3	
Industrial pollution	Environment Agency/Defra	4 to 5	
	MCA		Marine pollution 1–2
Forest fire	FRS		1
Aviation accidents	DfT	1	
Railway accidents	DfT	1	
Shipping – accident	MCA/DfT		1–2
Shipping blockade	DfT	0–1	
Vehicle (eg M –way pile up)	DfT	4	
Transport fire/ explosion	FRS		1
Structural			
Land movement	FRS	0–1	
Building, bridge, dams	FRS		1,01 to 1
Severe weather			
Storms & gales	Met Office	2–4	
Low temperatures	Met Office		3 to 4
Heat wave	Met Office		1 to 4
Flooding	Environment Agency/Defra		Major coastal 1–2, major fluvial 3, local coastal 3, local fluvial 4, local flash 3

[4] LRAG indicates that the risk is not expected to vary and so LRFs should apply the stated value.

Table 1: **Summary of lead organisations and LRAG likelihood guidance** (cont.)

	LRAG guide		
Risk category	**Lead agency**	**LRGA states that risk not expected to vary[4]**	**Likelihood range given**
Human Health	DH	4 for epidemic/ pandemic 3–4 for infectious disease 2 to 3 for legionella/ meningitis	
Animal health	Defra	1	
Industrial action	CO (critical service) DTI/BERR (fuel supply)	4	
Technical failures			
Oil and gas, electricity	DTI/BERR	2	
Telecom accident	DTI/BERR	5	
Water	Defra	1 to 3	
Telecom error	CO	3	
Terrorist	HO	Not stated	
International events	FCO		3 to 4

Availability of data and risk analysis tools per risk category

The feedback from LRFs about the availability of data and risk assessment techniques across the risk categories is noted in Table 2 and elaborated later in this section.

Table 2: **LRF opinion on availability of risk assessment data and techniques for use by LRFs**

Well supported by data and techniques	**Follow LRAG guidance**	**Less well supported by data and techniques**
Industrial fire and explosion (large scale events) Flooding (except flash flooding and dam failure) Industrial pollution Trains Vehicle	Human Health Fuel shortage Building collapse	Industrial fire and explosion (localised events) Aviation accidents; Industrial technical failures Shipping accidents; Land movements; Public protest; Mass gatherings; Animal health; Terrorist Storms and gales (smaller scale events)

The feedback about the less well supported risk categories focused on:

- Limited support to assess likelihoods and outcomes of 'localised' events
- Limited knowledge of sources of data and analyses and an element of 'do not know what we do not know' with regard to what data and tools are available
- Limited access to data on past events
- Limited access to data to help produce local risk assessments and associated plans
- No analytic tools to undertake local risk assessment
- A number of examples were cited where the LRAG likelihoods were considered to be unrealistic when compared with knowledge of actual (local) experience, such as aviation accidents, but where publication of a higher likelihood may pose presentational concerns
- In the case of the utilities, denial of access to risk information on the grounds of security
- Commercial sensitivity impeding access to data and provision of risk estimates (that will be published)
- Over reliance of utilities in sharing contingency plans rather than their risk assessments
- There was no common format or tool for tabulating the risk assessments with each LRF adopting its own reporting structure
- The risk categories and in particular the likelihood ratings were biased to urban scenarios. They were wrong or unsuitable for a rural situation.

In a number of cases the LRF contained unique features such as the Channel Tunnel and key sites. Due to the generic nature of the LRAG values it was problematic to risk assess 'unique' features and key sites.

Overall there was concern from LRFs that some of the local risk assessments were at best generic and would not stand up to close scrutiny.

It was also reported that, in some cases, the extent of Category 2 input to local risk assessment was limited for a number of reasons, including:

- Limited Category 2 resources
- Lack of suitable contact information, ie the Category 1 responders not knowing who to contact within a Category 2 organisation.

2.2.3 Gaps in specific risk categories

The feedback on specific risk categories is noted below. The feedback is not in any particular order.

Industrial fire and explosion

The likelihood and impact scenarios are expected to be developed by the HSE as the Category 2 organisation. The HSE does not expect LRFs to develop likelihood and impact ratings on their own behalf.

The HSE developed likelihood and impact scenarios through reference to their predictive risk assessments (such as Quick FN) and review of past events. The HSE indicate that as the likelihood of national, regional and localised events (that cause large numbers of deaths) tends to be less than 1 in 100,000 per year they fall within the lowest LRAG likelihood scale of less than 1 in 100,000. Thus:

- The HSE were able to draw on substantial predictive risk assessments and historical records
- These assessments provided firm guidance on risk assessments.

The local level assessment of likelihoods by the HSE was intended to be a simple exercise. If an area has a large number of sites, such as 10 or more, then the likelihood value in LRAG may be increased by one band. If the local sites were thought to pose a less severe impact, perhaps because they were in a rural setting, then a local outcome description can be used instead of a national scale outcome description. Internal HSE guidance advised the local HSE assessor on this process.

As the HSE hold records of all COMAH sites and pipelines, it was expected that they would have sufficient data to complete this exercise. Each HSE regional office has a delegated HID inspector who was tasked with providing the risk assessment input to their LRFs.

The HSE do hold site-specific assessments, including:

- Risk contours for use in land use planning (also held by local authorities)
- Societal risk results for COMAH sites.

The latter are security restricted. The former are available and could be used by an LRF to help gauge the scale of an event as they indicate the area at risk from incidents. However, it was expected that outcomes would already be available from COMAH safety reports and that emergency plans would already be developed through the standard COMAH processes. Therefore, the HSE did not think that LRFs need to have sight of risk contours or societal risk results for COMAH sites.

In the situation where an LRF identified a significant number of (for example) sites using less than 10 tonnes of chlorine (which falls outside of COMAH), it was expected that the LRAG likelihood values still apply in combination with a localised outcome description.

A number of issues were noted, including:

- The HSE assessment focuses on acute human effects (ie immediate deaths). The knock on effects due to (say) loss of water treatment works (such as loss of treated water) are not considered. Moreover, the assessment does not necessarily provide a likelihood value and outcome descriptions for events that cause 'few' deaths but have significant economic impacts, such as loss of chlorine supply to water treatment works, or loss of gas supply
- In some cases (eg biological sites) the count of sites is achieved using local authority records
- Where pipelines or roads cut across different types of areas it is difficult to define a simple outcome description
- The identification of non-COMAH sites is reliant on LRF data sources rather than the HSE and is considered to be a point of concern.

Feedback from LRFs included:

- Access to HSE delegated officers were impeded by resourcing issues, ie HSE officers have finite time to support LRFs and may be unable to attend sessions
- The LRFs can identify special local risks which they then experience some difficulty in assessing
- The LRF was not familiar with the HSE's approach to risk assessment or the application of the LRAG values
- The outcome descriptions were large and did not include the more local scale events that they also need to include in their assessments.

Some LRFs indicated they used local data and judgement to assess more localised events, but with the concern that their local data may be incomplete and unrepresentative. It was also noted that their local data appeared to conflict with the LRAG values in some cases, such as where they have had incidents which implied to them that the likelihood was higher than indicated by LRAG/HSE. The researchers' judge that this was because the local data relates to events of a lesser scale than those addressed in LRAG. On the other hand, in some cases the review of local experience indicated there have been no local incidents, which was interpreted by some LRFs as showing the likelihood was negligible (despite the very short time period considered).

Thus, as regards potential gaps:

- There was little doubt that data and tools were available to the HSE to assess industrial fire and explosion risks
- There may be gaps in the data and tools available to LRFs for assessing local scale events and for assessing the likelihood and impact of fires and explosions that pose an economic rather than safety risk.

Industrial pollution

The LRFs noted that the Environment Agency supply lists of sites that pose pollution risk and that this provides a useful basis for local emergency planning in combination with LRAG values.

The LRFs did not identify any significant gap in this risk category.

Flooding

The Environment Agency provide flood plain assessments that provide likelihoods in three increments (10 year, 50 year and 100 year events), and the number of people, buildings and factories that could be affected. This provided direct and very useful support for local emergency planning and risk assessment. One respondent elaborated how they had adjusted down the incident scenario to better reflect the scale of incident they had experienced in their area.

It was also thought that the high incidence of flooding provided:

- A robust local history on which to base risk assessments, and
- A robust base of actual experience in responding to floods on which to base effective plans for emergency preparedness.

The LRFs and FRSs cited the following limits of current local flood risk assessment:

- One LRF expressed concern about the national risk scenarios in respect of flooding, as they appeared to be London centred and not necessarily applicable to other areas in terms of reference populations (a similar concern was also expressed regarding the other risk scenarios)
- The current flood risk assessments did not identify caravan (which were thought to be at particular risk from flooding) or other forms of temporary accommodation
- The outcome descriptions were for larger scale events and therefore did not provide a prompt for considering more localised (but still significant) events involving hundreds of houses
- Another important gap in the current flood risk assessment provision was that flash flooding was not included at present. It was understood that the Environment Agency was developing a flash flood risk model and associated warning system.

It should also be noted that the Agency flood risk assessment does not cover dam/reservoir failure.

Thus, as regards potential gaps:

- There was a high level of risk analysis information to support local flood risk assessment and contingency planning
- The LRF flood risk assessment could be extended to address 'lesser' scale events than those cited in LRAG
- There may be gaps in LRFs assessment of dams and reservoirs, flash flooding and identification of caravans.

Maritime

The Maritime and Coastguard Agency (MCA) take the national lead in all offshore shipping and maritime contingencies. The LRF respondents indicated:

- The MCA only make available national risk assessment data
- The MCA have not produced or made available any regional or local risk assessments
- Local risk assessment was achieved by the MCA by use of professional judgement and review of local event (over past five years) and shipping data.

The researchers asked whether the MCA's Formal Safety Assessments (which is analogous to the HSE's quantitative risk assessment of COMAH sites) were used to support LRF risk assessment. The MCA respondent indicated that they did not use the results of Formal Safety Assessment. Formal Safety Assessment is not designed to support LRF style risk assessment and would require reinterpretation to be applicable.

Rather, the MCA respondent indicated that the local MCA officer examined the relative level of shipping traffic and compared it to other shipping lanes and ports in the UK. If the level of traffic was high, the incident likelihood may be raised. In addition, the types of shipping were examined. If the shipping includes larger than 'normal' vessels, such as very large passenger vessels, then the incident scenario was amended to reflect a fire or other incident on a very large passenger vessel. Local incident data was used to 'cross validate' the assumption that an incident was credible but was not used in a calculation.

The researchers judged that there were concerns in way in that local incident data was used. In particular, a five year period was judged by the researchers not to provide a sufficient period on which to assess likelihood of low frequency events. The absence of incidents over past five years does not provide a basis to assess likelihood of (for example) 1 in 100,000 years.

There was no readily available incident data identified by the MCA respondent. The respondent identified a range of sources from which shipping incidents were identified, such as MCA bulletins.

Thus, as regards potential gaps:

- The assessment of shipping incidents appeared to be poorly supported by data or risk analysis.

Building collapse

It was indicated that at a local level the risk assessment was limited to considering the consequence rather than the likelihood of building collapse. The FRS identify those buildings that are of a size and structure to present a risk of a large-scale incident, which they then plan for with the benefit of New Dimension urban search and rescue assets. The restricted national critical infrastructure database was used for this purpose. They considered this to be an adequate process and that a more precise assessment of likelihood was not feasible.

The researchers' opinion was that the rarity of (accidental) building collapse limits the extent to which it is feasible to assess likelihood of collapses. The application of a generic likelihood, as achieved by LRAG, was considered to be a practical approach.

The restricted National New Dimensions Project Method document provided a relatively risk scale for likelihood of incidents in individual buildings rather than area based assessment. The likelihood scale was not aligned to the LRAG likelihood scale.

Aviation accidents

One LRF, responsible for an area with major airports and multiple flight paths, identified a series of limitations of current local area aviation risk analysis. These included:

- A view that the LRAG national likelihood value of negligible was unrealistic (too low in comparison to history and current level of air traffic) and did not reflect variations in levels of traffic between LRF areas
- The LRF was unaware of sources of advice on aviation risk assessment and was unable to solicit any data or support from Civil Aviation Authority (CAA) or National Air Traffic Services (NATS)
- That the relatively low risk rating for aviation accidents meant that these did not receive the priority that the risk required.

A second LRF with a major airport noted that whilst the LRAG likelihood was reasonable for the county as a whole, it did not represent the risk in and around the airport. They expressed a need for support on how best to 'drill down' likelihoods from the county as a whole to specific local areas.

The researchers have identified that NATS provide third party risk contours for many UK airports, including the ones in this LRF, which some LRFs were reported to have requested. These risk contours are available on the Communities and Local Government RRTGIS. However, the risk contours (which show areas where individual risk is 1 in 1,000,000) are limited, in the researchers' opinion, in the context of civil contingencies risk assessment, in that:

- They only provide a measure of Individual Risk (the probability of any one resident being killed in an aircraft crash) – which is not compatible with the likelihood (annual frequency of major incidents) scale used for LRF risk assessment
- They do not provide an indication of the frequency per year of aviation accidents in or around an airport
- They would not include scenarios such as the Manchester aircraft fire (on the runway) or the Kegworth aircraft crash (on boundary fence) as neither impacted residents but which may reasonably fall within the remit of LRFs.

It should be noted that the NATS risk contours[5] were developed for the purpose of assessing third party risk only (ie residents and neighbouring workplaces) and for use in considering the tolerability of risk to third parties (especially for land use planning), ie not designed to support LRF risk assessment.

[5] R&D Report 0007 A Methodology for Calculating Individual Risk due to Aircraft Accidents near Airports, National Air Traffic Services, 2000.

The Fire Service Emergency Cover (FSEC) toolkit (provided by Communities and Local Government for use in IRMPs) includes a look up table of aircraft crash frequencies per civil airport in the UK covering on and off airport incidents, as a frequency per year (which is compatible with the LRF likelihood scale). The frequencies are based on a method developed for the HSE[6]. The frequencies in FSEC are limited by:

- Currently being based on 1990's movements data (they can be updated) and are based on generic accident rates (per aircraft movement)
- Do not take account of airport specific safety precautions or the mix of older and newer aircraft (both of which influence accident rates)
- Do not indicate the likelihood of aircraft striking third parties.

Research[7] indicates that 3rd generation aircraft have a crash rate half that of the generic rate quoted here, whilst 1st generation aircraft have a 10 times higher rate. Accordingly the risk of crashes at any one airport will depend on the mixture of aircraft and airport risk controls and features such as hills and navigational aids.

None of the LRFs were aware of the frequency data in FSEC.

Thus as regards gaps:

- There did appear to be a gap in the information available to LRFs regarding the likelihood of airplane incidents at their local airports
- There is information available from other sources that might help fill this gap.

Vehicle

The feedback from LRFs was that as the frequency of major vehicle incidents was high there is a sufficient record of local historical incidents on which to assess likelihoods. It was also indicated that incident data was available from Highways Agency and the police. All LRFs should have full access to national and local accident statistics. The majority of data collated was via the STATS 19 recording system compiled by the police which covers accidents where one or more persons has been killed or seriously injured.

No LRFs cited the use of road traffic data from FRSs. FRSs record the location of all RTCs attended by the FRS and the number of people killed, injured and rescued. They are able to identify incidents involving large (eg 10 or 20) casualties and are therefore able to assess frequency of 'major' vehicle incidents.

The responses from LRFs indicate that they do not judge there to be a gap or problem with local risk assessment of vehicle incidents.

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[6] Criteria for the rapid assessment of aircraft crash rate onto major hazards installations according to their location. D.W. Phillips, SRD/HSE/R435, HMSO 1987.

[7] External risk around airports: A model update, A.J. Pikaar, M.A. Piers and B. Ale, NLR Technical Publication NLR-TP-2000-400, August 2000.

Railway incident

The LRFs indicated that railway risk assessment was well supported by Network Rail and that there were no significant gaps in this area. However, the researchers identified data sources and tools that provide railway risk assessments, particularly those held by the Rail Safety and Standards Board, that the LRF did not cite. The LRFs also made use of local incident data. This again was of concern to the researchers due to the difficulty in using local incident data for periods of (say) five years to support risk assessment of local frequency events.

Therefore, it was concluded that whilst data and tools are available for this risk category, there was an issue with their application.

Human Health

Human health risk assessments were based on the national guidance. The feedback was positive on this point as the national risk assessment was considered by LRF respondents to be equally applicable to all areas and provides a generic impact assessment. There is also a generic pandemic flu contingency plan that is adopted nationwide. The Health Protection Agency (HPA) takes a lead in the assessment and analysis of human health risk including for example pandemic influenza. The HPA provides expert virological, modelling and epidemiological advice to the Department of Health. This has contributed to the development of the planning assumptions presented in the UK Influenza Pandemic Contingency Plan[8]. The HPA make use of mathematical models to explore the possible spread and impact of pandemic influenza. They are also used to assess the effectiveness of potential control programmes. Models are parameterised by comparing their results to data from previous pandemics.

Given that a human health contingency was considered to be equally likely in all parts of the country and to require a common response, the national LRAG guidance was considered to provide an adequate basis for assessing this risk category.

It was also noted by the researchers that the LRAG guidance was consistent with the pandemic flu risk assessment completed by Health Protection Agency which was the only identifiable source of authoritative risk assessment in this area.

HPA modelling work is supported by Cabinet Office, HPA and Defra updates that are designed specifically to brief Category 1 and Category 2 responders and the wider community. These often follow specific incidents or localised outbreaks where up to date information is considered essential.

No significant gaps were identified for this risk category.

[8] Source www.hpa.org.uk/publications/2006/pandemic_flu/pandemic_flu_plan.pdf.

Animal health

One LRF elaborated how they had explored the local specific impact of an animal health incident. This included noting how an incident would impact the local economy and social (eg schools) activities. For example, closure of roads and footpaths would have a particular impact on the local rural economy due to the importance of tourism and agriculture. It was also noted that the LRF considered it practical to develop effective contingency plans as the LRF had prior experience of animal health incidents, ie foot and mouth and BSE. Thus, contingency plans were based on prior incident experience.

A repeated concern was that there is limited support on data for use in preparing contingency plans in the event of an avian flu, or other type of poultry, incident. Pertinent data on points such as the location and size of poultry farms was not readily available due to security concerns[9]. This limited the ability of the LRF and its constituent Category 1 responders to develop meaningful contingency plans. As a consequence they encountered difficulties in foreseeing the level of resources needed to handle an incident and cannot plan contingency operations.

LRAG indicates a 1 in 100,000 years event frequency for worst case animal health risks, which in the opinion of LRFs and the researchers did not appear to match historical experience for events of lesser scale in the UK. It was judged, from discussion with animal health experts, that the risk of animal health (particularly avian flu) is increasing and that the public concern is also increasing due to the perceived potential link to human health. Thus, the risk rating for animal health was judged to be high by the LRF.

Defra leads on animal health risk assessment. They rely on a variety of risk assessment techniques to support their risk analysis which continue to be under constant review. Data and evidence to support this analysis include:

- Introductory web page on international disease monitoring www.defra.gov.uk/animalh/diseases/monitoring/
- Qualitative risk analysis of disease outbreaks in countries outside www.defra.gov.uk/animalh/diseases/monitoring/pdf/riskplan.pdf
- Twenty qualitative risk assessments of animal health risks performed between 14/08/2003 and 10/08/2004, www.defra.gov.uk/animalh/diseases/monitoring/riskassess.htm
- Handbook on Import Risk Analysis for Animals and Animal Products. Volume 1
- Introduction and qualitative risk analysis, (OIE, 2004) and Import Risk Analysis Handbook 2003, www.affa.gov.au/corporate_docs/publications/pdf/market_access/biosecurity/bde/irahandbook_revised.pdf.

[9] All poultry farms with 50 or more birds must be registered with DEFRA after February 2006. The list is restricted according to LRFs and was not issued to LRFs. Other types of farms are also registered with DEFRA.

For further detail see www.defra.gov.uk/animalh/diseases/monitoring/pdf/rvc_report.pdf & Risk Solutions Avian Flu cost benefits model (ExodisTM).

Thus, whilst Defra use a wide range of established risk assessment processes, the issues in this risk category include:

- LRF access to local information to support local emergency planning, and
- Uncertainty amongst LRFs regarding the applicability of the LRAG likelihoods to local risk assessment.

The LRFs were unaware (as were the researchers) of any risk assessment tool for completing more localised risk assessment. The researchers' review of this area indicated that the international nature of animal health risk (ie where disease originates from overseas) is influenced by overseas events. This means that any strategic risk assessment of likelihood would be completed at a national level and applied equally to parts of the UK. The consequence may vary according to the make up of local industry and importance of agriculture/outdoor leisure to the local economy. Thus, it was concluded that the gap in this area were limited to assessment of the consequences of incidents and the applicability/ meaning of the LRAG values.

Terrorist threats

It was appreciated that the need to fulfil security requirements regarding threat risk assessment obviously limits the sharing of information with LRFs. Whilst it was accepted that it was difficult to assess how terrorist risks vary between areas, a number of issues and concerns were cited, including:

- That the LRFs did wish to include terrorist threats in their local risk assessment
- That they judge that the likelihood of incidents does vary between areas based on the 'quality' and number of targets – ie between coastal resorts used for political events such as party conferences and other coastal resorts
- That some LRFs contain 'obvious' targets such as Heathrow airport and/or flight paths, which intuitively should be given a higher rating
- How should actual experience of terrorist threats be taken into account?

The LRF feedback was that there was no locally applicable tool or process to assess terrorist risk, even in generic terms, and that some level of area-based assessment may be of value, such as reading down some sort of analysis from national risk assessments to LRFs.

Public protest and mass gatherings

It was reported that risk assessment of public protest and mass gatherings was largely unsupported by data or analyses. The CRR was based on LRAG values.

As public protest risk assessment is led by intelligence and threat analysis, it was indicated that it is difficult to support assessments with data or tools, and that no risk analysis tool exists for this purpose. The National Intelligence Model (NIM) is a tool for pooling intelligence rather than a strategic risk assessment tool.

Severe weather

Feedback indicated that local assessment of the likelihood and severity of severe weather has been based on professional judgement and limited local historical 'data'. The data comprised, in one example, a list of instances of severe weather in one local authority (whilst the LRF cover a number of authorities). This led the LRF to determine that the scenario should be limited to 'snow for one week' rather than for one month, on the grounds that they had experienced severe snow for 3 to 4 days but not for one month. The researchers judged that this was a flawed basis for judging the likelihood of low frequency major events.

It was judged by LRFs that the severe weather assessment would benefit from a readily available list of previous incidents to help inform local risk assessments.

The LRF was unaware of any severe weather risk assessment tools or data that may be provided by the Met Office.

They also indicated that past data may not provide a valid prediction of the future likelihood of severe weather in the context of climate change.

Therefore, it appeared that there was a gap regarding the data and tools available to LRFs to assess local scale and likelihood of severe weather events.

Fuel shortage

The feedback was that as the possibility of a fuel shortage is common across the UK, that a common risk assessment, as provided by LRAG, for each LRF was suitable. It was also judged that the likelihood of a fuel shortage remains high as there are many potential 'triggers' for causing sudden abnormal public demand for fuel, such as a flu pandemic[10].

It was also noted that contingency plans can be effectively based on past experience due to the occurrence of past fuel shortages due to industrial action. The impact of a fuel shortage would be assumed to be the same as in the 2000 fuel shortage.

Finally, it was indicated that as fuel shortages can have a national impact that a national emergency plan should be developed and fed down to each LRF.

Therefore, it was concluded that there was no significant gap in this risk category.

[10] It was pertinent to note that there was no mention of the effect of fuel contamination on the possibility of fuel shortages.

Industrial infrastructure failure (water, telecom, oil, gas, electric)
Industrial technical failures were reported to be based on the LRAG values, supported by local data and (in the case of one LRF) referenced to events listed on Wikipedia.

It was noted that:

- Some Category 2 responders provide a probabilistic risk assessment of (for example) water treatment plant failure rates, that were based on an engineering analysis that Category 1 responders were not competent to scrutinise;
- Some Category 2 responders cited commercial concerns about providing data on failure rates as a reason for not providing data to support LRF risk assessments;
- Category 2 responders, when asked to provide support on assessing likelihood of failures, often provided copies of contingency plans as evidence that the risk was managed rather than advice on the likelihood of failures.

The LRFs indicated that this risk category was problematic due to data sharing issues with Category 2 responders. It was argued by LRFs that Category 2 responders did hold pertinent data on frequency of infrastructure failures.

It was uncertain if there is a problem with the LRF risk assessment of this risk category as the LRAG likelihood values were not expected to vary at a local level.

2.2.4 Outcome descriptions and emergency scenarios

Reviewing outcomes in respect of locale specific issues
The feedback from LRFs included:

- In some cases the LRFs applied the LRAG outcome description 'without question' as fulfilment of the risk assessment exercise
- LRFs did develop local scenarios that, in their opinion, reflected the scale and nature of events that may occur in their area. This was typically achieved by review of local events and from first principle, such as by considering the size of towns that may be subject to coastal flooding.

In one case a LRF noted that they cascade risk assessments to sub-areas (corresponding to council boundaries) in their LRF, producing sub-area profiling and sub-area specific consequences and emergency planning.

The approach to matching outcomes to local circumstance typically relied on reviewing the scale and type of events that have happened locally. A number of examples included:

- Ascertaining that one shipping channel wass frequented by large passenger vessels and so presents a higher risk of very large passenger vessel incidents, whilst another shipping channel did not

- Ascertaining that the relatively small size of coastal towns would lead to a lesser impact of coastal flooding than in other regions
- Identifying that an animal health episode would have a greater impact in the (rural) area due to the importance of the rural economy – compared with a similar outbreak in a more urban environment. This included assessment of the impact on tourism (due to closure of footpaths etc), loss of consumer confidence in produce and the economic value of farming to the rural economy
- Including a less significant 'severe weather' scenario (fewer days)
- Mapping out the impact of a fuel shortage on public services etc.

These locale specific assessments were developed through expert judgement based review of local risk factors and scrutiny of past local events.

Gaps and limits to localisation of outcomes

In the case of flooding the 'amendment' of the severity assessment highlighted a gap in the Environment Agency flood assessment. In the case of one LRF they identified that the impact of a flood in their area could be greater than indicated by the flood map due to the presence of caravan parks. They had local experience of caravan users being trapped by flooding and requiring rescue. The standard flood map did not necessarily include caravan parks or other temporary accommodation such as travellers' sites or major construction sites (with temporary accommodation).

There was an expressed wish for ready access to information on events that would help:

- Identify the types of incidents that could occur
- Conceptualise incidents
- Understand the circumstances in which such incidents could occur and therefore whether they could occur in the local area.

The researchers' observation was that in some cases the review of local events was limited and may not have provided a robust basis on which to identify and define scenarios. In particular:

- The period of time from which local incidents were drawn was, in our opinion, short, namely 5 to 10 years. This does not provide a sufficient period of experience to discriminate between likelihoods in the LRAG ranges most of which are far less than 1 in 5 years
- The number of incidents in the local area may be small and unrepresentative.

A number of LRFs expressed a wish for ready access to data and information on relevant incidents that they can draw on to identify and define outcomes, and to better inform the review of incident likelihoods.

Knock on effects

There was mixed feedback on the extent to which 'knock on effects' were considered. In some cases the LRFs noted that they tended to avoid mapping out how any one event could knock on to impact other risk categories, such as how a flood could cause infrastructure failure. A number of reasons were cited, including:

- There was a concern that 'mixing up' risk categories may lead to an overly complicated and erroneous risk analysis
- Emergency plans and mapping out scenarios focus on the primary risk, such as evacuating vulnerable people from floods
- Responsibility for looking at knock on effects lies with other parties, such as the utilities, whom it was assumed will have considered this eventuality (such as of flooding disabling a sewage plant).

As elaborated later in this report, FRSs tended to develop generic business continuity plans that cover loss of resources for all and any reason, rather than specific business continuity plans for each risk category (such flooding, terrorist incidents and flu pandemic).

However, opinion on this point was mixed. In some cases the LRF respondent indicated that the risk assessment process should consider 'domino effects'. They cited the example of the Buncsfield incident, which impacted road network and disrupted local business as well as posing an industrial fire and pollution risk. In the case of flooding, some LRF respondents indicated that their assessment did identify how flooding may impact COMAH sites (as part of the site's own emergency plan) and reception centres.

Feedback on the outcome descriptions

There was common feedback that:

- The LRAG outcome descriptions do not 'help' with emergency planning as they do not provide sufficient detail on the nature and features of the event
- The outcome descriptions (and associated likelihoods) focus on the very large-scale national and regional events. This did provide a suitable prompt for considering such events but did not support assessment and planning of more localised events such as motorway closures, cylinder explosions etc
- It was commonly indicated that LRFs also wish to include more localised events in their assessments and planning. The very large-scale outcome descriptions were not felt to provide a basis for considering more localised events.

There was an expressed need to include assessment and planning for more localised (but still significant) events, which was thought to be consistent with the requirements of CCA. The outcome descriptions were, in some cases, not considered to be representative of the more localised types of events that they are more likely to encounter and therefore more likely to have to prepare for and respond to.

It was also noted that it was difficult to agree on a single event description where the outcome of an incident can vary across an LRF. The example of gas pipelines was cited, where the outcome of an incident would vary according to the population density along the pipeline route.

2.2.5 Risk rating and prioritisation

Feedback from LRFs indicated that some look to include additional factors in the prioritisation of risks and that there were some queries regarding the risk rating process.

The additional factors included:

- Public risk perception and expectations
- Whether the risk is considered to be well managed and planned for already.

Incorporating public perception and demonstrating due diligence

One LRF consulted in this study had enhanced the six step process by creating a 7th stage of priority scoring intended to *'… take into account measurable scales as well as incorporating a 'public perception' element. The principle is that considerations are not constant for all risks. This method allows a 'shopping basket' approach to produce the best aggregate priority number'*, (Cleveland Community Risk Register Risk Priority Guidance).

The importance of the public perception element was emphasised and was considered by the LRF in two parts:

- The need to demonstrate due diligence with regard to risk controls/treatments
- The degree to which public fear of a particular risk will influence the need for public information – reassurance – and the ways in which perceptions of risk, such as the 'dread risk' factor associated with radiological incidents, may affect the emergency response.

The development of this process by Cleveland LRF was interpreted by the researchers to indicate a potential need for additional 'functionality' in the local civil contingencies risk assessment and associated planning process.

This additional stage was used by the LRF to indicate:

- The order of priority for additional work necessary to reduce risk
- Progress with that work
- Timings for scheduled reviews
- Triggers for exception reviews – used especially where there are unknowns and uncertainties that must be resolved in order fully to understand the risk
- Any prevailing changes to the status of the risk – this includes, for instance, seasonality and other periods of elevated risk.

These factors were determined using a five point scale defined (in summary) as:

1. The controls in place are considered to be such that unduly diverted resources would not contribute significantly towards immediate reduction of risk. The additional risk treatment required can be considered through normal processes.
2. Controls in place are sufficient, tested and proved. However, additional plans and/or resources may need to be prepared in order to reduce the risk rating further. Some diversion of resources required for scoping.
3. The risk rating is such that additional time, resources and effort may have to be allocated to significantly reduce the risk.
4. The risk to the community is such that immediate action and allocation of resources from other tasks may have to be undertaken. To the possible detriment of other projects.
5. A series of events has occurred in the UK or abroad which has resulted in an unforeseen requirement for immediate or pro-active action.

A further enhancement was used in the published community risk register whereby a five point scale was used to indicate to the public the current level or status of each risk, this scale was defined (in summary) as:

0. Unclassified – assessment not completed, or under review or not relevant to the LRF area.
1. Routine – as far as can be determined, the risk is controlled as far as possible, no further measures need be taken unless the situation changes.
2. Elevated – as Routine but further control measures have been identified that may contribute to a risk reduction and are under consideration.
3. Significant – the hazard is controlled but requires a significant diversion of time, resources and effort within a strict timetable otherwise the hazard may become acute.
4. Acute – the hazard has the imminent potential to cause casualties or damage and requires a diversion of resources to reduce the risk to Significant or lower.
5. Exceptional – a rapidly evolving hazard not normally considered a risk under present or foreseen conditions.

Assessing risks individually

It was also been argued that some risk categories share similar 'scenarios' and would have similar 'generic' contingency plans. For example, it was suggested by one LRF respondent that aviation accidents, chemical leaks and a terrorist dirty bomb would all require mass evacuation, rescues, decontamination and clean up. This raised the question of whether the prioritisation of activities such as emergency exercises should be based on the risk rating of individual risk categories or of 'groups' of risk categories that share similar

emergency planning scenarios. If the latter approach was used this may lead to a different prioritisation of emergency preparedness.

In addition, it was suggested that there is operational value in having a small set of generic emergency plans (where appropriate), as this facilitates a more effective response. This point was cited in further support of the option of grouping risk ratings for those risk categories with similar outcomes.

The researchers' opinion was that there was some logic in grouping similar risks for the sake of prioritisation of emergency planning and risk rating. The division of risks into, for example, industrial fire and explosion versus industrial pollution (whilst assisting with risk assessment) can be argued to be an artificial divide, as industrial fires can cause industrial pollution. The sub-division of events into sub-categories will inevitably lead to a lower risk rating for any one sub-category. This may lead to the possibility of some risk categories receiving a lower rating because they have been sub-divided for the sake of simplifying the analysis to a greater degree than other risk categories.

Prioritisation of risks for emergency preparedness

Whilst it was accepted by LRFs that priority should be awarded to the higher risks, concern was expressed about the application of this principle. In particular, whether in practice this was interpreted to mean that emergency exercises were only completed for the Very High risks. Two concerns were expressed about this.

- That the frequency of High and perhaps even Medium risks also justified exercising plans. For example, should an LRF with Very High human health, flood and severe weather risk run exercises for High risks such as aviation accidents?
- Given that there was wide uncertainty in the risk assessment, especially likelihoods, the results should not be used in a literal way to decide for or against emergency planning and exercises.

2.2.6 Treated Risk

The LRFs acted to bring the various agency plans together into multi-agency response plans and strategies and therefore rely on the expertise and knowledge of the constituent organisations to that end.

The process of vetting risk after treatment was dealt with in the same way as the initial assessment and the same comments apply.

2.2.7 Scheduled and Exception Reviews

The FRSs and LRFs generally demonstrated robust regimes that are essential to maintaining the currency of a risk assessment and the effectiveness of the associated control measures. The LRAG process was considered a useful tool for recording risk and for flagging up issues requiring further attention. Reviews were generally dynamic with LRFs responding to new guidance or information as it becomes available.

2.2.8 Community Risk Registers

Almost every LRF adopted the common risk assessment template in the construction of their internal Community Risk Register (CRR). They followed the recommended Cabinet Office format based around each of the specific hazard scenario. There was very little variation between LRFs although differences in the approach adopted in collating and using the risk assessments and the administrative arrangements adopted.

A number of LRFs recognised the administrative difficulties with adopting a paper-based system to record and disseminate the risk assessments and supporting documentation. Paper systems can be inaccurate, out of date and complex to maintain. The paper systems have also caused difficulty regarding access and confidentiality.

For these reasons LRFs have looked at a variety of IT platforms to assist in the management both the risk assessment documentation but aloes enable links to other key documentation. Examples being adopted include:

- Use of Access database systems (several examples)
- Simple spreadsheets
- Evidence Based Management Systems
- Internal and cross region extranet systems
- Real time editing of core documentation.

These systems were designed to support the implementation of the LRAG, and do not go beyond the LRAG approach.

Internal Community Risk Registers

The researchers checked whether the internal (restricted versions that re not published) Community Risk Registers disaggregate the risk assessment geographically. A number of LRFs were asked whether their Internal CRR involved risk assessments for sub-areas. In addition, two LRFs provided copies of their internal CRRs. In all cases the LRFs stated that the internal CRR did not disaggregate risk assessments geographically. The internal CRR provided a higher level of explanation of the sources of the risk assessment, the judgements made and recommendations.

2.2.9 How outcomes of risk assessments are used

The feedback on the application of results varied. As elaborated below, some LRFs cited application of results within their emergency planning whilst some declared that the process had not led to any changes in their emergency planning.

Examples of application of results to emergency planning
Some LRFs clearly indicated that the results had been used to check:

- If there were any gaps in the portfolio of emergency plans?
- If the prioritisation of plans was appropriate?
- If multi-agency plans had been developed for all key risks?

The risk assessment was judged by LRFs to have added value to these decisions.

In addition, some respondents indicated that the Six Step process of risk assessment had provided a more traceable and robust basis for prioritising contingency planning.

No change
It was indicated that as local emergency plans have been in place for many years prior to the Civil Contingencies Act that the results of the LRF risk assessments were used to review existing plans and identify any areas for revision (rather than initiate totally new emergency plans). It was also noted that many risk categories were already addressed by other regulations, such as COMAH, that require and have led to generic and specific emergency plans. Thus, the risk assessments do not necessarily lead to a significant amount of new emergency planning and preparedness.

The researchers also explored whether the process supported cost benefit decisions and tactical decisions, as part of our research remit. The findings are noted below:

- The LRFs noted, and the researchers agreed, that the 6-step process did not support nor require cost benefit analysis or formal assessment of resource levels. Instead it supported judgement of which risks warrant an emergency plan and what priority should be awarded such plans.
- The Six Step process was not thought to provide support for 'tactical decisions' such as where to locate resources to cover, for example, predictions of areas of high outdoor fire risk in any one summer.

2.2.10 Competence requirements
The FRSs and LRFs placed great emphasis on the need for risk assessors to be experienced and knowledgeable and for risk assessments to take place within a consultative peer review process. The results of such methods were generally considered reliable where risks within their own areas of competence were concerned. However, in some cases, the lack of transparency regarding the risk analyses inputs from some (not all) Category 2 responders tended to reduce LRF confidence in some areas of risk assessment, particularly infrastructure failure.

FRSs and LRFs were confident with regard to the way in which their risk assessments support activity to control/treat risk provided that the Category 2 inputs were considered by the LRF to be reliable.

A number of competence concerns were expressed about the risk assessment process as a whole.

- Experience of local risk assessors
- Uncertainty regarding the competence and experience of some Category 2 responders
- Uncertainty regarding the adequacy of risk processes used by some Category 2 responders
- Lack of clear competence requirements for LRFs Risk Assessment Working Group chairs and members.

There were also some concerns expressed by LRFs that responsibility for leading the assessment of some risks was allocated (or falls upon) an agency or individual who lacked suitable knowledge and experience of the risk category. The individual may lack knowledge of data sources, the nature of the risk or how to complete a risk assessment of it. It was often for this reason that the LRAG ratings were not challenged or varied from. A number of individuals involved in LRF risk assessment stated they had not received any risk assessment training, neither on risk assessment techniques generally nor in relation to specific risk guidance (eg LRAG). One example included aviation accidents and severe weather being assigned to a Category 1 responder with no previous knowledge or experience of these risks or how to assess them.

The limited experience of LRFs' members in assessing specific risks also contributed to a limited ability to scrutinise, validate or challenge the data or estimates provided to them by other organisations. In addition to undermining the governance of LRF assessments, this led to a lack of confidence in the assessments in some cases.

2.2.11 Data sharing

Is the sharing of the latter information restricted by legal, security, commercial, organisational or other factors? Do any technical, administrative or organisational requirements restrict the sharing of information?

Feedback from LRFs indicated that FRSs and LRFs shared data willingly.

A number of examples were cited of where the sharing of data by Category 2 assessors with LRFs was limited by security and commercial factors, including:

- Sharing data on location of facilities and sites that may be a security risk. This included sharing data on poultry farms that could be targets for animal rights activists

- The societal risk analyses for COMAH sites are security restricted
- Water risk assessments completed as part of Security and Emergency Measures Direction (SEMD) are withheld for security reasons
- Commercial concerns about publishing the likelihood of industrial technical failures, such as indicating the likelihood of different telecom providers experiencing failure
- Reluctance on the part of utilities to share information regarding sensitive utility assets such as water treatment sites.

The LRFs indicated that these restrictions impaired understanding of the risks.

Some LRFs suggested that the process of publishing CRRs made some Category 2 organisations reluctant to contribute to the risk assessment due to commercial sensitivity and concern about public reaction to high likelihoods.

In addition, a practical problem concerns being unable to identify suitable organisations and individuals within them to approach for data. Examples were cited by LRFs where effective contact could not be established with Category 2 organisations due to the LRF lacking any suitable point of contact with them. This linked to the observation that some LRF assessors lack previous knowledge and experience of a risk category and hence lack awareness of potential sources of support.

One suggestion was to centrally provide tools and data that enable local risk assessments to be completed without dependence of commercial sources of data.

It was also noted that many people who hold key risk assessment positions within LRF RAWG do not possess security clearance and that this limits the acquisition and use of sensitive information.

2.2.12 Occupational health and safety of responders

To what extent is there an established process of assessing the occupational health and safety risks for Category 1 responders? Does this apply to the CCA risk categories?

Feedback from the police, fire and ambulance service respondents indicated that in their opinion the FRS had developed the most sophisticated and well-established processes. The process in FRSs was based around Generic Risk Assessments (GRAs). These are broken down as follows:

- Responding to Emergencies
- Carrying out Rescues
- Fighting Fires
- Incidents involving Transport
- Generic Hazards.

The management of risk at operational incidents was stated by FRS respondents to be a continuous process of identifying hazards, assessing risks, taking action to eliminate or reduce risk in the changing circumstances of an operational incident. This was termed 'dynamic risk management'. Dynamic risk management was said to operate at the Strategic, Systematic and Dynamic Level and involved the concept of the safe person. In normal activities safety performance relies upon the safe person and safe place strategy. In dynamic incidents the safe place cannot be assured and therefore greater emphasis falls onto the need to ensure a safe person strategy is adhered to. The process was judged to cover all types of incidents attended by the FRS.

The principles of dynamic risk management were prepared specifically for the FRS although respondents suggested that the process could be extended to the other emergency services.

Ambulance service respondents indicated that the Ambulance Trusts have also adopted a dynamic risk assessment approach. This was a generic approach and did not deal specifically with civil contingencies scenarios. Ambulance trusts have been implementing national policy on occupational health risk in relation to civil contingencies. Examples include the provision of electronic dosimeters (CBRN incidents) and supply of nerve agents.

The feedback from a Police Federation representative was that there was little assessment of occupational health and safety risks for civil contingencies, such as COMAH site incidents, within the police service. 'Risk assessment' was reported to rely on the judgement of the officers first on the scene. It was also noted that provision of personal protective equipment was very generic, with a basic level of PPE provided, that operational data (such as information on chemicals at a site) was sparse and often out of date and that the provision of risk assessment training to police officers (for dynamic or other forms of risk assessment) was in its early days. The respondent suggested that the level of training and development of risk assessment processes was ongoing in the police service, and was given added impetus by the death in service of an officer.

Thus, the FRSs were viewed by respondents as possessing the more advanced form of occupational health and safety risk assessment, followed by the ambulance and police services.

There was less feedback regarding other responders, but with some mention of social services risk assessing PPE needs for pandemic flu incidents.

In summary responders place great importance on take occupational health and safety seriously and apply generic risk assessments supported by dynamic risk assessments. Respondents indicated that this was an appropriate approach. They did cite some concerns, as noted below, with the implementation of this approach, including:

- Resources do not always ensure that individuals are fully trained in dynamic risk assessment techniques

- A mistaken assumptions that where a major incident is led by say the FRS that their risk assessment precludes the need for other responders to risk assess the situation
- Lack of transparency in the transfer of responsibility as a scenario evolves
- Over reliance on the generic risk assessment.

These concerns do not provide reasons for changing the GRA approach in the opinion of the researchers.

2.2.13 CRR IT support

IT support

The CRR risk assessments were mostly paper based (with some exceptions), published as pdfs on the internet. Each LRF had developed its own presentation of the CRR, with wide variations between them.

GIS

A number of LRFs have indicated that some form of GIS may be of value. However, one LRF noted that they had initially applied a GIS but found that the GIS was over complicated and so adopted a standard LRAG approach.

A number of GIS packages are summarised later in this report in section 5.2.4.

Chapter 3

IRMP specific risk analysis

3.1 Introduction

This part of the study explored a number of key questions, namely:

- To what extent do, or could, the assessment of operational risks in IRMPs, such as aviation accidents, benefit from the application of the civil contingency risk assessments completed by LRFs?
- To what extent do FRSs business continuity planning benefit from application of the civil contingency risk assessments completed by LRFs?
- What are the gaps and limitations in the suite of risk analysis tools, data and techniques required by FRSs for IRMPs?

The latter question was posed with respect to the full spectrum of operational FRS risks, including fire, Road Traffic Collisions (RTCs), other special services and major incidents. The question regarding FRS business continuity was posed in relation to the FRS ability to continue providing a response capability.

The feedback from FRSs indicated that they use their IRMP processes to good advantage in terms of strategic planning over the longer term. Where tactical planning was concerned, the FRSs demonstrated the ways in which they use risk information to support their operational risk assessments and associated plans, risk, dynamic risk assessments and operational management. These methods derived largely from the established and reliable methods used for workplace health and safety assessments. The general view was that FRSs are well supported with respect to strategic planning, tactical decisions, operational planning and occupational health and safety.

However, the adoption of additional tools and data by FRSs, and feedback from FRSs, highlighted a series of specific limitations of risk analysis tools, including the Fire Service Emergency Cover tool kit, and a requirement for additional risk assessment functionality. These are elaborated below.

The interplay of IRMPs and civil contingencies LRF risk assessment was explored along with the assessment of major incidents within IRMPs.

Responding FRSs did not cite any risk analysis problems, in the context of IRMPs, with respect to Other Buildings, the Regulatory Reform Order or of heritage risks. The Regulatory Reform Order was mentioned briefly in the context of a shift of emphasis from statutory fire safety to community fire safety.

3.2 Major incidents and civil contingencies

3.2.1 IRMPs and LRFs

LRFs and FRSs noted that FRSs make a number of important contributions to CRRs, particularly in the area of industrial fire and explosion, such as by identifying COMAH sites. No respondents cited examples of IRMPs being explicitly used to inform CRRs.

Benefit of CRR to IRMPs

A number of FRS respondents indicated that:

- They have made very limited (if any) use (to date) of the LRF risk assessments or CRR in the development of their IRMPs
- The LRF assessments have not (to date) helped FRSs assess likelihoods of lower frequency incidents such as aircraft crashes
- FRSs provided inputs to the work of LRFs rather than receiving assessments from the LRFs
- It was stated in one case that there was no obvious value from the Community Risk Register for the FRSs
- Responding FRSs have not used the CRRs to determine what 'reserve' resources are needed to handle major civil contingencies or the impact of (for example) pandemic flu on FRS operational capability
- Responding FRSs also noted that they rely on regional and national arrangements and contingency planning already completed within IRMPs, rather than any new plans developed in response to CRRs.

It was indicated that the civil contingencies risk assessments completed by LRFs have to date not added greatly to the assessments already completed by FRSs. None of the FRSs indicated that they had changed their resources due to LRF risk assessments.

Reasons for limited FRS use of CRRs

This was indicated by responding FRSs to be due to a variety of reasons, including:

- IRMPs pre-date the assessments completed in response to the 2004 Civil Contingencies Act – therefore the CRR were under developed at the time IRMPs were first being developed
- The roll out of New Dimensions assets prompted FRS review of CBRN, urban search

and rescue and flooding risks independently of the CRR. This included assessing if FRSs have sufficient resources to handle major incidents such as CBRNs or floods, and what level of 'resilience' in resources was needed for this purpose

- The roll out of New Dimensions assets had already prompted examination of what level of resources is needed to achieve 'resilience' in the event of civil contingencies
- IRMPs initially focused, in accordance with Communities and Local Government guidance, on dwelling, RTC and other building risks
- The local Community Risk Register was a 'drill down' of regional events that provided county level assessments – which were too high level to add value to IRMPs
- The local CRR did not provide geographic specific assessments
- The CRR and LRAG scenario descriptions were too high level to be of practical value – for example the description of severe weather does not detail the level of damage, size of area affected or impact of weather on infrastructure or what the FRS may need to do
- The LRAG scenario descriptions of 'up to…' casualties was of limited value
- FRSs wished to consider smaller scale events that are not captured by current CRR
- FRSs already assess a range of major incidents and have established contingency planning processes for many risks, such as COMAH sites, ferry fires
- As FRSs have generic business continuity contingency plans for attrition of resources, the assessments of individual risk categories within CRR did not necessarily add value.

FRS resource resilience risk assessment

A number of FRSs cited examples of resource resilience policies that have been developed in parallel to the civil contingencies risk assessments of LRFs, such as having 20 per cent of appliances held as a reserve for major events, assessing resources against certain assumed scenarios (such as deploying a CBRN unit plus 14 appliances), or having sufficient resources to handle two simultaneous incidents each demanding 20 appliances. In some cases the FRSs explicitly checked fire cover decisions against the CRR to check how resourcing decisions may impact response to the civil contingencies, with one saying that the LRF would challenge FRS resourcing decisions as part of their work.

It was also noted that the approach to assessing the level of 'reserve' resources varied between FRSs. The approach tends to involve considering the maximum scale of event that the FRS will retain resources for, by examining the scale of past events, which is a form of risk assessment. These approaches were developed by the FRSs, with some consultation with neighbouring FRSs, rather than as part of the LRF process. In one case it was noted that the current level of resourcing did not allow for any reserve or the ability to handle more than one major incident at a time. In this case reliance was placed on support from neighbouring FRSs. In the case of some metropolitan FRSs, with a larger number of resources, they explicitly planned for 'reserve' resources and for handling multiple incidents. In one FRS the policy is to have resources to handle two simultaneous

major incidents, in the other case a proportion of fire crews were allocated to community fire safety activities but with an ability to become operational within a specified period (and therefore acting as a reserve). The magnitude of the two events was identified by reviewing the past 5 years of local FRS operational experience and identifying the largest simultaneous incidents that had occurred, namely two 20 appliance incidents. Thus it was apparent that:

- 'Reserve' policy was influenced by perceived feasibility, and
- The need to consider reserves and handling multiple simultaneous major incidents was prompted by developments beyond the LRF risk assessments, such as the New Dimensions programme.

It was also suggested by responding FRSs that the resilience planning within IRMPs focuses on FRS specific events rather than regional or national scale events. Whilst it was assumed that resources could be drawn upon from neighbouring FRSs, a concern was raised that if the event was truly regional or national, then these neighbouring resources may not be available. Such a scenario did not appear to be explored in detail within IRMPs. This was considered by the researchers to be an issue if it is accepted that IRMPs are intended to cover the full spectrum of risks that the FRS may encounter.

Some FRSs also noted two reasons for wishing to ensure that the level of risk assessment awarded by them to civil contingencies is proportionate, including:

- A view that risks such as RTCs and dwelling fires are the predominant risks that warrant more attention, and that detailed assessment of civil contingencies needs to be proportionately less
- A view that many types of civil contingencies can be covered by a single generic emergency plan, and so there is little value in risk assessing individual risk categories.

These observations led to the view from FRS respondents that detailed risk assessment of individual risk categories may not always be justified and that assessment of similar types of risks (eg transport accidents) that share a common type of response may be more proportionate. Any civil contingencies risk assessment needs to be completed in the context of the full range of incidents handled by the FRSs for such assessment to be integral to IRMPs.

In the case of business continuity, FRSs indicate that they developed generic contingency plans for loss of resources, in parallel to the LRF risk assessments. The need to assure business continuity had already been highlighted by events such as the 2002 industrial action and the promulgation of flu pandemic plans to local authorities. These 'degradation of resources' plans cover (in a generic way) all causes of loss of resources, such as pandemic flu, industrial action, foot and mouth, flooding of fire stations etc. They identify which fire stations would be staffed in the event of loss of resources as well as noting which non-

essential activities would be halted, such as community fire safety work. The plans assume a progressive reduction in resources to for example 50 per cent, 20 per cent etc of the norm. A preference for generic plans was reported to mean that business continuity plans per risk category are unnecessary. The FRSs indicated they have made some, limited, use of the CRR to check they have addressed all risks to business continuity.

Recent developments in FRS use of CRRs

It was apparent that some FRSs were exploring the potential value of the LRF risk assessments and were beginning to identify some points of cross over that may be of value to the next round of IRMPs.

There were examples of where FRSs are currently reviewing their IRMP against the CRR and expressed the view that the LRF assessment does assist, to a limited extent, with prioritising risks. It was noted that the CRR did help to:

- Identify flooding as a key risk
- Identify severe weather (storms) as a high risk
- Raise the question of whether the FRS has sufficient resources to handle major incidents such as severe storms
- Identify that some fire stations are in flood areas and would be impacted in the event of a flood
- LRF risk assessment provides reassurance of IRMP arrangements
- LRF risk assessments have helped identify some scenarios for training purposes
- Prioritise the risk posed by a local airport.

The CRR risk ratings were indicated to be of value in focusing on the higher risks.

When FRSs review their IRMP against the CRR they reported that:

- They had covered the vast majority of their risks but
- Had added a couple of new risks after the review of the CRR and/or
- Recognised that the hazard posed a higher risk than previously thought.

Moreover, review of the LRF CRRs highlighted to FRSs a number of issues that they judged may benefit from further review, including:

- Does further consideration need to be awarded to the impact of civil contingencies on 'reserve' resources?
- IRMPs tend to focus on local events. The CRR process may help identify regional and national events that could impact them.

It was queried by FRS respondents whether current assessment of 'reserves' was entirely sufficient. It was common practice to assess the availability of 'over the border' resources to assist in the event of a major incident in an FRS. However, in the event of a national incident (that affects many FRSs) these 'over the border' resources may not be available. The consequence for operational capability in each FRS could benefit from greater review, including the need to consider further options such as 'return to duty systems' and wider regional support in event of larger scale incidents.

It was also considered that the LRFs can act as a conduit between the FRS and other agencies for the purpose of identifying and sharing data and information for use in IRMPs. The example of sourcing airport risk contour maps was cited.

Finally, it was queried by FRSs whether there is an alignment of regional IRMPs to regional civil contingencies planning.

FRSs did not see any conflict between the demands of IRMPs and LRF assessments.

It was suggested that the civil contingencies risk assessments completed by LRFs would be of greater value to IRMPs if there was some element of spatial (geographic assessment) that addressed more localised incidents.

3.2.2 Major incidents risk assessment in FRSs

The responding FRSs indicated that the assessment of major incident risks by FRSs involved:

- Identification of risks by considering (qualitatively) the range and nature of risks in the area, such as identifying airports, railways, chemical sites etc – including using the restricted National Critical Infrastructure database
- Reviewing the FRS's own incident data to identify where incidents have occurred and how many times– these include 'incidents' such as standby at airports, flooding, aircraft wheel collapse etc – this supports a qualitative judgement of the need to plan for these risks
- Identifying development plans for, for example, airports – to factor these plans into the decision on whether a contingency plan is needed.

Some FRSs have reviewed their own incident data to ascertain the frequency of simultaneous major incidents, typically two major fires. In some cases this was gauged in respect of, for example, the frequency of two or more simultaneous incidents requiring 4 appliances, 10 appliances and so on. The assessment was then used to inform decisions on the need to retain resources to handle simultaneous major incidents. Such assessment was not specific to any one type of incident. Rather it examines coincidence of any types of incidents.

Some examples of judgements were:

- As a serious train incident had occurred in the memory of the assessment team then this validated the need to plan for train incidents
- As a small airport was planning to be expanded this raised the need to plan for airport contingency planning
- As the county was next to the busiest shipping channel in the UK (and there have been some vessel incidents) it was a suitable place for a National Incident Response Group
- As floods have occurred and the Environment Agency flood maps indicated areas in the county at risk, flood response plans were required.

The judgement involved consideration of both likelihood and consequence, particularly a judgement of an event and the likely scale of that event.

Areas for further development

FRSs indicated there was little analytic risk analysis of major incidents.

As noted later in this report, the vast majority of FRSs have completed the FSEC risk assessment toolkit. However, as the FSEC major incident module has offered less functionality than the other modules, this model has not been greatly utilised. It was also noted that the version of FSEC distributed to FRS does not model simultaneous major incidents, although a national FSEC model used by Communities and Local Government does.

However, there was mixed opinion on the need for additional data and tools to risk assess major incidents. On the one hand, as decisions were already made using qualitative information in some cases, it was doubted whether further 'data driven' risk analysis would add value to planning decisions. On the other hand:

- It was expressed that there was very little local data on major incidents
- It was questionable how assessments can be completed by any one FRS if they have not experienced a particular type of incident, ie local experience would not be a valid basis for an assessment of local frequency incidents
- It was also questioned whether a review of (say) five years of operational experience provides a valid basis on which to gauge the likelihood of low frequency major incidents.

Accordingly there was some support from responding FRSs for providing additional data and risk analysis of major incidents, but only where the resources needed to develop such analyses is proportionate.

Two specific areas of concern relate to:

- Chemical incidents. It is suggested that as the majority of industrial chemical incidents occur at non-COMAH sites that the risk assessment process needs to extend beyond COMAH to include sub-COMAH sites and the transport of chemicals
- Simultaneous incidents: Whether a tool could be developed or made available to provide predictions of simultaneous major incidents.

Finally, it was suggested by FRS respondents that there would be value in having a process for capturing major incident data and providing a firmer basis for risk analysis of major incidents, including both the likelihood and magnitude of events.

3.3 IRMPs

3.3.1 Overview

IRMPs are intended to cover the full range of risks in the area served by a FRS, including fire, RTCs, other special services and major incidents, including civil contingencies.

The level of progress with risk assessment and the availability of risk analysis tools (other than FSEC which is provided to all FRS in Great Britain) was indicated to vary, with most progress being made with dwelling fires, RTCs and other building fires. However, even within these categories there were aspects of risk assessment that could benefit from further development or sharing of tools and data.

Many of the potential gaps arose, in the opinion of the researchers, from the need to adapt to changes in society and the role of the FRS, including:

- The focus on community fire safety requires a higher level of predictive assessment, including assessment of the socio-demographic risk, using more current and predictive information
- The shift towards prevention and partnership working requires a wider view to be taken of risk – beyond dwelling fires and towards wider community safety issues
- The increased importance of FRSs trying to prevent RTCs increases the demand for quality data on and assessment of RTCs
- Whether the shift towards prevention and the emergence of fire engineered solutions leads to a need to re-align competences with the new range of risks and their characteristics
- A need to foresee future changes in local population rather than rely on historical data
- The recognition of the FRS role in rescue and recovery from floods, along with gaps in current flood risk assessment

- The recognition of wider social responsibilities requires further account to be taken of the impact of activities, such as fire fighting, on the environment and society.

These emergent needs prompted the development of a range of tools and data sources by FRSs. The need for more predictive community fire safety tools was explained in the context of needing to predict the impact of CFS interventions, foresee areas that will have more fires and the need to identify specific addresses for CFS.

In addition, a number of FRSs have developed or acquired tools to explore workload and resource utilisation issues, again highlighting a gap in the suite of tools provided nationally. This extended to modelling the resource implications of prevention work in addition to response activities.

FRSs did not cite a need to improve risk assessment of special services, other than RTCs. In the opinion of the researchers this was a potential misjudgement by FRSs, given that other special services include a wide range and large number of life threatening scenarios.

3.3.2 FSEC

It was clear that FSEC (Fire Services Emergency Cover) was widely used by FRSs. Table 3 provides a summary of the results of the OASD findings regarding of FRS risk analysis, including identifying FRSs that stated they use FSEC. The majority of FRSs are reported to use FSEC. Communities and Local Government reported that 43 FRSs have had or have requested a review of their FSEC analyses.

FSEC was a risk assessment tool kit designed to facilitate the development of Integrated Risk Management Plans. It enables FRSs to:

- Assess the distribution of risk in their area -particularly dwelling fire, RTCs, other special services, Other Building fire risk and major incidents
- Record resources which they decide are required to deal with risk in individual risk areas: and
- Estimate the consequences (measured in terms of loss of life and property) of making a given level of provision of emergency cover resources within their area.

FSEC is based on GIS bespoke software supported by digital mapping; census data, road data, valuation office date and local incident data.

The following sections of this report outline where FRSs have adopted techniques to build on FSEC and/or identified new risk assessment needs.

Table 3: **FSEC usage as cited in Operational Assessments Service Delivery report of FRSs**

FRS	FSEC Cited	Other Tools
See footnote	Yes	Performance Information Unit (PIU) is responsible for the handling of performance data and the identification of trends and forecasts by statistical analysis.
See footnote	Yes	Fire Brigade Union (FBU) critical attendance standard (CAST) model in its entirety as part of the risk analysis process. Now adopted by FBU.
See footnote	Yes	
See footnote	Yes	ACORN – (Demographic data). This is used with FSEC in reports as part of the decision-making process with all data available on the FRS internal Management Information System, (MIS).
See footnote	Yes	In house Management Information System is used in conjunction with a mobilising incident browser to provide a real-time incident mapping facility at all stations. FSEC, proprietary systems and the incident browser inform both management and operational crews of identified and emerging risks, within given areas.
See footnote	Yes	Amethyst Hub – a multi-agency risk information database utilised across Cornwall & Devon and the indices of multiple deprivation – complimentary with FSEC.
See footnote	Yes	
See footnote	Not stated	Statistical analysis of a number of data sets, including incident, demographic and Census data.
See footnote	Yes	
See footnote	Yes	Regional Management Board (RMB) is used in conjunction with the mobilising incident browser.
See footnote	Yes – being re-introduced.	IRMP

Footnote: FRS name removed as OASD reports have not been published.

Table 3: **FSEC usage as cited in Operational Assessments Service Delivery report of FRSs (cont.)**

FRS	FSEC Cited	Other Tools
See footnote	Yes	MaiDeN is used to enhance FSEC and together they support planning and implementing initiatives, such as eight minute response time standards.
See footnote	Yes	Appliance – Community Safety Workload Analysis Tool – to assist with the development of a 'Flexible Operational Resource Deployment' strategy.
See footnote	Not stated	
See footnote	Yes	
See footnote	Not stated	
See footnote	Yes	Active Total Solutions – This informs both the management and the operational crews of identified risks within a given area.
See footnote	Not being used to its full extent	
See footnote	Yes	
See footnote	Not stated	This service has worked with a consultant to develop innovative analysis and modelling techniques tailored to meet its specific needs. The advanced model considers the efficiency of appliances and stations and the equity and effectiveness of response against risk.
See footnote	Not stated	IRMP Risk Map and Bespoke Software Solution. They both provide a visual reference, broken down by mobilising area of risk for the whole of the service area. The information supports service delivery staff in understanding and reducing risk.
See footnote	Yes	
See footnote	Yes	

Footnote: FRS name removed as OASD reports have not been published.

Table 3: **FSEC usage as cited in Operational Assessments Service Delivery report of FRSs (cont.)**

FRS	FSEC Cited	Other Tools
See footnote	Yes	OFRS Risk Management Strategy and Toolkit – used to deliver improvements. OFRS is part of the County Council's data observatory and has access to a large and varied amount of data that can be used to support risk analysis and Community Safety (CS) initiatives, as it is not geo-coded it cannot be imported into FSEC.
See footnote	Not stated	This service has employed an external consultancy to develop sophisticated analytical and modelling across Royal Berkshire. They use a software package that enables an advanced and robust monitoring of performance against local and national performance indicators.
See footnote	Yes	Integrated Personal Development System (IPDS) is used by staff for personal development opportunities. There is also in-house Performance Management Software which is used as the tool to identify and modify resource allocation to deliver objectives of the Service via meaningful activities.
See footnote	Yes	The Risk Information Unit have developed a Risk Analysis Tool called "Drive Time Calculator". This links with FSEC to help identify the most effective location of resources.
See footnote	Yes	Mapping Software System is also being issued to Area Risk Teams (ARTs), populated with data from 2000 onwards. They also intend to import incident data monthly to maintain currency.
See footnote	Yes	CADDIE – which is an innovative intranet data warehouse.
See footnote	Yes	Bespoke databases – Used to monitor operational and community safety activities, using 11 risk indicators within a matrix.
See footnote	Yes	MIS are used.

Footnote: FRS name removed as OASD reports have not been published.

Issues cited about FSEC by three FRSs

Three of the FRSs consulted in this study indicated that they did not use FSEC, or made limited use of it. They cited the following reasons (as stated by the FRS respondents). It should be noted that these are the views of the FRSs and are, in some cases, factually incorrect.

- It was too time intensive, requiring (in their opinion) excessive resources to operate – especially for Other Building risk assessment;
- That the census (which is included in FSEC) was not valid
- That some of the factors used to predict dwelling risk were not valid, such as the proportion of housing that is rented
- That a sophisticated tool was not needed for reviewing fire cover, as a simple response time standard can suffice (such as attending every dwelling fire in five minutes)
- That a tool that models response times against a response time standard was sufficient for fire cover review (ie there is no need to assess impact on risk to life etc)
- That FSEC was a 'black box' whose criteria cannot be seen
- That the FSEC response time bands (response times are assessed in five minute bands) were too coarse
- FSEC does not take account of factors, such as the duration a fire has been burning, that may influence risk
- FSEC does not take account of secondary fires and 'none life risk' incidents
- That FSEC does not use real (local) fire data for other buildings
- FSEC does not model workloads.

Feedback from Communities and Local Government indicated that some of these concerns were factually wrong. For example, 'none life risk incidents' can be used in FSEC to help assess risk levels and the criterion are stated in FSEC user manuals as well as displayed on screen in the FSEC programme. It can also be noted that the population data can be updated and that the risk assessment routines have been tested and validated, including the factors used for predicting dwelling fire risk and modelling response times. FSEC does not currently model workload but this was not thought to significantly affect the assessment of risk.

3.3.3 Dwellings

Overview

To some extent it was indicated that there was a sufficient range of tools and data to support assessment of dwelling risk assessment. However, as discussed below, the development of in-house tools by some FRSs indicated that FRSs have additional needs not met by FSEC. If these needs are judged to be substantive, this may indicate a need for providing a set of tools nationally to FRSs. In addition, it was indicated that these data sources and tools were fragmented and would benefit from being integrated into a single tool.

Tools currently used by FRSs

A wide range of risk analysis tools and data are available for dwellings fires. These can be split into at least three types, as noted below with some example tools.

1. Fire cover (response)
    - FSEC – FSEC provides an assessment of risk, including the prediction of loss of life associated with alternative levels of resourcing[11], and includes a cost benefit analyses of resource options as well as application of guidelines on the level of risk.

2. Geographic targeting of CFS and resources
    - Indices of Multiple Deprivation (IMD) – as some research has found an association between dwelling fires and deprivation, the IMD can be used to identify areas of deprivation for targeting
    - Census – this can be used in combination with research on the association of socio-demographic factors with incidence of fire to identify areas with high proportions of 'at risk' people
    - FSEC – FSEC risk assesses Output Areas (using the census and incident data) and thus enables geographic targeting of Community Fire Safety;
    - Crime and disorder statistics – as some research has found an association between crime and fire, crime and disorder statistics can be used to identify areas with high incidence of crime for targeting
    - Incident Risk Analysis Toolkit (iRAT) was developed by London Fire Brigade as part of their IRMP planning process. It uses a computer modelling approach to determine patterns of different incidents occurring in geographical locations. iRAT uses a combination of datasets (eg census, deprivation, environmental and historic incident data) . It also incorporates data from preventative activities such as home fire safety checks and smoke alarm installation so that measurable impacts can be included.

      The iRAT model was developed by London FRS (supported by consultants ORH who provide demand model data) to identify the cause of each incident and so identify incident based "prevention strands" and so iRAT can be used as a partial "predictive tool"[12]. It gives a predictive incident count that can be ranked by ward.

    - Coalesc – this contains a module that plots incidents and so can be used to identify areas with higher incidence of incidents
    - GMAC – a combination of FSEC and MOSAIC used by Greater Manchester Fire Service.

[11] The researchers have not identified any other tool or technique in the UK that models the impact of response resources on loss of life and property or which provides measure of risk to life and property.

[12] It should be noted that FSEC also provides a predicted rate of dwelling fires, per output area. iRAT uses a similar method to produce a count on a ward level.

3. Household targeting of CFS
    - MOSAIC – MOSAIC is a commercially available market segmentation tool. It is a tool that allows a detailed analysis of consumer segmentation based on socio-demographics, lifestyles, culture and behaviour. Other related tools are available including MOSAIC Public Sector. MOSAIC categorises post codes and households into 'types' of people, which in combination with research on which household types are most at risk can be used to identify post codes or households that are likely to be at greater risk from fire
    - ACORN – this categorises post codes and households into 'types' of people, which in combination with research on which household types are most at risk can be used to identify post codes or households that are likely to be at greater risk from fire.

Extensions to FSEC

A number of FRSs have developed their own tools and identified additional data sources. These tools tend to build on the functionality of FSEC, as follows:

- FSEC, as noted above, assesses dwelling fire risk to the level of output areas and identifies some high priority household types. MOSAIC was used to help target community fire safety at a postcode and/or household level
- FSEC uses a three (or more) year period of incidence data. In some sub-areas of FRSs, the number of dwelling fire incidents is low and so the trend may not become apparent for a number of years. Crime and disorder statistics were used by some FRSs to provide another measure of risk, in the expectation that it may better reflect the current status. As crime is more common it may indicate trends sooner than fire data
- FSEC (which uses the census) was supplied with socio-demographic data from 2001. Social change and immigration may have altered the make up of the local population in the period since these metrics have been developed. Therefore, more current data sources (such as crime and disorder data) have been sought to help cross-reference and validate these metrics. Whilst the population data in FSEC can be updated, some FRSs choose to use alternative data to model potential trends.

It was suggested by respondents that it was difficult (but not impossible) to include new or proposed housing developments in FSEC, again highlighting the need for further development of forward-looking dwelling risk assessment.

It is pertinent to note that Greater Manchester FRS (GMFRS) completed an assessment of the extent to which FSEC identifies high risk areas and the extent to which the use of MOSIAC identifies additional areas of high risk. The study included assessing the association of dwelling fires with MOSAIC, to identify MOSAIC categories to search for. They found that FSEC identified the vast majority of high risk areas and that there was a very high degree of overlap between MOSAIC and FSEC results. Therefore, whilst MOSAIC

builds on FSEC by identifying specific postcodes and households for targeting, the study confirmed (in the researchers' opinion) the value of FSEC for identifying high risk Output Areas.

The same study by GMFRS found that the more limited range of household categories used by ACORN limited its use in identifying high risk areas.

The tools being developed by FRSs focus on providing current and predictive assessments of community risks by drawing on a suite of lifestyle, demographic and other sources of data that indicate risk to the community.

The crime and disorder, mental health and other sources of data on current social/ community safety were also used in order to demonstrate the coincidence of fire risk with other aspects of local social issues. The aim here was to indicate how fire (including arson) fits in with wider social and community agendas and hence to demonstrate the role of the FRS in achieving wider social agendas. Such analysis was of growing importance with the development of partnerships working between the FRS and other agencies and the operation of Local Area Agreements.

The involvement of FRS in partnership working has led to additional needs. In the case of anti-social behaviour, crime and disorder, it has led to the need to assess deliberate fires and malicious calls, and to draw on data on stolen vehicles to support tactical decision-making. GIS systems are used to plot deliberate fires and malicious calls, to support strategic and tactical decisions on arson prevention, covering response and prevention. In the context of integrating the FRS into wider social agendas, local ward or district profiles were said to be needed that provide an integrated view of dwelling fires, anti-social fires (a term used by some FRSs), car fire crimes, along with wider crime, ASBOs and health data.

Some examples of tools include:

- An Incident browser developed by Cleveland FRS
- Arson Predictive tool – developed by Cleveland FRS.

The need to draw on a wider range of data was reflected by the use of multi agency data exchanges.

A number of FRSs cited the use of Crime and Disorder data. There were examples of databases designed specifically to support multi-agency working. For example Southeast England has developed Crime and Disorder Data Information Exchange (CADDIE) to share crime and disorder data between the agencies that work together as Crime and Disorder Reduction Partnerships (CDRPs). The CADDIE website brings together partnership data in one place where it can be accessed, researched and mapped by all the partners involved in crime and disorder reduction. The recorded crime data is provided by 43 police forces

throughout England and Wales, who are required to supply the Home Office with monthly figures for all of the CDRPs in their police force area. Merseyside FRS is an example of an FRS that has overlain fire with crime and disorder data.

Thus, the risk analysis aims for dwelling fires included:

- Assessing impact of fire cover on dwelling fire risk, and vice versa
- Supporting geographic targeting of resources, especially CFS
- Supporting household level targeting of CFS
- Establishing the association between fire and wider social, criminal and health issues – in support of partnership working and social agendas.

There was also some wish to be able to look ahead at community risks. It was stated by responding FRSs that the current suite of data and tools tend to be retrospective. The police National Intelligence Model (NIM)[13] was cited by some FRS respondents as a tool for considering future as well as current threats. However, NIM is primarily a decision-making tool that draws together qualitative and quantitative data, rather than be a repository of such data. Again Cleveland were an example of an FRS using NIM to support FRS decision-making. In the researchers' opinion whilst NIM may help structure decisions, it did not constitute a risk assessment tool that provides data or analysis routines.

West Midlands FRS also identified a need for a more predictive approach to community risks that does not rely on historical data. Their concern was that historical incident data and socio-demographic data did not provide a full basis on which to assess future trends and demands. Therefore, tools and data have been sought to provide forward-looking assessments of, for example, community fire safety demands. In the case of West Midlands FRS a tool called Coalesc (previously called Amethyst) was being developed for this purpose. Coalesc contains many modules. These include past incident data as well as trend analysis.

Non-operational activities

With the growth in the level and importance of activities such as HFRC, this was thought by FRS respondents to lead to a greater need to record and assess the resourcing of non-operational activities along side response activities. At the time of reporting the resource implications of CFS were not modelled, nor was the impact of completing, for example, HFRC on response times, such as the point that the appliance may not be at the station when it is mobilised.

[13] NIM is an information-based deployment system which is now regarded as a cornerstone for the management of law enforcement operations in England and Wales. NIM identifies patterns of crime and enables a more fundamental approach to problem solving in which resources can be tasked efficiently against an accurate understanding of crime and incident problems. (Source www.acpo.police.uk/asp/policies/Data/nim2005.pdf)

It was suggested that FRSs need to better record the activities of crews, so as to record their involvement in community fire safety and then include CFS in workload modelling.

The researchers suggested that there may be value in checking the absolute level of CFS work to check that it is a significant workload factor before extending workload models to include it.

3.3.4 RTCs

FSEC was reported to be relatively well developed for RTCs and to be commonly used by FRSs for assessing RTCs. FSEC is designed to plot those RTCs attended by the FRS which are life threatening and models the impact of FRS response resources on loss of life at these incidents. It is also possible to load and plot other RTC data in FSEC, such as STATS 19 data.

Some FRSs were moving towards RTC prevention. This raised the question of widening the capture of RTC data to include those not attended by the FRS and to address the problem of what can be low quality RTC data held by FRSs[14]. It was argued by respondents that if FRSs are to be engaged in RTC prevention they need a full view of where incidents occur and the areas where people (who cause accidents) live. The suggestion was that knowledge of the address of drivers was needed in order to target prevention work (typically driver education) onto areas where people live rather than where the accidents occur. Also, other information such as the age, sex and address of the driver may be equally valuable. It was reported that pertinent RTC data was readily available from the local Highways Agency or police (STATS 19) on all RTCs. This data can be acquired and loaded into FSEC (for example) for geographic plotting.

Some FRSs such as Cheshire FRS have been adopting a risk-based programme for dealing with RTAs at a regional and local level. They only consider Killed and Seriously Injured (KSI) incidents from STATS 19. This targeted approach was used to develop education and training initiatives. However a weakness was that the data needs to be routinely cleaned and was typically 12 months out of date and does not produce the real time data that FRSs collect for fire incidents.

Finally, whilst sources of RTC data were identified, their assessment and application in IRMPs, especially with respect to RTC prevention was said to be in the 'early days'. There were fewer examples of geographic assessment of RTCs or of assessment of the link between RTCs and factors such as socio-demographics, although it was sometimes assumed that RTCs coincide with deprivation as with dwelling fires. There was an expressed interest in moving into a more predictive approach to prevention of RTCs that does not rely on historical data and which develops a richer picture of locations and their risk factors.

[14] The introduction of the new electronic incident data collection (IRS) by Communities and Local Government should lead to a far higher standard of RTC data collection by FRSs.

3.3.5 Other special services

The assessment of other types of special services, such as extricating people from machinery or holes, was limited, mostly confined to workload assessment and response assessment rather than risk assessment. The FRS respondents did not accord such importance to this area of assessment.

3.3.6 Workload modelling

FSEC does not currently model workload, although Communities and Local Government indicated they are aiming to develop and supply a workload module. Consultation with Greater Manchester FRS indicated they developed Phoenix with Active Solutions (which they use alongside FSEC) as a tool for:

- Resourcing and workload analysis
- Usage data
- Stations that can be stood down over night.

It was also noted that at least one FRS used Northgate StruMap, which is a generic GIS tool that can be populated with incident data and models response times, to aid workload modelling.

The feedback from some FRSs indicated that there was value in modelling workload in respect of assessing when crews can be deployed on CFS and development of new shift systems.

3.3.7 Wildfire

It was reported that there was growing interest in the assessment of wildfire for a number of reasons, including:

- Scotland has the potential for larger scale fires although lowland heath land type fires do present particular risks in England and Wales
- A perception that more remote locations need better protection (prevention) because it is difficult for tenders to arrive in time to put out fires
- Recognition that wildfires can have a significant impact, particularly where there are consequential impacts such as closure of motorways – a fire near the Thames crossing which closed the M25 is cited as an example of the consequential risk of wildfires
- A view that wildfire does have an economic cost (farmer, consequential, nuisance concern) and an impact on fire fighters
- The view that climate change will lead to longer and dryer summers (and hence more fires and larger fires)
- The potential for increased cost of retained fire cover and demand for permanent fire cover in the event that climate change leads to more fires.

The potential for increased cost of fire cover, in the event of climate change leading to more fires, was said by FRS respondents to being prompting a shift of focus from response to prevention. This includes, for example, working with farmers and drawing on New Zealand and other countries' experiences in prevention[15]. It was also noted that there is a need to raise awareness of the benefit of features such as hedgerows that act as firebreaks as well as being good for biodiversity and sustainability.

Thus, there were a number of key decisions that need to be supported in relation to wildfire, including:

- Better use of fire cover
- Prevention
- Operational planning, especially with respect to availability of open water (to avoid water tanker shuttle runs).

It was reported that the following points were not key issues in respect of wildfire:

- Cost benefit analysis of local resources
- Tactical and dynamic decision-making – which are already part of FRS arrangements.

Given the focus on fire prevention, data was being sought on issues such as:

- Sources of ignition modelling, area nature
- Prevention strategies and their effectiveness, such as banning burning of stubble.

Key issues cited by FRS respondents included:

- Getting balance between retained and whole time fire cover right
- Need to be able to respond dynamically and look long term
- Prevention remains the focus
- Look at better use of other tools (eg from New Zealand)
- Better use of FDR1 and FDR3 reports
- Lack of consequential risk data.

It was suggested that FRSs were weak on trend analysis and forecasting, especially of spate conditions, and that a forecasting tool would be of value.

FRSs did not mention the role of volunteers in respect of wildfire. The FRS did not cite use any specific fire risk analysis tool, such as the Met Office's Fire Severity Index.

[15] Whilst the respondents did not mention Canadian work, the researchers identified the Canadian Wildfire Threat Rating System (http://fire.cfs.nrcan.gc.ca/Downloads/WTRS/4786a.pdf) as a tool that may warrant consideration by the UK FRS. This tool is discussed later in this report.

3.4 Dynamic risk assessment

3.4.1 Overview

The general view of FRS respondents was that established processes were in place for the emergency fire fighting response to 'traditional' events such as COMAH site incidents and incidents with potential of industrial pollution, such as through the use of 7iiD cards, wind sensors and pre-attack plans. It was also noted that a number of FRSs have developed and operate mobile data systems that provide information to support dynamic decision-making for building fires. However, there was a need for considering further the wider impacts of incidents such as the environmental and social impacts of major fires. It was suggested that tactical deployment plans focus on fire fighter safety and fire fighting (including the risk from hazardous chemicals) rather than other impacts, and that higher risk sites may justify plans that cover societal and environmental impacts.

Concern was expressed by FRS respondents about the arrangements for alerting FRSs to weather related incidents, such as flooding and severe weather, as elaborated below.

3.4.2 Severe weather warnings

Several FRSs expressed concern regarding the provision of flooding and severe weather risk (real time alters) warnings by the Environment Agency and Met Office. These agencies were not considered to be proactive in providing additional risk information beyond the public warnings that they issue, although they do provide additional information when requested. The FRS were looking for more informative real time warning systems that enable the FRS to judge what response they need to start enacting, such as advising FRSs that an impending flood may require evacuations rather than simply alerting FRS to the possibility of a flood.

One FRS with a need to develop a flood response plan for a frequently flooded urban area was unable to ascertain from the Environment Agency any reliable local indicators of the need for action (moving assets to active standby, initial deployment, intervention, etc) and had developed its own flood risk triggers. To do this it obtained raw flood data from the Environment Agency for the area over the preceding 15 years. This was then plotted against river gauge boards so as to establish what each gauged depth meant in terms of the likelihood and impact of flooding. The FRS found this modelling very difficult.

This approach was being further developed to try to incorporate lessons from events such as Boscastle and Carlisle and techniques developed in the United States by FEMA and the North Carolina Storm Centre. The outputs supported a number of risk control activities including contingency planning, operational risk assessments and dynamic risk assessments.

Seasonality was taken into account so as to ensure that, for instance, planning reflects the change in risk arising from temporarily increased populations, campers, etc, during the holiday periods.

Two outstanding issues were noted by the FRS;

- Firstly, is 15 years a sufficient return period for flood risk?
- Secondly, is there a process for ensuring that future changes in the flood plain are reported, understood and used to remodel the triggers?

The Met Office publishes severe weather warning on its website.

At a dynamic level, it was reported that the Met Office and Environment Agency alerting systems were insufficient as:

- The Met Office does not directly alert the FRS, instead relying on FRS visiting their website
- The Environment Agency will only fax the FRS, with it incumbent on the FRS to seek further information from the Agency.

3.4.3 Wider impacts

It was stated, by responding FRSs, that:

- FRS plans focus on FRS operational needs and fire fighter health and safety, namely tactical issues, and
- Further attention could be awarded to wider environmental and societal risks.

This has led onto the idea of higher-level plans (for high risks) that cover a wider spectrum of impacts on the grounds that FRSs should consider the full range of impacts when responding to major incidents. The researchers' opinion was that plans need to address the full range of impacts in an integrated way, given that operational decisions may affect all of the impacts.

Lancashire FRS was developing a template (to be made available nationally) covering the environmental aspects of fire fighting and rescue activities. The template covered the emergency and non-emergency phases of an incident where FRS intervention can reduce the impact that spillages, drain blocking and firewater run-off may have on the environment and public health. It identifies sources of pollution on site, pathways for run-off and receptor sensitivity as well as key environmental protection actions (as agreed with the Environment Agency). In this way it provides a form of site-specific risk assessment, especially as the receptor sensitivity is graded as is the risk posed by on site pollutants.

The template will not incorporate any risk assessment tools to identify industrial sites – users will employ their existing operational methods for that purpose, such as 7iiD inspections. However, the Environment Agency will share its information with FRSs on environmentally sensitive areas, risk sites (including sites regulated under the Pollution Prevention and Control Regulations 2000) and drainage information or site plans. The Environment Agency can also provide GIS data on groundwater vulnerability, water abstraction points and flood zones. In addition, FRSs can notify Environment Agency Regional Communications Centres for the sake of establishing if an incident has the potential to pollute the environment and to draw on Environment Agency staff expertise in incident assessment and response. Thus, there is a wide range of information available to FRSs to identify in advance industrial sites that pose a risk in the event of fire fighting.

Chapter 4

Gap analysis

4.1 Introduction

This section of the report summarises the 'gaps' in the array of risk analysis tools, techniques and data available for LRFs and IRMPs. The gaps are presented separately for LRFs and IRMPs. We then proceed to discuss some options on how best to fill 'gaps' in the tools and data in section 5.

As elaborated below, there appeared to be a number of areas for further development, including:

- Development of LRF risk assessment competence and capabilities
- Enabling further assessment of localised events by LRFs
- Disaggregating LRFs risk assessments geographically
- Assessing knock on effects of risks
- Overcoming LRF obstacles to data sharing
- Recognising differences between urban and rural type events
- Developing a proportionate LRF approach to considering knock on effects
- Including additional factors and considerations into LRF risk prioritisation
- IRMPs could benefit from further development, consolidation and sharing of tools and data in respect of dwelling and community risk assessment (in support of prevention), workload, RTCs, wildfire prevention and major incidents
- The process of assessing resource resilience within IRMPs, including the extent to which regional and national events are included.

FRSs currently see only limited value in drawing on CRRs within their IRMP work. CRRs, in the opinion of FRSs consulted here need to be further developed to include more localised events to be of value to IRMPs.

The researchers' opinion was that the LRAG guide focused on national and regional scale events and provided likelihoods and scenarios of commensurate magnitude. The theme in LRF feedback was that further support was needed and value was to be gained in assessing more localised 'lesser' scale events and disaggregating risk assessments. This indicated a gap in respect of the guidance and tools available to LRFs to assess localised events and to disaggregate risks geographically within areas covered by a LRF.

4.2 Gaps in LRF civil contingencies risk assessment

The gaps identified through consultation with LRFs can be summarised under a number of headings, namely:

- General issues regarding the conduct of risk assessment by LRFs, such as competence
- Gaps in tools and data for specific risk categories
- Localised risk analysis (local events and disaggregation)
- Data sharing (commercially sensitive and security issues)
- Assessment of knock-on effects
- Concerns about risk rating and prioritisation.

General issues raised by LRFs

Whilst LRFs regarded the LRF risk assessment process to be a valuable and useful process, and regarded the LRAG guidance to be equally useful and authoritative, they cited a need for:

1. Risk assessment training, especially to Category 1 responders
2. Competence criteria for RAWGs (group and lead assessors)
3. Clearer guidance, such as regarding the application of LRAG
4. A better understanding of the models and data used by Category 2 responders;
5. More support on how to 'drill down' risks to local areas within LRFs
6. Greater support on risk assessment of localised events
7. A better understanding of the use and application of historical incident data
8. More consistency in the CRR reporting templates
9. An LRF forum to share good practice.

There was mixed opinion about the value of GIS by the LRFs. Whilst some LRFs indicated that a simple GIS would provide added value, others suggested that a GIS would be overcomplicated.

The provision of further training[16] in risk assessment and explanation of the risk analysis methods used by Category 2 responders reflected the LRFs' RAWG concerns (especially Category 1 responders) about their ability to understand and scrutinise the risk analyses provided by Category 2 responders. Similarly the request for clearer guidance on LRAG and how it was derived reflected a need by LRFs to understand the basis of the LRAG values so that they may better apply and, where appropriate, challenge or amend them.

[16] Some training on LRAG and LRF risk assessment is already provided to LRFs by the Emergency Planning College.

Points 5, 6 and 7 regarding 'drilling down' to local areas, use of historical data and support on assessment of localised events shared a common theme, namely of enabling LRFs to include localised events in their assessments (in addition to regional and national scale events) and to complete assessment for sub-areas of the LRF. A common theme running through the feed back from many LRFs was that the current CRR and the LRAG focuses on larger scale events and that they would benefit from further assessment of more localised events, especially as they are more likely.

Points 8 and 9 reflected the suggestion that LRFs to some extent operate independently of one another. This contributed to the development and use of different CRR reporting practices as well as differences in tools for recording assessments. At the same time, LRFs consulted in this study indicated that they have not necessarily had the opportunity to share working practices with other LRFs, which therefore led to the suggestion of some type of forum for LRFs to meet and share good practices.

Data sharing

The identification and sharing of data was reported to be limited by:

- Security concerns
- Commercial sensitivity
- Concern about public reaction to published results
- Lack of knowledge of sources of data and how to acquire data from other organisations.

Some options that have been cited by LRFs were:

- A 'yellow pages' of data sources – covering department, name of contact and type of data that is available
- With respect to security sensitive information seek security clearance for a wider range of RAWG members
- Limiting public reporting of risks to the risk rating rather than the likelihood, in order to reduce concerns about public sensitivity. It has been suggested that this may facilitate greater provision of risk analyses by Category 2 private sector organisations
- Provision of advice on how to avoid reliance on commercially sensitive sources of data
- A top down approach to data sharing led by lead agencies.

The latter suggestion arose from the observation that it can be difficult to solicit the support of local offices in providing data and information. Therefore, a central approach to either supplying information to LRFs or at least a clear lead from central/HQs to regional offices was recommended by LRF representatives consulted in this study.

It was also apparent that problems with sharing of data have in some cases been resolved by the use of inter departmental data sharing protocols and, in some cases, secure data exchanges.

Risk category specific gaps and issues

In addition to the general concern about assessment of localised events, the review of risk assessment for each risk category indicated some specific gaps, including:

- Omission of caravans and dams/ reservoir failure from Environment Agency flood risk models
- Identification and assessment of sub-COMAH sites
- Animal health risk assessment data, such as poultry farms and footpath data
- Local shipping accident risk assessment
- Airport specific and flight path risk assessment
- Industrial technical failures
- Storms and gales (less severe events)
- Threats (mass protest and terrorism).

The researchers were aware of some sources of data and analyses that could address some of these 'gaps'. These are detailed in sections 5 and 6.

Knock on effects and consequence modelling

The extent to which the 'knock-on' effects of events were assessed varied. LRFs were also mixed in their opinion on the benefits and practicality of exploring the wider effects of events. The researchers' interpretation of the feedback was that if the aim was to 'simply' produce a CRR then there was less value in exploring the knock on effects of events. However, if the aim was to develop effective contingency plans then there was greater value in exploring the knock on effects of events, for example foreseeing the impact on major roads of COMAH site incidents.

A further consideration was indicated by the feedback from some LRFs and FRSs about the balance to be struck between generic and specific contingency plans. Some respondents indicated that generic contingency plans were more effective for emergency planning and response, in some cases, where different risk categories have similar outcomes (or have a similar response) and where the risk posed by individual risk categories is relatively low. This led onto the question of whether there were benefits in exploring the knock on effects of specific risks if a generic contingency plan was being developed.

One option suggested by the researchers was to provide additional guidance on this element of LRF activity, possibly covering options such as:

- Advocating more detailed consequence modelling for those risks that have higher risk ratings – to support the contingency planning process rather than the CRR
- Grouping risks together where they share common effects and similar responses – and then exploring their wider knock-on effects in a generic manner.

Risk rating and prioritisation

The feedback from LRFs regarding whether there were gaps in the risk rating and prioritisation process was mixed. Some LRFs applied the current risk rating process to prioritise risks and indicated that there was value in LRFs adopting a consistent approach to risk ratings.

Some LRFs considered it necessary to add additional factors into the prioritisation process, which may be taken as a sign of a gap in the process. In particular, it can be asked whether the following factors should be considered in the prioritisation of risks:

- Public concern and expectations
- Extent to which a risk is already covered by established contingency plans.

In addition, it has been queried whether risks should be grouped into 'similar' types (with risk ratings summed for each group of risks) before they are prioritised.

These points indicated to the researchers that there was some value in further exploring the application of risk rating and prioritisation aspects of LRF risk assessment, and providing further guidance and/ or risk rating tools.

4.3 Gaps in IRMP risk analysis

Risk analysis tools

In producing this list of gaps we assumed that the development of a tool by a single FRS was, in some cases, indicative of a 'gap'. With this premise, the feedback from FRSs indicated the following gaps:

- Workload modelling, including workload involved in prevention and workload by time of day to support resource planning for both prevention and response to incidents
- Prediction of future dwelling fire risk and other community safety issues within the remit of the FRS (eg car fires), and finer geographic and household targeting of community fire safety – to better support prevention work
- RTCs – better data and predictive assessment to support prevention work

- Wildfire – better data and predictive assessment to support prevention work
- Major incident risk assessment – to support response planning.

The feedback on workload modelling covers a number of points. First, that modelling workload in respect of responding to incidents can provide a valuable input to decisions on resourcing, such as how many appliances were needed to achieve a certain response time and whether some appliances can be either stood down or used for prevention work (due to lesser workloads). Secondly, with the increase in community safety work there was an increasing prevention workload that it would be useful to model.

Whilst many FRSs have developed tools and identified data to assess dwelling and other community risks, these are fragmented and inconsistent between FRSs. This raises the question of whether one or another tool should be further developed and offered as a standard to all FRSs, and specifically whether these functions should be implemented within FSEC.

In the case of RTCs it was recognised that FRS RTC data was of variable quality and only represents a fraction of all RTCs. If the FRSs are to engage effectively in RTC prevention work, then further data and assessment is needed covering all incidents, their causes and association with other social and demographic factors. This work was at an early stage within FRSs.

With climate change, the risk posed by wildfire was thought to be increasing and with it a potential increase in rural demand for fire cover. Therefore, there was a perceived need to develop better data and predictive techniques to support wildfire fire prevention work, rather than only looking at wildfire fire response resource needs.

It was recognised by FRSs that examination of local FRS experience may not provide a valid basis for assessing low frequency incidents. Some FRSs indicated that the provision of readily available data or tools to enable further assessment of major incidents has some value, especially if FRS are to apply a consistent approach to assessing and measuring major incident risks. The high level nature of CRR was thought to limit the value from drawing on the work of LRFs. As IRMPs were more 'granular' and included a greater level of geographic assessment, a county or multi-county risk assessment was of limited value to IRMPs. Therefore, it appeared to the researchers that CRRs would need to be further developed, such as to include more localised events and a greater geographic element, for them to provide a more useful input to IRMPs. On the other hand, ongoing development of the major incident module in FSEC and its supporting data should help address this aspect of IRMPs' risk analysis.

Resilience and reserves

The extent to which there were gaps in the risk assessment aspect of resource resilience and reserves amongst FRSs was considered to be uncertain by the researchers. On the one hand, FRSs have examined resource needs in respect of the New Dimensions programme and in respect of resource attrition. Some FRSs have explicitly applied a policy of retaining sufficient resources to attend simultaneous major incidents of defined sizes. All FRSs consulted had generic business continuity plans for the eventuality that resources were reduced due to industrial action, flu pandemic or other unspecified reasons.

There was indication that the assessment of 'resilience' and reserve resources may warrant some further attention. Whilst many FRSs assessed the resource implications of major incidents, the consistency in this and the extent to which regional and national events were considered in IRMPs was unclear. In addition, the size and number of simultaneous events assumed for assessing resource resilience appeared to be FRS specific and focused on actual historical experience. Therefore, there may be some value in further developing a common approach to assessing resource resilience and, for example, applying common 'worst case' scenarios. In addition, it was unclear whether IRMPs' contingency planning directly links into and addresses the regional and national scenarios covered by CRRs, although FRSs have addressed similar scenarios via the New Dimensions work.

Regional Fire control

FRSs also queried the implications of Regional Fire Control for IRMPs and contingency planning. That is, if resources are mobilised on a regional basis, does this mean that some aspects of IRMPs should be developed at a regional level?

Chapter 5

Filling the gaps: data, tools and techniques

5.1 Introduction

This section of the report provides a summary of what data, tools and techniques are available for each of the risk categories addressed by LRFs and FRSs, focusing on the gaps noted in section 4.

Appendix A provides a summary of a range of generic and specific risk analysis tools and techniques. We summarise here those areas where there appeared to be tools and where we considered significant gaps to exist, and identify those tools that were identified that may help fill gaps noted in section 4.

5.2 Local Resilience Forum risk assessment

5.2.1 Introduction

The gap analysis identified three generic areas that could benefit from further development, namely:

- Enabling LRFs to assess 'smaller' scale events and to disaggregate risk assessments geographically
- Assessing the knock on effects of incidents beyond the risk category under review
- Factoring in public risk perceptions into decision-making.

This section of the report reviews the extent to which data, tools and techniques were available from other sources (outside LRFs) to address these points.

In addition, the availability of data, tools and techniques for each of the areas of risk assessed by LRFs is reviewed here.

5.2.2 Availability of risk assessment data, tools and techniques

Appendix A provides a summary of a range of data sources, tools and techniques which have some relevance to risk assessment performed either by originating lead agencies or individual LRFs. The research identified both strengths and weaknesses in the availability and suitability of these in the application of civil contingency risk assessments. We assessed the availability of tools and techniques for each risk category, as per Table 4, according to:

- Range: This indicates the availability of a range of generic and specific techniques of particular relevance to that risk category (Poor; Adequate; Good; Excellent)
- Robustness: This indicates the degree to which techniques available are adequate in terms of their timeliness, reliability (including the status of the originating agency) and quality of data (Poor; Adequate; Good)
- Local risk assessment: Are there data, tools or techniques to support assessment of localised events and disaggregated risk assessment (Poor; Adequate; Good)
- Gap: Indicates the degree to which the availability of tools could impact on the completion of suitable and sufficient risk assessments for that risk category (Minimal; Partial; Significant).

On the whole, in some risk categories a wide range of robust tools exist but were not developed to support LRF risk assessment and had limited applicability to local risk assessment.

Table 4: **Availability of risk analysis tools per risk category**

Risk category	**Range**	**Robustness**	**Local risk assessment**	**Gap**
Flooding (coastal and river)	Excellent	Good	Good	Minimal
Flooding (flash floods/dam failure)	Adequate	Good	Poor	Significant
Industrial fire and explosion	Good	Good	Good	Minimal
Industrial Pollution	Good	Adequate	Poor	Partial
Human health	Good	Good	N/A	Minimal
Transport (Rail)	Good	Good	Poor	Partial
Transport (Road)	Good	Adequate	Poor	Partial
Fuel Shortage	Poor	Adequate	N/A	Significant
Building Collapse	Poor	Adequate	Poor	Significant
Aviation incidents	Adequate	Good	Adequate	Partial
Industrial technical failures	Poor	Poor	Poor	Significant
Shipping	Adequate	Good	Poor	Significant
Land movements	Poor	Poor	Poor	Significant
Public protest	Poor	Poor	Poor	Significant
Mass gatherings	Poor	Poor	Poor	Significant
Animal Health	Good	Good	N/A	Minimal
Terrorist	Poor	Adequate	Poor	Significant
Severe weather incidents	Good	Good	Poor	Minimal

Gaps

It should be noted that:

- The search did not identify any specific risk analysis tools, data or techniques for terrorist, public protest, mass gatherings, industrial action, infrastructure failure, land movement or building collapse
- In the case of Human and Animal health, the review indicates that the Defra risk assessment and surveillance system is appropriate to utilise.

In the case of the former risk categories, the researchers concluded that the nature of these risks lead to difficulties in producing 'scientific' analysis tools to predict events. In the case of terrorist, mass protest and industrial action, these risks are 'man-made' and hence subject to change in accordance with social and political developments. A judgement based approach based on intelligence appeared to match the nature of these risks. In the case of land movement and building collapse the low frequency of events renders probabilistic assessment difficult, beyond the use of national historical data to give approximate likelihoods.

One option for terrorist risk suggested by the researchers was to produce an areas version of the National New Dimensions Project Method, where the assessor considers the number of buildings of each category in an area and assigns a likelihood value.

In the case of human and animal health, Defra's risk assessment uses a combination of international as well as national surveillance systems, and scientific estimates of consequences. The nature and likelihood of incidents changes over time in accordance with changes in contagions. These are 'real time' surveillance systems for which locally applicable risk analysis may not be suitable.

Data and tools identified to assist with local risk assessment

An extensive range of risk assessment techniques were identified. These were mostly generic quantitative and qualitative techniques rather than techniques developed specifically to support LRF risk assessment. The majority of these techniques were very specialist and did not appear to offer benefit to either LRF CRRs or FRS IRMPs. These are described in Appendix A.

The data, tools and techniques that were identified by the researchers that may assist LRF (and FRSs) in assessing more localised events are summarised below.

- Rail Safety and Standards Board (RSSB) strategic risk model for train incidents.

The Rail Safety and Standards Board operate a strategic risk model[17] that provides measures of the frequency of train accidents involving multiple deaths for Great Britain overland trains. These estimates could be combined with estimates of the length of route kilometres (about 15,900 km) to produce incident rates per km, that are then applied to each area.

- Aircraft crash frequency.

The Health and Safety Executive has completed two studies that provide estimates of the rate of aircraft crashes:

- Criteria for the rapid assessment of aircraft crash rate onto major hazards installations according to their location fd[18]
- The calculation of aircraft crash risk in the UKf[19].

The latter report supersedes the 1987 study and provides incident rates per km^2 for general areas (ie not around airports), areas of high crash concentrations (Areas of Intense Aerial Activity and Military Training Areas) and airfield related crashes.

The crash rates can be translated into incident frequencies per airport and for other areas. This approach has already been implemented within FSEC[20] which provides a look up table of incident frequencies at UK airports.

Whilst these studies can be used to provide estimates of likelihood, an assessment of impact requires further specialist modelling.

The National Air Traffic System (NATS) provide risk contour maps for about 20 UK airports[21]. These show the area around an airport where the risk of death equals or exceeds 1 in 1 million per person (a measure of Individual risk). These maps could be use to identify whether residential areas are in the risk contour and hence whether a crash could involve large scale casualties amongst the public.

- Maritime incidents

Whilst the Maritime and Coastguard Agency have completed Formal Safety Assessments of some categories of shipping, these assessments cannot be directly or easily applied to the purpose of LRF assessment. However, they do provide incident rates per vessel that could be combined with data on vessel movements to provide estimates of the likelihood per port. This approach is currently being applied by Communities and Local Government in the further development of FSEC.

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17 http://www.rssb.co.uk/pdf/reports/Risk_Profile_Bulletin_-_Overview_of_Issue_5.pdf.

18 Criteria for the rapid assessment of aircraft crash rate onto major hazards installations according to their location. D.W. Phillips, SRD/HSE/R435, HMSO 1987.

19 http://www.hse.gov.uk/research/crr_pdf/1997/CRR97150.pdf.

20 The researchers are not aware of any other source of predicted aircraft crash frequencies at UK airports.

21 R&D Report 0007 A Methodology for Calculating Individual Risk due to Aircraft Accidents near Airports, National Air Traffic Services, 2000.

- Major vehicle incidents

The sources of data known to the researchers regarding major vehicle accidents are:

- The list of major accidents held by the Emergency Planning College, and
- RTC incident data held by FRSs
- STATS 19, which should report number of casualties per incident.

In each case these sources provide historical data. It should be noted that a review of incidents in any one area, such as the area within a LRF, may be statistically unreliable. Therefore, a predictive approach to risk assessment would require an incident rate per km of road to be produced and applied to each area. The latter approach is being developed within FSEC by Communities and Local Government.

- National Flood Risk Assessment (NaFRA) for flooding.

NAFRA[22] provides a spatially differentiated and quantified picture of flood risk throughout England and Wales. The likelihood of flooding has been calculated using predicted water levels and taking the location, type and condition of any flood defences into account, whether or not they are currently shown on the Flood Map. This is a raster output, ie risk is designated in squares throughout England and Wales. The three risk categories are:

(i) Low – 0.5 per cent (1 in 200) chance of flooding each year or less

(ii) Moderate – 1.3 per cent (1 in 75) chance or less but greater than 0.5 per cent (1 in 200) chance in any year

(iii) Significant – greater than 1.3 per cent (1 in 75) chance in any year.

NAFRA does take account of flood defences.

Whilst Nafra provides a likelihood assessment, the local Strategic Flood Risk Assessments (completed for local authorities) need to be consulted to identify the potential impact.

The researchers also understand that reservoir and dam owners are responsible for completing risk analysis of their assets. Whilst it has not been possible to identify publicly available examples, it should be possible to acquire these from the respective organsiations.

- FRS outdoor fire data for wildfires (geocoded version of such data held by FRS rather than FDR 3 records held by Communities and Local Government).

[22] http://www.halcrow.com/nafra/index.html

We were unable to identify an established method in the UK for strategic risk assessment of outdoor fires. Data is available from FRS records in the form of FDR1 and FDR 3 reports (geocoded versions held by FRSs).

However, tools have been developed overseas that provide ignition risk and assessments of values at risk (value of human life, community and commercial assets), in particular the Canadian Wildfire Threat Rating System. The review of WTRS indicated that it provides the capability of assessing likelihood, outcome and impact of fire suppression on outdoor fires. Therefore, this tool could be considered for application in the UK.

The Met Office operates the Fire Severity Index. This currently provides 5 day forecasts. Consideration could be given to exploring if the tool could be adapted to provide estimates for longer time periods.

- The Met Office's Severe Weather Impacts Model (SWIM)

SWIM[23] provides estimates of the likelihood of severe weather (such as gusts of 120 km hr) per postcode (as well as for larger areas) per year and provides estimates of the scale and type of damage. The GIS tool allows consideration of small and large areas, and hence could be used to support local risk assessment.

- Environment Agency: Operator and Pollution Risk Appraisal (OPRA) for industrial pollution.

The Environment Agency hold lists of sites on their Pollution Hazards database that is built using the Operator and Pollution Risk Appraisal for Integrated Pollution Control. Information is held at Environment Agency local office level. OPRA includes assessments of the environmental risk of specific processes and the operator's performance in managing these risks. Each site has a Pollution Hazard Appraisal from A to E where E is highest risk. Operator performance is rated from A to E with E for worst operator.

OPRA should enable identification of industrial sites that pose a pollution risk. However, the appraisal provides qualitative ratings rather than likelihoods of incidents, which limits its application to LRF risk assessment.

- Riskat Tool (Risk contour maps for COMAH sites), Quick FN for societal risk and MARS.

The Health and Safety Executive have produced risk contour maps and societal risk analysis for all COMAH sites, of which they hold location and content information. The former are maps that show the area around sites that are at risk from site incidents (using measures of individual risk). The societal risk analyses give the frequency of incidents with various levels of casualty. The risk contour maps are unrestricted and provided to local authorities. The societal risk analyses are restricted.

[23] http://www.metoffice.gov.uk/research/nwp/publications/nwp_gazette/sep02/impact_sw.html

These analyses provide results that can, baring security restrictions, be used to assess local risks.

The Major Accident Reporting System (MARS) was introduced across European Union members as part of the Seveso II Directive. Competent Authorities in each member state report major accidents that meet certain criteria. The Major Accidents Hazards Bureau provides a searchable database[24].

- Ordnance Survey Mastermap[25] and Barthomolew digital data[26].

These commercially available tools provide GIS based mapping and enable identification of local features, such as airports, road and rail networks.

- National Population database[27].

A method for producing a national population database, drawing on multiple data sets and including populations located within residential, workplace, retail, transport and leisure land uses and within communal establishments involving particularly sensitive populations (such as schools and hospitals). It therefore provides a robust population data set for use in assessing people at risk.

Other data sources that could assist with LRF risk assessments are noted below.

- Health and Safety Executive lists of COMAH sites
- A list of accidents covering UK and overseas held by the Emergency Planning College
- DTi lists of designated filling stations
- Civil Aviation Authority maps of Lower ATS flight paths
- Environment Agency flood maps
- DTi list of oil refineries and power stations
- Environment Agency list of reservoirs (restricted)
- Defra lists of registered poultry farms and other farms
- Environment Agency data on pollution incidents.[28]

The Environment Agency publicly provides data on the location (by Government Region) of incidents scaled from category 1 (worst) to 4.

[24] http://mahbsrv.jrc.it/mars/Default.html
[25] http://www.ordnancesurvey.co.uk/oswebsite/products/osmastermap/
[26] http://www.bartholomewmaps.com/
[27] http://www.hse.gov.uk/research/rrhtm/RR297.htm
[28] http://www.environment-agency.gov.uk/commondata/103601/poll_incidents_2006_1826504.xls

5.2.3 Assessing knock on effects

Our search indicated that:

- There was a wide range of generic risk assessment tools and techniques available for assessing the consequences of an event, such as event trees, most of which have been developed to assess complex industrial accidents
- There were many examples of risk assessment techniques that assess specific types of consequences of events, such as the chemical hazards posed by types of chemicals.

However no specific tool was identified that models the knock on effects of (say) a flood on critical infrastructure, or an industrial fire on infrastructure.

The researchers suggested that there are at least two ways of assisting LRFs to assess knock on effects.

First, generic techniques such as event tree analysis could be tailored to the needs of LRFs. For example, a set of standard event trees could be developed that include the full range of possible consequences that could occur, such as flooding impacting utilities, causing roads to be closed as well as flooding houses. The LRFs could then systematically check whether a flood in the area under consideration could have one or more of these consequences.

Secondly, GIS could be used to support the assessment of local impacts. At the simplest level, a GIS that shows local features, such as transport networks and industrial sites, can be scrutinised by risk assessors to identify features that may be affected by an incident, ie what features are within the area that could be affected. GIS packages such as Mastermap or Bartholomew's are commercially available and provide a high level of information on local features, and are candidates for use by LRFs. The bespoke GIS package developed by Communities and Local Government for use by Regional Resilience Teams (RRT GIS) is an example of a more advanced package that allows the area impacted by an incident to be displayed and for features, such as roads to be identified. The RRT GIS also contains pre-loaded data on, for example, COMAH sites and flood maps that support assessment of interactions between risks. Whilst the RRT GIS was not considered suitable for use by LRFs, due to it being a restricted standalone facility, it was an example of the type of bespoke GIS that could be developed to help LRFs assess knock on affects.

5.2.4 Tools for facilitating localised LRF risk assessment

There are at least two types of risk assessment packages that may support more localised assessments by LRFs, including:

- Risk assessment databases, such as that used by Cheshire LRF
- Geographic information systems (GIS).

Cheshire LRF CRR database

The Cheshire LRF access database was designed to support the current scope of resilience risk assessment rather than a more disaggregated form of risk assessment. It uses Access which is a commercially available relational database. The LRF developed a set of bespoke functions and database structures. The database records the information and judgements applied to produce the CRR and provides an auditable record of work. The researchers considered this to be a useful way of recording assessments but would not support assessment of knock on affects or local disaggregation of risks.

GIS packages

There was a wide range of GIS available, as summarised in Table 5. However, no GIS has been developed to meet the specific needs of LRFs, nor did we identify a GIS used by the equivalent of LRFs overseas.

The Regional Resilience Team (RRT) GIS (which is based on ArcView) does contain a wide range of data that would be of direct value to LRFs. The RRTGIS though is security restricted, works on isolated /secure laptops is and not distributed beyond RRTs. Notwithstanding the security restrictions, the RRTGIS could be an example of the type of GIS LRFs could use as (1) it is pre-loaded by Communities and Local Government with pertinent information and (2) is supported by the Communities and Local Government resilience team.

Communities and Local Government has been using the ArcGIS application to map and analyse current data. The tool is used primarily to predict responses, plan for future responses and to provide additional 'aftermath' information from incidents. The application also aids in setting targets and key performance indicators for FRS and Regional Resilience Forums, as well as helping capability managers assess and understand their individual FRS needs and requirements.

The ArcGIS application already has a vast array of pre-existing data taken from government agencies and selected non-governmental agencies, such as Ordnance Survey and utility companies. The data is updated on a regular basis, ensuring that any analysis is as up-to-date as possible, and there are already processes and methods in place for providing this information to Communities and Local Government in order for it to be imported into the application.

Communities and Local Goverment are also in the process of enhancing the major incident module within FSEC (also a GIS). This may offer the possibility of information and analyses being fed up from FSEC to LRFs. As the FSEC major incident module is being developed with compatible criteria to those used by LRAG the outputs from FSEC should be translatable to CRRs. However, FSEC addresses a sub-set of the risk categories covered by LRFs. Therefore, it can only provide partial support for LRFs.

An option would be to implement a simple bespoke GIS facility for LRFs on the proposed resilience extranet, and an electronic version of LRAG, but extending LRAG to support assessment at a smaller geographic level and covering 'local' scale events.

Table 5 provides a summary of some commercially available GIS packages. There are a number of desktop based GIS applications, and a number of server based GIS technologies available. The server based packages help manage and share information across networks and between departments and agencies that may not be within the same location. It is clear that there are a number of database options, client-server connections and security protocols that can be considered when planning to implement a new GIS system across a large network or to share amongst numerous users, such as distinguishing between SQL databases and the Microsoft .NET Framework. ArcGIS has already been used by Communities and Local Government as a basis for their RRT GIS tool and in the researchers opinion, from reviewing the packages, is an appropriate package to adapt.

Table 6 provides some examples of GIS packages that have been tailored to the needs of emergency services. They exemplify how generic packages can be adapted to the specific needs of emergency services, in the same way that Communities and Local Government adapted ArcGIS for the needs of RRTs.

Table 5: **Summary of GIS systems**		
GIS Application	**Description**	**Additional Modules**
Cadcorp SIS	Corporate desktop and web based application developed with CadcorpSIS and using GeognoSIS. NET technologies. Spatial Information System & Web Based Software. Software has the ability to inter-operate with 150 native GIS, CAD, graphics and database formats without any additional translation or change of data structure. Software includes Imapping – allowing the filtering of data, creating user drawn graphics, printing (using specific and customized reporting templates) with detailed searches based on co-ordinates or LFB Stations Reporting based over 3 year period. Shows incident locations and additional attributive data. Data can be thematically mapped and split into different geographical categories, for easy analysis and visual distinction.	None

Table 5: **Summary of GIS systems** (cont.)

GIS Application	Description	Additional Modules
ArcGIS	Two applications: ArcGIS Desktop and ArcGIS Server. ***ArcGIS Desktop:*** • Desktop-based application used to discover trends, patterns, relationships in data; • Allows users to import new data structures, manage that data, perform a more advanced analysis; • Allows for structured modelling and an advanced mapping service. ***ArcGIS Server:*** • An integrated, client server-based GIS package to be deployed across any sized network; • Users are provided with web browser based access, allowing the application to be deployed across a secure intranet or online; • Obeys GIS standards and all web (W3C) standards; • Complements ArcGIS Desktop, allowing analysts to author, customise maps and perform geoprocessing tasks. Both packages come with an analysis framework built in allowing users to build process models and scripts, allowing for customisation.	None
Northgate StruMap	Spatial Data Analysis Software. Adheres to the latest OpenGIS standards, enabling data to be exchanged across different networks and across platforms. Numerous data presentation methods- Maps, reports, charts and legends. Enhanced 'Positional Accuracy Improvements (PAI) affecting all Ordnance Survey Maps.	StruMap Mobile – for handheld Devices StruMap Explorer StruMap DataNet StruMap GE3 Strumap Select StruMap Lite

Table 5: **Summary of GIS systems** (cont.)

GIS Application	Description	Additional Modules
MapInfo Professional	Perform analysis between data and geography, with a visual presentation of results. Produces maps. Ability to manage geographically based assets, such as stores, property and people. Ability to plan logistical operations.	None
MapInfo MapXtreme	A windows-only based technology. Enables any user with granted access to view mapping applications over their web browser. Information is stored securely in an online database, where users can access the data and perform filters and online analysis. Allowing multiple users to perform different tasks simultaneously.	None
MapInfo SpatialWare	Professional Data Management Software allowing organisations and agencies to store, manage and manipulate location based data, spatial data all within a Relational Database Management System (RDBMS). Allows for large-scale deployment of powerful GIS mapping. Uses SQL and obeys SQL standards – ISO SQL-1999 and ISO SQL/MM.	None

Table 6: **Examples of bespoke GIS packages**		
GIS Application	**Description**	**Additional Modules**
CADDIE	Crime and Disorder Data Information Exchange. Allows the sharing of crime and disorder data between agencies that work together as CDRPs. Web based application holding data from Police, County Councils, Local/District Councils, Fire and Rescue Service, Probation, Prison Services and the NHS. Maps Crime and Disorder, plotting incidents. Creates Incident Tables that can be viewed by members of the public to raise and share awareness of crime in their area. Additionally, contains a secure access area for outside professionals working within the partnership and within other contributing organisations.	None
SCRIBE	Sharing Community Related Information in Bedfordshire Electronically. Brings together data from the different agencies around Bedfordshire, such as Council, Police and Fire and Rescue Services. Secure, online data tool accessible through local web browser, requiring secure, administrative access. The application is a GIS co-ordinate based system, holding a CADCore system devised by GeognoSIS.NET. Monthly updated information.	None

Table 6: **Examples of bespoke GIS packages** (cont.)

GIS Application	Description	Additional Modules
Delft-FEWS	State of the art flood forecasting and warning system – a collection of modules designed to aid in the creation of a robust flood forecasting system. Application contains an open shell, a comprehensive library of data handling utilities, forecasting models and can be customised to meet the needs of specific agencies. Application can be self-contained (desktop based), but can also be deployed across a client-server, to multiple users. Application can support both Spatial data and Radar based data, as well as meteorological and hydrological data. Allows for time series displays, for added visual prediction and enabling users to explore data further. HTML reports can be generated for easy sharing across organisations and agencies.	Correlation Module Look-up Table Module Data Validation Module Training courses – showing users how to use the software but also how to independently add new models and customisation of the application.
ETEAM (NC4)	Emergency Management System, enabling users to respond and recover faster. Allows cross-organisational collaboration and management from a single, common co-ordinational point. Software is visual, based on real time data, historical data and allows for GIS mapping of this data. Contains a powerful information management system and contains numerous high-scale reporting facilities that can scale-up or scale-down information as required. System Features include: • No specific client set-up, software is all browser based; • Fast Scalability (multiple users can be easily added in event of a major incident); • Support for Incident Command Systems (ICS).	None

Table 6: **Examples of bespoke GIS packages** (cont.)

GIS Application	Description	Additional Modules
iRAT	Incident Risk Analysis Toolkit (specific to London FRS). Predictive modelling tool combining information from historical incidents with environmental and demographic data. The main aim of iRAT is to target preventative actions and activities. iRAT uses a number of analysis methods and modelling techniques to forecast incidents within set areas. Data is taken from many different sources – Census, Mosaic, OS and has the ability to model against many different incident types. Built-in ability to perform a colour coded geographical models for easy, visual distinction.	None

5.2.5 Factoring in public risk perceptions

Current LRF practice

At least one LRF has considered public perception. This has been in the presentation of the final risk priority calculation that factors in public perception. The approach to taking into account risk perception and the other factors was as a result of a local incident where the actual threat level did not correspond to the public's perception of the level of risk. It was felt necessary that in order to prioritise the risk assessments a screening tool should be used. This was based on local and historic knowledge and professional judgment of the Cat 1 and Cat 2 responders who participated in the risk assessment. An example of this is presented below,[29] where they take the average of 5 ratings.

Table 7: **Cleveland LRF risk priority template**

Risk priority Calculation				
Explanation	**Consequences**	**Review timescale**	**Cost (funds/resources)**	**Public Perception**
3	3	2	2	3
Overall risk priority score:		(2.6) = 3		

The approach follows a standard 1-5 rating system and uses simple descriptors to rate public perception. It would, for example, give a high rating (5) where the control over the event was outside that which the local Category 1 responders could control and where the perceived media/public impact could consider the threat as high.[30] The approach is thought by the researchers to be easily transferable, but is limited in the sophistication of how it gauges public perception.

The researchers' opinion was that there are valid reasons for including a rating of public risk perceptions into decisions on emergency planning, including:

- Retention of public confidence (noting that loss of confidence can impair the functioning of public services) – by ensuring plans are in place for risks that pose a concern to the public
- Recognising that the public reaction to events can influence their outcomes (with the result that the consequence of incidents is magnified), and that adverse public reactions may be avoided by ensuring effective emergency plans are in place to reassure the public and hence avoid an adverse reaction.

[29] Source: Cleveland Emergency Planning Community Risk Register
[30] Eg Radioactive sources

However, in the researchers' opinion, the rating of public risk perception should not be used to alter the risk rating, which should be based on the objective assessment of risk. Rather, a rating of public perception may be used to review the prioritisation of risks and the adequacy of emergency plans.

Availability of tools and guidance to assess public risk perceptions

There are a variety of models and techniques that can be employed to take account of risk perceptions in decision-making. The following summarises some of the approaches that have been used to support decision-making in this area.

Heuristics

Heuristics, or "rules of thumb", are internal frames of reference used by individuals and groups to inform judgment when no firm data are available.[31] Bias plays an important role in the estimates or assessments that arise out of this approach. In particular, motivational bias (where the assessor seeks to improve the apparent position of the situation by modifying the estimate of risk probability); and cognitive bias (arising from unconscious attempts to rationalize lack of certain knowledge) can bias risk perceptions.[32] Hillson and Hullet state that, "…the assessment of risk probability is a situation where uncertainty is evident, and individuals and groups need to become aware of the inherent heuristics which are operating when they assess probability, so that corrective action can be taken."

These principles have evolved into a variety of approaches and practice in looking at risk perceptions. Of interest are:

- Risk Perception Strategic Decision Making: General Insights, a New Framework, and Specific Application to Electricity Generation Using Nuclear Energy[33]
  - The report provides insights into risk perception and decision-making across a range of domain ranging from nuclear power technology safety, cognitive psychology, economics, science education, public policy, and neural science. It also presents a concise framework and list of strategies to aid in decision-making.
- United Kingdom Offshore Operators Association (UKOOA) "A Framework for Risk Related Decision Support"
  - UKOOA has produced guidelines for assisting with the risk related decision-making process and for recording and demonstrating the robustness of the decision. It describes a framework that is intended to help decision-makers assess the relative importance of codes and standards, good practice, engineering judgment, risk analysis, cost benefit analysis and company and societal values when making decisions.[34]

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31 Hillson D, & Hulett T, (2004) Assessing Risk Probability : Alternative Approaches refereeing to Tversky & Kahneman 1974; Kahneman et al 1986; Cooper & Chapman 1987, 94-98; Keeney & von Winterfeldt 1989; Keeney & von Winterfeldt 1991; Hillson 2003)

32 Hillson D, & Hulett T, (2004) Assessing Risk Probability: Alternative Approaches

33 Brewer J, Sandia National laboratories (2005).

34 http://www.hse.gov.uk/offshore/fireexp/riskeval.htm

These 'approaches' require a judgement to be made by risk assessors of public perceptions and to factors these into their decisions.

Reducing Risks and Protecting People (R2P2)

The most influential document that takes account of risk perception as part of a risk assessment decision process is the HSE's discussion document on risk management and decision-making[35]. The discussion reflects on how human judgment and values determine which factors should be defined in terms of risk and actually made subject to analysis. The discussion extends into the social amplification of risk and, in particular, how risk can be amplified or attenuated depending on how the reporting of the risk interacts with psychological, social, cultural, and institutional processes.[36]

R2P2 does not present a specific model for analysing risk perception. However, it does represent the recognised TOR (Tolerability of Risk) framework, which is a well-established approach. This is an important model as it explicitly takes account of individual risk and societal concerns in judging the acceptability of a given risk.[37] TOR is based on well understood and evaluated risk assessment principles that could, in the researchers' opinion, easily be transferable into a civil contingencies risk analysis context.

Model for Gauging Societal Concern

RSSB sponsored two studies aimed at developed tools to assess societal concern, which produced a complex and a simpler tool.

The first report[38] looked at a model that could take account of societal concern in safety decision-making process. It specifically took into account the "societal concern" as expressed in R2P2 (as described above). The model presented relies on focus group gathered data, which involves answering 20 questions using a rating of 0-10. The model consists of a number of elements including:

- Questions and anchors: each low-level model factor is associated with a question, designed to elicit a score between 0 and 10. Anchor points at each end and at intermediate points on the scale from 0-10 are provided for each question
- Scenarios: a series of stories setting a range of potential railway risks within a context, to which members of the public can relate.

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35 www.hse.gov.uk/risk/theory/r2p2.pdf

36 Sources various including; Douglas MS and Wildavsky A. Risk and Culture. University of California Press Berkeley 1982; Funtowicz SO and Ravetz JR 'Three types of Risk Assessment and the Emergence of Postnormal Science' in Social Theories of Risk Praeger Westport Connecticut 1992 251-274; Pidgeon NC Hood C Jones D et al Risk: Analysis, Perception and Management. The Royal Society London 1992; Wynne B 'Risk and Social Learning: Reification to Engagement' in Social Theories of Risk Praeger Westport Connecticut 1992 275-300; Kasperson RE Renn O Slovic P et al 'The social amplification of risk: A conceptual framework.' Risk Analysis 1988 8 (2) 177-187; Beach LR Image Theory: Decision Making in Personal and Organizational Contexts Wiley New York

37 Sources various. www.hse.gov.uk/nuclear/tolerability.pdf; www.defra.gov.uk/environment/water/rs/pdf/defra_rs_flood-etc-06.pdf

38 Risk Solutions: Development and Calibration of a Model for Gauging Societal Concern for the Railway Industry, Report for Rail Safety and Standards Board, undated.

The model has been shown to be suitable to gauge societal concern and provides a robust framework for any risk decision-making that wishes to take account of societal concern. The model is rail centric and so its wider application has not been considered. On the other hand, the model appears to be very resource intensive and complex, and so may have limitations if used as a routine tool to aid decision-making.

A second study for RSSB by Galson Sciences Ltd[39] produced a simpler rating tool. The report puts forward an approach for stakeholder engagement. It proposes a series of screening tools and response attributes for gauging the level and form of engagement that should be entered into, reflecting the degree of societal concern. The user applies an attribute scale to gauge stakeholder concern, which covers six attribute such as dread, unfamiliarity and distrust. The approach presented is flexible in that it can be as simple or complex as the user wishes it to be. For this reason, it could provide a useful framework against which civil contingency risk could factor in public perception.

Thus, there does appear to be tools available to rate public risk perceptions (or societal concerns) and a simple way of incorporating them into LRF decision making.

5.3 Fire & Rescue

Risk Assessment Tools and Techniques

The research identified both strengths and weaknesses in the availability and suitability of these in the application of IRMP and related risk assessments performed by FRSs. We assessed the availability of tools and techniques for each of the risks cited by responding FRSs.

It was concluded that:

- Whilst workload models are available, there are a number of competing models rather than a single commonly used model that enables consistency between FRSs. Therefore, there may be value in including a workload model into FSEC (Communities and Local Government indicated they are developing one) that is then made available to all FRSs
- There are wildfire techniques and data available (as discussed earlier in this report) which could be developed into a practical tool for use by UK FRSs
- Whilst some RTC data is available, its application to IRMPs requires further development

[39] Galson Sciences Ltd, Approach to stakeholder engagement, R. Kemp and T Greulich, Report for Rail Safety and Standards Board, October 2005.

- Whilst data is available regarding major incident risks, these have yet to be translated into a practical form for FRSs to use in IRMPs (although work is in progress on this in respect of FSEC), and the approach to modelling resource resilience could be further developed
- Current workload models may be able to be applied to modelling resource implications of regional and national scale events.

In the case of dwellings fire risk, there were minimal gaps in the tools. A number of FRSs have developed bespoke tools that enable modelling of the link between dwelling fires and other aspects of community safety. One or more of these could be further developed into a common tool for use by FRSs.

Wildfire

In the case of wildfire, FRSs can use FDR1 and FDR3 data to assess historical frequency and location of fires, including large fires. Overseas examples of effective use of historic data for wildfire risk analysis were identified in the review[40]. FDR 3 fire data would provide limited information on causes and so provide limited support on wildfire prevention. In addition, such data is obviously historical rather than predictive.

As previously noted the Canadian WTRS appears to offer the potential for a tool to assess likelihood, scale and impact of fire suppression on outdoor fires. The method combines historic data and models to assess likelihood and fire spread, taking into account detection time, time of arrival of suppression resources and time to suppress. This and the other referenced tools could be reviewed in detail to determine if they could be applied directly or after modification to the UK.

The latter approaches use historical data. One study that is of potential value in predicting future trends was completed by University of Manchester[41] and part funded by Defra. Some examples of the types of findings included:

- "Changes in climate variability and weather extremes generate most extra fire risk. Finally, a gradual rise in mean temperature was found to have only slight effect"
- "Climate change scenarios suggest that the maximum temperature in the Peak District is likely to increase by (between) 3°C to 5.5°C during the summer, and that the area is likely to receive 23-45 per cent less rainfall in summer by the 2080s (section 2.4). This will have significant consequences for wildfire risk"
- "Speed of response of the fire service will become more important in limiting the fire spread, since the burn area is likely to increase with more intensive fires, and will result in further destruction of the landscape".

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[40] Ashley Kirvan. Quantification of wildfire risk in south west Western Australia. The University of Western Australia. June 2005. http://www.sese.uwa.edu.au/__data/page/96394/Kirvan_2005.pdf
B.J. Shields and K.G. Tolhurst. A theoretical framework for wildfire risk assessment. http://nrfa.fire.org.nz/projects/wta/_docs/IWF_Paper218_WTA_Shields.pdf

[41] (Climate change and the visitor economy' Technical report 3: Moorland Wild Fires in the Peak District National Park *January 2006).*

They produced a probit, showing probability of fire on a spring bank holiday in Peak District related to average temperature. The current average temperature is 14.87°C. So a rise in temperature of 1°C (as suggested for the 2020's) would increase risk of fire from ~7 per cent to ~9 per cent whilst a rise of up to 2°C by 2050 would increase fire risk to 10 per cent.

Thus, this model may have the potential for providing long-term predictions of the frequency of outdoor fires that could be used by FRSs for strategic wildfire risk assessments that take account of climate change, in conjunction with historical outdoor fire data.

A final alternative was to explore whether the UK Met Offices Fire Severity Index could be amended to provide longer term outdoor fire risk assessments.

Chapter 6

Conclusions and recommendations

6.1 Overall

It was concluded that:

- There is significant scope to further develop the risk assessment tools and techniques used by LRFs for the sake of assessing more localised events, to model knock on effects, factor in public risk perceptions and to disaggregate risk assessments within their areas
- There are some aspects of IRMP risk assessment that could benefit from further development, such as wildfire, RTCs, workload modelling and major incidents.

The search for data, tools and techniques did identify a wide range that can be used by LRFs and FRSs. In addition, there are some emergent ideas and techniques for including public risk perceptions into decisions.

However:

- In most risk categories these are specialist techniques and data. Although they require specialist expertise to operate, LRFs and FRSs may benefit from the results produced by these techniques, but would either need expert assistance in sourcing and applying the results or would benefit from results being translated into locally applicable risk analysis metrics
- In a few of the LRAG risk categories there remain gaps in the range of data, tools and techniques available
- There are no 'off the shelf' tools available that would help LRFs assess more localised events or to disaggregate risk assessments geographically
- There are no 'off the shelf' packages for LRFs to assess knock on effects of risks, although many generic consequences modelling techniques do exist.

A series of recommendations were provided to address these conclusions.

6.2 Recommendations

6.2.1 Risk assessment data, tools and techniques

Whilst providing a database of tools may assist LRFs and FRSs, it may not by itself provide a complete solution to their expressed needs, in the opinion of the researchers. The Category 1 responders comprise emergency service personnel rather than experts in (for example) the quantified risk assessment of chemical plants. The researchers' recommendation was that LRFs are provided with tools that enable them to (1) identify local risks, (2) apply risk estimates produced by Category 2 responders to these risks and (3) identify local spatial interactions.

Local Resilience Forums

The following recommendations were offered to help LRFs assess 'local' scale events, complete risk assessments of sub-areas and model knock on effects:

- Providing a bespoke tool (either as a simple GIS or database) that supports LRFs assessment of localised events, with a more 'bottom up' approach to identifying and assessing risks and knock on effects.

A specific option was to use the proposed Resilience extranet to meet the needs of LRFs, such as by adding a risk analysis module to it that applies a risk assessment approach similar to the LRAG approach (but perhaps at a more disaggregated level and which examines knock on effects) either to the LRF as a whole or to sub-areas in LRFs. The extranet could link to other risk related data as far as possible.

A GIS tool may offer the opportunity for LRFs to identify potential knock on effects of events, such as by identifying infrastructure that would be impacted by floods. Accordingly, we expect that a GIS package may be best suited to the need of disaggregating risk assessments and assessing knock on effects. A GIS tool can map infrastructure and, using overlays of the event, allow users to identify what structures are in the potentially affected area.

- Advising LRFs of databases, tools and techniques that they could draw results from to identify risks and from which they could draw risk estimates.

Section 5.2.2 identified a range of tools and data that could be recommended to LRFs and FRSs.

- Providing a simple rating tool for assessing and incorporating public risk perceptions into risk prioritisation decisions.

As previously noted, it was suggested that an assessment of risk perception or societal concerns could useful inform decisions on emergency planning, but should not be used to alter the rating of risk. The practical approach adopted by Cleveland LRF may be of value to LRFs, possibly using an adaptation of the Gallon Sciences screening tool developed for RSSB to assess level of public concern. In addition, a factor can be included in risk prioritisation that captures the current adequacy and level of contingency plans; such that high risks may have a lesser priority due to existence of effective plans whilst lesser risks may take a higher priority. This is an area judged to need further development.

These recommendations implicitly suggested to the researchers that LRF risk assessments may be further developed to cover three phases of assessment, namely:

- Phase 1: National and regional scale events – This would encompass the completion of standard risk assessments in accordance with the current LRAG
- Phase 2: Localisation – Inclusion of 'local' scale events and disaggregation of risk within LRFs, taking account of local circumstances
- Phase 3: Prioritisation – A prioritisation phase which would factor in factors such as public perception, adequacy of current contingency plans, availability of resources etc.

This combined approach would enable a more localised risk assessments conducted by LRFs at the same time as retaining a consistent approach to the regional element of risk assessment and emergency planning.

In the event that the LRF risk assessment process is extended to cover local scale events, knock on effects and disaggregation of risk assessments, the LRAG would need to be revised to cover this wider scope of risk assessment.

It was also suggested that the incident likelihoods being developed by Communities and Local Goverment for use in FSEC could also be used by LRFs to assess local scale events. It is understood that the incident likelihoods in FSEC are being produced in a way that they can be applied directly, without recourse to interpretation of specialist risk analyses. However, as FSEC only covers a minority of the LRF risks this will only partly help LRFs.

FRS IRMPs

It was recommended that:

- **Major incidents:** FSEC was upgraded to fully assess major incidents.

It was indicated by Communities and Local Government that the New Dimensions assets are to be transferred to FRSs. This is likely to increase the need for FRSs to risk assess their major incident risks, as decisions on the management of these assets will be made by FRSs. Therefore, it was considered by the researchers important to ensure FRSs have suitable

tools to assess major incident risks within their FRSs as well as to identify and consider regional scale events. This led to the suggestion that the further development of FSEC major incident module and increased liaison with LRFs, as proposed above, is of growing importance.

It was also recommended that guidance and tools are provided to support assessment of resource implications of regional and national scale events as well as simultaneous large-scale events. The national version of FSEC used by Communities and Local Government models simultaneous incidents and could be used for this purpose.

- **Flooding:** Recommendations were offered in respect of dynamic and strategic risk assessment:
  - Given the role of the FRS in responding to floods and the predicted impact of climate change, including their rescue role, that priority is awarded to further development and application of flood risk mapping and assessment tools by the FRS
  - Exploring the potential for improved real time flood risk assessment, such as by the utilisation of rainfall and water level gauges to alert FRSs to imminent flooding.

- **Workload modelling:** FSEC is upgraded to enable workload modelling;
  There are a number of examples of workload modelling that can be used, including two already under development by Communities and Local Government. However, consideration may need to be given to extending workload modelling to include CFS activities. As previously noted, there may be value in checking the absolute level of CFS work to check that it is a significant workload factor before extending workload models to include it.

- **Community fire safety:** Tools used by some FRSs to assess FRS specific issues, such as the overlap of dwelling fire and crime, and tool that enable more targeting of community fire safety (including the tools developed by Greater Manchester FRS – GMAC- and the tools developed by Cleveland FRS) are recommended to FRSs more broadly
- **RTCs:** No existing analysis tool was identified that would assist with the risk assessment of RTCs other than FSEC[42]. FSEC focuses on the frequency of RTCs and the FRS response to RTCs. Given the interest in FRS involvement in the prevention of RTCs, consideration could be awarded to exploring the use of STATS19 (a database of RTCs and their causes) in helping FRS develop preventive interventions.

[42] Other tools used by FRSs assessed workload, response times and plot incidents but did not predict outcomes such as loss of life or apply risk criteria.

- **Wildfire:**
  - Developing an approach for the use of FDR1 (to be replaced by the Incident Reporting System) and other FRS outdoor fire data to aid decisions on outdoor fire prevention, such as identifying areas at greatest risk
  - Development of a predictive strategic outdoor fire risk model drawing on work such as the University of Manchester's, to assess future outdoor trends arising from climate change
  - Exploring the application of one or more of the tools developed in Canada, Australia or New Zealand to UK wildfire risk assessment, or the potential for improved real time risk assessment of outdoor fires, such as using the Met Office's Fire Severity Index to inform short term (five day) interventions.
- **Environmental risk:** The current Lancashire FRS work on an environmental impact template should be used to support operational decision making. Work is also needed to better support strategic assessment of environmental pollution risks. This could draw on the use of the Environment Agency OPRA data to identify sites. However, further research is needed to develop easily applicable major pollution incident likelihoods that can be applied by FRSs for strategic risk assessment, such as by dividing the number of sites by the number of incidents to produce a typical likelihood per site.
- **Heritage risk:** FRSs did not report any specific problems with heritage risk assessment. It would appear appropriate to ensure sources of information for identifying buildings with heritage value are identified to FRSs[43].
- **Business continuity:** It was recommended by this study that:
  - Guidance is provided on best practice in assessing the impact of events on the ability of FRSs to maintain a service
  - The validity of relying on generic business continuity plans is checked, such as by testing (on paper) the impact of a variety of scenarios (such as flooding of fire stations versus flu pandemic vs industrial action) on the adequacy of the emergency plans. This would help test whether the current use of generic business continuity plans is appropriate.

6.2.2 Risk assessment competence and support

LRFs

The feedback from LRFs indicated a need for:

- A forum to share lessons, experience and ideas between LRFs
- Advice on sources of data including a central/local approved "yellow pages" type source book
- Advice on competence standards for LRFs

[43] English heritage holds information on listed buildings and provides searchable database, such as at http://www.heritagegateway.org.uk/Gateway/About/

- Ensuring that updated LRAG is updated on a rolling programme with updates marking changes (eg using track changes) and citing reasons for those changes.

FRSs

Whilst the FRS respondents did not cite competence in risk assessment to be a concern, the researchers noted some points of concern. In particular:

- The examples of using incident data from a limited time period for assessing frequency of rare events suggested that there could be benefit in increasing awareness of how best to use historical data for assessing low frequency events
- The use of tools that do not provide risk measures for supporting IRMPs suggested that there could be benefit in increasing awareness of what constitutes risk assessment.

Feedback from Communities and Local Government indicated that currently there is no training in IRMP related risk assessment, other than in the operation of FSEC. Therefore, it was recommended that consideration be given to extending the FSEC related training to cover the principles and process of IRMP related risk assessment more generally, and that guidance is provided to FRSs on the competence needs for producing IRMPs.

6.2.3 Security classification

The security classification of some data does limit its use by LFRs and FRSs.

It was suggested that consideration is given to:

- Clarifying with Category 2 responders that LRFs do not publish sensitive information, as a way of encouraging greater sharing of information
- Identifying the minimum information that LRF and FRS organisations need, and where possible deleting restricted or confidential information, to reduce security related restrictions in data sharing
- Increasing the level of security clearance of LRFs and FRSs staff, to facilitate their use of such data
- Developing standard data sharing protocols for exchange of information between LRFs, FRSs and other Category 2 responders, including system protocols to ensure data remains secure and guidance that helps organisations recognise when their data should be restricted.

It was noted that FRSs may need to be provided with advice on what information they collect should be classed as restricted or confidential. This included where information becomes restricted due to the combination of data rather than due to the security classification of any one body of data.

The latter protocols may benefit from being produced centrally, such as by Communities and Local Government or CCS, so that they have an appropriate level of authority. The protocols could be applied locally by LRFs and FRSs.

6.3 Interplay of LRFs and IRMP

Increasing interaction of CRRs and IRMPs

There did appear to be some value in a higher level of co-ordination and integration between LRFs and IRMPs, in respect of:

- LRFs identifying the national and regional scenarios that FRSs need to assess (in respect of resilience of FRSs resources and operational continuity)
- FRSs checking that they have included all types of major incidents in their IRMPs and assigning them proportionate weighting
- FRSs sharing local major incident risk assessment results with LRFs.

Accordingly, guidance could be given to FRSs to (always) refer to LRF risk assessments (and RRT risk assessments) in their preparation of IRMPs, and to check their IRMPs each time a LRF updates its CRR.

The benefit to IRMPs of the risk assessment carried out by LRFs would be increased if the LRF assessment was further developed to provide more disaggregated forms of risk analysis and if they included more 'localised' events to a higher degree.

FRSs may also benefit from advice on how to determine scenarios for use in assessing resilience against major events.

6.4 Regional and national IRMPs

LRFs indicated that FRSs already provide useful input to LRFs. In addition, respondents indicated that LRFs are already useful forums for identifying and sharing data and information. This led to the suggestion that FRSs may benefit from further developing similar structures to review IRMPs at a regional level, to overview regional risks for FRSs and act as an interface between FRSs and their respective LRFs, RRFs and RRTs. As previously noted, some FRSs raised the question of how the development of regional control centres may affect IRMPs. This again led to the suggestion that consideration is given to the FRS developed a set of regional IRMPs, perhaps with regional IRMP forums, to mirror the LRFs. A regional IRMP forum could address issues such as:

- Planning for regional scale events
- Agreeing 'over the border' co-operation for major events

- Co-ordinating the retention and use of 'reserve' resources
- Liaison with LRFs, RRFs and RRTs.

It was also noted by the researchers that the summer 2007 flood events involved the use of FRS resource from across England and required national co-ordination of resources. This raised the question of whether some form of national IRMP and IRMP forum was needed to risk assess and plan for such large scale events.

The current IRMP steering committee role and composition could be reviewed to see if this committee could be suitable for a national IRMP with a remit to identify national scale events and co-ordinate FRS planning for these.

If regional and/or national IRMPs are developed this was thought to lead to the need for software support for regional FRS risk assessment. Therefore, it was suggested that Communities and Local Government consider developing a national and regional version of FSEC, to support national and regional level IRMPs.

Implicit in these suggestions is the principle that FRSs should consider regional and national scale risks when making decisions about 'reserve' resources and resilience, with input and consultation with regional and national IRMP groups.

Chapter 7

Appendix A: Tabulated summary of data, tools and techniques

Table 8: **Flood risk assessment**

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F1	Flood Estimation Handbook (FEH)	Data	Yes	The Flood Estimation Handbook (FEH) is a Centre of Ecology and Hydrology (CEH) publication, giving guidance on rainfall and river flood frequency estimation in the UK. Flood frequency estimates are required for the planning and assessment of flood defences, and the design of other structures such as bridges, culverts, and reservoir spillways. There is an increasing demand for estimates that can form the base for flood risk maps, important in the planning of new developments. The FEH also provides methods for assessing the rarity of notable rainfalls or floods, which are of interest to insurers and others. The procedures are clearly explained, and supporting theory and results included. The Flood Estimation Handbook is issued in a set of five printed volumes (Institute of Hydrology, 1999, 5 volumes, ISBN 0 948540 94 X). Licensed software is available to support the implementation of the FEH procedures.	Local application. Dynamic; data from local gauging stations in the UK	Open access to all at a fee for commercial use (Rates available at: http://www.nerc-wallingford.ac.uk/ih/feh/feh/Price%20list%20for%20FEH%20products.pdf)

Table 8: **Flood risk assessment** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F2	HiFlows UK	Data	Yes	The Flood Estimation Handbook (FEH) is the basis for most current flood estimation in the United Kingdom. This website provides updated flood peak data for use with the methods in the FEH. The data are available up to 30 September 2003 (end of water year 2002/2003). The version number is 1.1, release date 1 August 2005.	Local application, Dynamic; data from local gauging stations in the UK	Environment Agency, SEPA & Rivers Agency http://www.environment-agency.gov.uk/hiflowsuk/?version=1&lang=_e
F3	National Flood and Coast Defence Database (NFCDD)	Data	Yes	The aim of the NFCDD project is to provide a single, easily accessible and definitive store for all data on flood and coastal defences, that is made available to all operating authorities to allow them to make better-informed, risk-based decisions on the implementation of flood and coastal erosion management. The database will contain data provided by, and make information available to, the flood and coastal defence operating authorities (the Environment Agency, local authorities and internal drainage boards), Government and other interested public sector organisations. Linking these organisations with one common data source gives rise to potential benefits in terms of consistent policy development and improved procurement opportunities.	Strategic application. Controlled access for flood and coastal defence operating authorities (the Environment Agency, local authorities and internal drainage boards), as well as other government or public sector organisations	In development. http://www.defra.gov.uk/environ/fcd/hltarget/nfcdd.htm

Table 8: **Flood risk assessment** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F4	Water Framework Directive River Network (1:50 000)	Data	Yes	The basis of the river network (1:50,000 digital river centre line network) belongs to NERC (CEH) and a licence is required to be able to view the WFD river water body stretches. These include Freshwater Fish stretches (Economically Significant Species protected area) and river drinking water protected areas.	Local-regional application. Strategic; coarse high-level assessment of risk to water bodies and long-term trends towards achieving sustainable use of water resources	Commercial – though some maps are available freely at regional level. http://www.nercwallingford.ac.uk/ih
F5	Multi-coloured manual (MCM)	Data	Yes	It is used in calculating inundation damage. The standard baseline date for use with the new data is April 2005. Provides data in several levels of detail, from single digit for average of all property, to three digit for property type and social class. Information is available for both residential and non-residential properties. The manual was an update and improvement of the previous 'Blue', 'Red' and 'Yellow' Middlesex University manuals and for the first time brought together information and assistance on calculating the benefits of flood alleviation, coast protection and sea defence into one book.	Strategic use.	Commercial product. (Middlesex University – Flood Hazard Research Centre) http://www.defra.gov.uk/environ/fcd/pubs/pagn/fcdpag3/fhrcmch.htm
F6	Storm tide	Data	Yes	Storm Tide Forecasting Service (STFS)	Provides predictions of coastal flooding, surge and wave activity	http://www.metoffice.gov.uk/publicsector/emarc/stfs.html

Table 8: **Flood risk assessment** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F7	Internal flooding from sewers (DG5 risk of flooding indicator)	Data	No	Tool that assesses risk of flood of buildings by sewers.	Strategic tool aimed at Water companies, Water regulator (Ofwat), overall figures released publicly	http://www.ofwat.gov.uk/aptrix/ofwat/publish.nsf/AttachmentsByTitle/los2006.pdf/$FILE/los2006.pdf
F8	RASP – Risk Assessment of Flood and Coastal Defence	Model	Yes	One identified use of RASP is for targeting flood warning and emergency preparedness. The RASP model includes a number of national data sources, including the Environment Agency Flood Zones, the Environment Agency NFCDD, detailed digital terrain models and river centrelines, and subdivides flood zones into flood impact zones which are related to a system of flood defences. For each impact zone the probability of failure of its associated defence is estimated using a fragility curve. The model allows for the probability of individual sections of defence to be estimated, and eventually the probability of failure of a combination of sections of defences in a system. This produces a flood outline and probability for a floodplain. Flood probabilities are given on a 100x100m grid matrix.	Strategic; model looks at analysing flood defence failure and flood forecasting	http://www.rasp-project.net/ http://www.abi.org.uk/display/File/Child/554/Managing_Flood_Risks_Vol2_Chapter7_Chapter8partA.pdf

Table 8: **Flood risk assessment** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F9	HEC-RAS	Model	Yes	Hydrologic Engineering Centers River Analysis System (HEC-RAS) allows modellers to perform one-dimensional steady flow, unsteady flow, sediment transport/mobile bed computations, and water temperature modelling. It is one of the 3 models used by the Environment Agency to support its work in flood risk management.	Strategic; model looks at analysing flood risk and real-time flood forecasting	US Army Corps of Engineers model. Open Access http://www.hec.usace.army.mil/software/hec-ras/
F10	ISIS	Model	Yes	ISIS is a comprehensive software system developed by Halcrow and Wallingford Software for managing change in river basins. ISIS provides engineers and managers with a flexible and comprehensive range of tools for designing cost effective engineering schemes, flood forecasting, flood risk mapping and developing catchment management strategies that address the needs of all river basin users.	Strategic; model looks at analysing flood risk and real-time flood forecasting	Commercial Product (Halcrow/Wallingford Software) http://www.wallingfordsoftware.com/products/isis/ http://www.halcrow.com/software/solutions/isis.asp
F11	MIKE 11	Model	Yes	MIKE 11 is an industry standard for simulating flow and water level, water quality and sediment transport in rivers, irrigation canals, reservoirs and other inland water bodies. It is a comprehensive engineering tool with a wealth of capabilities provided in a modular framework.	Strategic; model looks at analysing flood risk and real-time flood forecasting	Commercial product (DHI Water and Environment) http://www.dhi-uk.com/Software/feh.htm

Table 8: **Flood risk assessment** (cont.)						
Ref:	**Tool or Technique**	**Approach**	**Specialist expertise needed?**	**Summary**	**Possible application to LRF and FRS civil contingencies risk assessment**	**Notes & Source**
F12	JFlow	Model	Yes	A 2-D cellular inundation model was developed by JBA Consulting as a flood extent modelling tool. It has been tested and validated for large scale automated flood mapping (JBA Consulting, 2003) and also applied successfully at a much more detailed scale in flood mapping studies, to model breaches in defences and also for coastal inundation modelling. It is based on an approach developed by Bates and De Roo (2000). JFLOW was designed to model the flow of water over the floodplain, and does not currently include a model for flow within the river channel itself, which is regarded as the volume contained within the river banks. This was in part motivated by the needs of large-scale automated flood extent mapping, where the detailed river channel survey data needed to set up a conventional 1-D hydraulic model would be too expensive and time-consuming to collect.	Strategic; model looks at analysing flood risk and real-time flood forecasting	Commercial product (JBA Consulting). http://www.scotland.gov.uk/Publications/2005/04/19110405/04113

Table 8: **Flood risk assessment** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F13	Local Area Mesoscale Numerical Weather Prediction Model	Model	Yes	This model was established to interpret and refine (1) surge and astronomical forecasts of North Sea water levels for the East Coast down to a boundary at Sheerness; (2) spatially distributed rainfall over the Thames area with wind fields coupled with wave state data for the lower estuary. This model was to provide forecast ensembles to aid understanding of uncertainty in the context of real-time flood forecasting in Thamesmead. (A number of similar such models are developed in the course of research.)	Static model. (In development)	The Flood Risk Management Research Consortium (FRMRC) controls access. http://www.floodrisk.org.uk/images/stories/docs/Press%20Release.pdf
F14	SUDS (Sustainable Urban Drainage Systems)	Technique	Yes	Surface water drainage methods that take account of quantity, quality and amenity issues are collectively referred to as Sustainable Drainage Systems (SUDS). These systems are more sustainable than conventional drainage methods because they: Manage runoff flow rates, reduce the impact of urbanisation on flooding; Protect or enhance water quality; Are sympathetic to the environmental setting and the needs of the local community; Provide a habitat for wildlife in urban watercourses, and; Encourage natural groundwater recharge (where appropriate). They do this by dealing with runoff close to where the rain falls; Managing potential pollution at its source now and in the future; and protecting water resources from point pollution (eg accidental spills) and diffuse sources. They may also allow new developments in areas where existing sewerage systems are close to full capacity	Strategic; models look at establish impact and mitigate runoff at a much localised level in relation to surface drainage systems.	Tends to involve agreements between local authorities and developers. PPS25 promotes the use of SUDS for sustainable urban drainage. Issues about longer-term maintenance. http://www.ciria.org/suds/publications.htm

Table 8: **Flood risk assessment** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F15	OSRAS	Technique	Yes	OSRAS is a GIS-based information management methodology. It aims to provide a process for the identification and analysis of waterborne sewage pollution risks associated with decentralised sewage management activities. It is intended to help local councils develop evidence based, risk management approach to regulating decentralised sewage management facilities. OSRAS provides a new tool for improved catchment management of decentralised sewage facilities and potentially, other diffuse pollution sources.	Strategic; assists in setting management goals to inform development of systematic, least cost sanitation strategies. Appears to be an approach in use in Australia and New Zealand.	Free – use by catchment management authorities and local government. http://www.dlg.nsw.gov.au/dlg/dlghome/documents/septicsafe/OSRAS_63-75.pdf http://www.dlg.nsw.gov.au/dlg/dlgHome/documents/septicsafe/OSRAS_8-30.pdf; http://www.regional.org.au/au/asssi/supersoil2004/s16/poster/1864_chapmang.htm

Table 8: **Flood risk assessment** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F16	National Flood Risk Assessment (NaFRA)	Tool	Yes	The Environment Agency's National Flood Risk Assessment forms an important part of their Flood Mapping Strategy and supports their aim of reducing flood risk through targeted and prioritised investment. Its success depends on first understanding "where" and "how great" such risks are. It is important that the public, insurance industry and other parts of central and local government that work in partnership with the Environment Agency are also informed of these risks. It provides a spatially differentiated and quantified picture of flood risk throughout England and Wales. The likelihood of flooding has been calculated using predicted water levels and taking the location, type and condition of any flood defences into account, whether or not they are currently shown on the Flood Map. This is a raster output, ie risk is designated in squares throughout England and Wales.	Strategic; NaFRA includes flooding from all rivers with a catchment size greater than 3 square kilometres, and all flooding from the sea (both along the open coast and tidal estuaries). Smaller rivers are included in the assessment where they fall within the area that could be affected by an extreme flood (0.1 per cent chance in any year). It does not include other forms of flooding such as from highway drains, sewers, overland flow or rising groundwater. This is updated in cycles – 3 assessments have been completed to date.	Controlled access for central and local government and other organisations working in partnership with the Environment Agency. http://www.halcrow.com/html/proj_popup/nafra.htm

Table 8: **Flood risk assessment** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F17	Strategic Flood Risk Assessment (SFRA)	Tool	Yes	SFRAs provide a framework to undertake appropriate scenarios to indicate the scale of impact should prime flood defences not perform as intended. It is also intended to provide an informed understanding of flood risk, delineating the extent and nature of flooding within the flood risk zones categorised and mapped by the Environment Agency. In East London a source-pathway-receptor model was used to understand the relative importance of the different sources of flood risk. Detailed modelling was then undertaken to refine the understanding of the potential impact of some of those sources.	Strategic; covers most types of flood risk – fluvial, tidal and estuarine – excludes features such as dams and reservoirs. Most local authorities in England have completed one or are in the process of doing so in respect to planning and development needs.	Open access – local councils, part. Planners. Public access to overall maps, though this can be dependent on the LA concerned http://www.thames-gateway.org.uk/uploadedFiles/projects/Environment_and_Quality_of_Life/SFRA%20Summary%20Leaflet.pdf

Table 8: **Flood risk assessment** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F18	Flood Risk Assessment (FRA)	Tool	Partial	This is Environment Agency guidance on requirements for undertaking a Flood Risk Assessment (FRA) for planning applications. In Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low, a Flood Risk Assessment is still required but it should be focused on the management of surface water run-off. Development that increases the amount of impermeable surfaces can result in an increase in surface water run-off, which in turn can result in increased flood risk both on site and elsewhere within the catchment. This is particularly important for larger scale sites, which have the potential to generate large volumes of surface water run-off. The site may also still be at risk from other sources of flooding (eg groundwater and overland runoff), which are not considered in the mapping of Flood Zones. Further information is provided in Annex C of PPS25.	Strategic; used in relation to planning to determine level of flood risk for a particular development (site, area or zone), as well as areas that could be impacted as a result of the development.	Commercial – various models can be used that are licensed software to evaluate the level of risk. Typically used in relation to planning applications for new build/urban developments and involve local authorities and developers. http://www.pipernetworking.com/floodrisk/fra1.htm

Table 8: **Flood risk assessment** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F19	Flood maps (England & Wales)	Tools	Partial	Flood zone maps provide the worst case projection of flood risk to an area. It shows flood likelihood as overlays on a OS map, as well as in relation to the different flood likelihoods – low (more than 1 in 200), moderate (between. 1 in 200 and 1 in 75) and significant (1 in 75 or less). Also indicates areas that are defended.	Strategic; looks at identifying flood risk in relation to rivers, estuaries and coast only. Flood maps are updated annually	Open access (public) – the Agency will provide data subject to licensing agreement. http://www.environment-agency.gov.uk/subjects/flood/826674/829803/858477/?lang=_e
F20	Indicative river and coastal flood map (Scotland)	Tool	Partial	The flood map has been developed to show areas that may be affected by flooding from either rivers or the sea. The scale of a flood can depend on a variety of things. The flood map shows an estimate of the areas of Scotland with a 0.5 per cent or greater probability of being flooded in any given year, or put another way the areas estimated to have a 1 in 200 or greater chance of being flooded in any given year.	Strategic; looks at identifying flood risk in relation to rivers, estuaries and coast only. Flood maps are updated annually	Open access. http://www.sepa.org.uk/flooding/mapping/important.asp
F21	Norwich Union Flood Insurance Database	Tool	Yes	Currently being developed by Ordnance Survey for Norwich Union. Part of the database involves uniquely pinpointing or 'geocoding' more than 26 million addresses recorded in the Royal Mail Postcode Address File (PAF). This national digital flood map is designed to pinpoint the risk to individual properties based on height data, digital terrain modelling and flood trends analysis.	Strategic application.	Confidential; accessed by the insurance industry only http://www.ordnancesurvey.co.uk/oswebsite/business/sectors/insurance/news/casestudies/raisingstandardfloodrisk.html

Table 8: **Flood risk assessment** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F22	Portfolio Risk Assessment for Dam Safety	Tool	Yes	The PRA approach is a tool for prioritising structural and non-structural measures for reducing dam safety risks across a group of dams. It can also be used to prioritise further investigations and analyses, and to give a basis for the evaluation of other dam safety activities such as, monitoring and surveillance, inspections, and emergency planning. Management, who are responsible for integrating dams into business processes, will find PRA outcomes useful for capital budgeting, insurance, legal liability and due diligence assessments, and business criticality evaluation and contingency planning.	Strategic tool.	http://www.engineering.usu.edu/uwrl/www/faculty/DSB/USCOLDdsb.PDF
F23	Engineering guide to emergency planning for UK reservoirs – draft	Tool	Yes	Under contract to Defra, Jacobs Babtie is preparing a Engineering guide to emergency planning for UK reservoirs. The purpose of the guide, when finalised, is to assist panel engineers and reservoir undertakers comply with the requirements of directions to prepare flood plans under the powers in the Reservoirs Act 1975, as amended, which may be made by the Secretary of State. The preparation of the Guide to Emergency Planning for UK Reservoirs extends the guidance on assessment of the likely consequences of dam failure developed in the Interim Guide to Quantitative Risk Assessment, published in 2004. As a consequence Jacobs Babtie has prepared a Supplement to the Interim Guide and the intention is to incorporate this eventually into the final Guide to Quantitative Risk.	Strategic tool for Water companies, local authorities, Environment Agency	http://www.defra.gov.uk/environment/water/rs/emergplanning-guide.htm

Table 8: **Flood risk assessment** (cont.)						
Ref:	**Tool or Technique**	**Approach**	**Specialist expertise needed?**	**Summary**	**Possible application to LRF and FRS civil contingencies risk assessment**	**Notes & Source**
F24	Reservoir Safety Flood Plans	Tool	Yes	The Water Act 2003 requires Flood Plans to be produced for specified reservoirs. It is important that arrangements are in place so that Emergency Services, led by Local Authorities, can provide an effective lead in the event of an emergency, which at worse could lead to a reservoir causing a flood following an uncontrolled release of water. The requirement for Flood Plans is planned to commence in spring 2009 at the earliest, following direction from the Secretary of State. There is due to be a comprehensive industry wide consultation process led by Defra in summer 2008. Subsequently the Environment Agency will be required to ensure the adequacy of the plans, their existence and maintenance. The offsite component of Flood Plans will be produced under the leadership of Local Authorities as part of their role under the Civil Contingencies Act 2004.	Strategic tool aimed at Local authorities, water companies, Environment Agency, emergency services	www.environment-agency.gov.uk

Table 8: **Flood risk assessment** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F25	Reservoir safety advice	Technique	Yes	Predictions for dam & reservoir failure.	A detailed quantitative technique for predicting likelihood and severity of dam and reservoir failure. Can derive generic failure likelihoods from it.	Engineering guide to emergency planning for UK reservoirs. Defra research contract, 15/6/06.
F26	Triton	Exercise	Yes	Exercise that tested the nation's ability to work together and deal with extensive flooding. The scenario deliberately tested systems that would not normally be planned for.	Yes	http://www.environment-agency.gov.uk/subjects/flood/1217883/1218121/1218156/?lang=_e

Table 9: **Severe weather**

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
SW1	British Rainfall (Hydro-GIS Ltd)	Data	No	An archive of annually published rainfall observations, and will eventually provide daily rainfall depth at up to 6,000 locations with records ranging from 1860 to the present day.	Local	http://www.metcheck.com/V40/UK/FREE/warnings.asp
SW2	Gridded data sets	Data	No	Daily rainfall data for all parts of the UK at 5 km resolution, dating back to 1958. These data have been created from up to 7000 rain gauges, using sophisticated interpolation methods and taking into account coastal effects and orographic enhancement. The data are available on CD in ASCII format for specific regions of the UK, which is useful for modelling purposes, eg urban drainage.	Dynamic; coarse resolution at 5km	Commercial license required. http://www.metoffice.gov.uk/water/met2603griddeddatasetsdatasheetst2.pdf
SW3	Gust severity risk maps	Data	No	Mapping data on potential gust severity	Yes	Met Office
SW4	Early drought forecasts	Data	No	Forecasting data for drought forecasts	Yes	Environment Agency

Table 9: **Severe weather** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
SW5	MetCheck	Data & tool	Partial	Metcheck forecasters issue warnings of adverse weather expected across the UK. The warnings consist of:- Weather Watch – Information on the potential for adverse weather up to 5 days ahead which initially may not be severe; Advanced Weather Warning – Information on adverse weather that is expected within the next 3 days which initially may not be severe; Severe Weather Warning – Information on the likelihood of severe weather conditions within the next 2 days; Flash Weather Warning – Information on expected severe weather within the coming 12 to 24 hours.	Dynamic use. Number of facilities offered free to online users; there are a number of premium tools also available, eg data archive to 2003, RainRisk, SnowRisk, GaleRisk etc., which involve period subscriptions of 1 – 12 months	http://www.metcheck.com/V40/UK/FREE/warnings.asp

Table 9: **Severe weather** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
SW6	Severe Weather Impacts Model (SWIM)	Model	Yes	The Met Office's Severe Weather Impacts Model (SWIM) is designed to help local authorities, industry and emergency services prepare and plan for severe weather events. It provides information on the impact of severe weather on a range of UK infrastructures, down to the resolution of a postcode district. Used with other information SWIM can be an extremely valuable tool for policy development, scenario planning and emergency response training. The model has been used as an investigative tool to identify potential improvements in the warning/mitigation chain. Key factors such as forecast accuracy, optimum lead times, effective dissemination and the raising of public awareness have been investigated to find areas of potential improvement. The results of the analysis indicate that there is much scope for decreasing the number of people who are involved in mitigation, increasing its effectiveness and thus reducing the time that is spent in mitigation. Forecast accuracy is generally acceptable at its current level for large-scale events, but more detail is required for the accurate prediction of localised events, particularly when there is heavy rainfall.	Strategic; can be used to postcode level; particularly useful for broad-scale flooding impact assessment	Controlled access – local authorities, industry and emergency planners. http://www.metoffice.gov.uk/research/nwp/publications/nwp_gazette/sep02/impact_sw.html http://www.flood-fighters.com/MEDIA%20PDfs/6%20040-041%20crj2%204%20climate.pdf

Table 9: **Severe weather** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
SW7	ECMWF ensemble system	Model	Yes	This involves data-based and statistical techniques, complemented by a state-of-the-art ensemble numerical weather prediction model and generates multiple prediction scenarios for member states	Dynamic tool.	http://www.ecmwf.int/products/forecasts/d/charts
SW8	Extreme Forecast Index (EFI)	Model	Yes	Information made available to member states on parameters for severe weather (rainfall, temperature and wind) as a synoptic map.	Dynamic tool.	http://www.ecmwf.int/products/forecasts/samples/efi.html
SW9	NIMROD	Tool	Partial	A forecasting system using satellite, radar and NWP model data. It provides forecasts of rainfall rate, rainfall accumulation, precipitation type, snow probability, cloud, visibility and wind gust speeds. The value of this model has been shown in two severe flooding events during 1998 (at Easter over the Midlands and in late October over Wales), when estimates of surface rainfall derived from radar data provided evidence of the extent and severity of the rainfall events	Dynamic; short period forecasts up to 6 hours in advance	Commercial – freely available to Met Office forecasters and customers. http://www.metoffice.gov.uk/water/nimrod.htm

Table 9: **Severe weather** (cont.)						
Ref:	**Tool or Technique**	**Approach**	**Specialist expertise needed?**	**Summary**	**Possible application to LRF and FRS civil contingencies risk assessment**	**Notes & Source**
SW10	Gandolf	Tool	Partial	Gandolf is a thunderstorm warning system, developed in partnership with the UK's Environment Agency, which uses radar, satellite and Met Office model data to predict the development and decay of heavy showers. This tool offers very short-range forecast of rainfall intensity, drawing on techniques developed for Nimrod, a specialised thunderstorm model, and a project diagnosing convection.	Dynamic; short-range forecast at 2km resolution (grid)	Commercial – license agreements via Met Office & Environment Agency http://www.metoffice.gov.uk/water/gandolf.html
SW11	Heat-Health Watch	Tool	Partial	A Heat-Health Watch system operates in England and Wales from 1 June to 15 September each year. The Heat-Health Watch system comprises four levels of response based upon threshold maximum daytime and minimum night-time temperatures.	Dynamic; 3 day forecasts to national, regional and local levels	http://www.metoffice.gov.uk/weather/uk/heathealth/index.html#more

Table 9: **Severe weather** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
SW12	Euro Tempest	Tool	Yes	EuroTempest provides real-time weather forecasts out to 5 days ahead for European windstorms and their localised potential wind damage. The interactive web-based service http://www.eurotempest.com offers local damage forecasts, down to postcode level, for winter storms affecting seven European countries (United Kingdom, Belgium, Denmark, France, Germany, Ireland, and the Netherlands). The new service also includes warnings for the severity and timing of high wind speeds in all other European countries. The EuroTempest main objective is to support risk management, loss mitigation and decision-making across a wide range of European industry with financial exposure to extreme and unseasonal weather. This is achieved by providing advanced real-time 5 day forecasts of high wind, potential wind damage, wind loss by portfolio, high precipitation, low temperature and high temperature extremes. There is also an archive facility for the retrospective verification of UK wind, precipitation and temperature extremes.	Dynamic; up to 5 days lead; with 6 hourly forecast updates	http://www.eurotempest.com/

Table 9: **Severe weather** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
SW13	Tropical Storm Risk (TSR)	Tool	Partial	Tropical Storm Risk (TSR) is used to forecast the risk from tropical storms worldwide. Information and innovative forecasts are provided to benefit risk awareness and decision-making in (re)insurance, other business sectors, government and society. Recent innovations include a breakthrough in the seasonal prediction of hurricane activity reaching the coast of the US, the first demonstration of the business relevance of seasonal US hurricane forecasts, and the introduction of forecast wind speed probabilities for tropical cyclones worldwide.	Strategic; seasonal probabilistic forecasts	International tool http://tsr.mssl.ucl.ac.uk/
SW14	Global Drought Monitor	Tool	Partial	Previous drought monitoring information has only been issued routinely on a regional basis. The Global Drought Monitor provides a clear summary of current hydrological drought conditions worldwide. The product is updated monthly and has a spatial resolution of ~100km. Interactive elements allow users to select the prior period for drought assessment (1 to 36 months), to zoom in at several levels, to display the number of people affected by exceptional drought within a user-defined area, and to choose whether to display city names, rivers and lakes. Hydrological drought conditions are displayed based on the two leading drought indices called the Standardised Precipitation Index (SPI) and the Palmer Drought Severity Index (PDSI).	Strategic; 1-36 months forecasts with spatial resolution of approximately 100km	http://drought.mssl.ucl.ac.uk/index.html

Table 10: **Transport**

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
T1	STATS19	Data	No	Provides rates of traffic accidents and number of accidents by road type and area. Does not indicate number of major accidents involving multiple vehicles.	Vehicle accidents	DfT
T2	CAA Airport Statistics	Data	No	Provides data on the number of aircraft movements (take offs and landings) which can be used in airport risk analysis. Updated each year.	Number and type of aircraft movements at UK airports	CAA
T3	Marine Accidents	Data	No	Provides total number of accidents and merchant vessels, and reports on more serious ones.	Reported vessel incidents	MAIB Annual Reports
T4	Safety Risk Model	Tool	Yes	The model provides predicted frequencies of accidents (of given magnitudes) per year for the UK. The risk assessments would need interpretation and to be extrapolated to be applicable to a region.	Railway accidents (all types)	www.rssb.org.uk
T5	FSEC	Tool	No	The FSEC major incident module is being upgraded. It currently provides a look up table of aircraft crash rates at airports, generic rates of ferry fire and simple 'rules' for assessing rate of train accidents and motorway accidents in an area.	Airport crashes, ferry fires, motorway and railway incident likelihoods.	Communities and Local Government

Table 10: **Transport** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
T6	Aircraft accidents near airports	Tool	Yes	Produces predictions of the individual risk of death from aircraft crashes to 3rd parties (residents and businesses) around airports. Takes account of airport specific safety measures.	Aircraft crashes at airports	Source: NATS NLR-TP-2000-400, August 2000. R&D Report 0007 A Methodology for Calculating Individual Risk due to Aircraft Accidents near Airports, National Air Traffic Services, 2000
T7	Airport Crashes	Tool	No	The tool includes risk contour maps for a proportion of UK airports, derived from the NATS model. They show the area around an airport exposed to 3rd party individual risk greater than 1 in a million per year. These are restricted	Airport crashes	Source: Communities and Local Government
T8	Aircraft accidents near major hazard installations	Technique	Yes	A paper based technique that predicts number of aircraft crashes in and around airports. Can be made into a computerized tool. Does not take account of airport specific safety measures	Aircraft crashes at airports and during transit	Source HSE: Criteria for the rapid assessment of aircraft crash rate onto major hazards installations according to their Location. D.W. Phillips, SRD/HSE/R435, HMSO 1987
T9	Formal Safety Assessment	Technique	Yes	A specialist approach to predicting frequency of various modes of vessel major incidents, such as sinking and fires. The results can be used (once re-expressed) to give incident frequencies per vessel year.	Passenger vessel accidents	MCA

Table 11: **Industrial pollution**

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP1	Notifiable diseases	Data	No	All notifiable releases are recorded by the Environment Agency.	List of notifiable pollution incidents	Environment Agency
IP2	Air quality data sets as part of the Atmospheric Dispersion Model System (ADMS)	Data	Partial	The Met Office offer a wide range of analyses support areas including pollution episode forecasting and risk management. Data are available from a large number of observation sites, as well for individual sites. Weather information is formatted for direct input into a range of dispersion models, including Atmospheric Dispersion Modelling System (ADMS) and Industrial Source Complex (ISC). In an emergency, a map can be produced using a version of the Atmospheric Dispersion Model System (ADMS), which can be run in a few seconds on a PC. The forecaster inputs basic wind and stability information and an area-at-risk plume is output on a 1:50,000 Ordnance Survey map grid.	Dynamic: In an emergency, the Environmental Monitoring and Response Centre (EMARC) can respond immediately with a verbal forecast, followed within 20 minutes with a written forecast, including an 'area-at-risk' map.	Met Office http://www.metoffice.gov.uk/environment/serv10.html http://www.flood-fighters.com/MEDIA%20PDfs/6%20040-041%20crj2%204%20climate

Table 11: **Industrial pollution** (cont.)						
Ref:	**Tool or Technique**	**Approach**	**Specialist expertise needed?**	**Summary**	**Possible application to LRF and FRS civil contingencies risk assessment**	**Notes & Source**
IP3	Pollution Inventory (PI)	Data	No	The Pollution Inventory (PI) provides information on emissions (to air, water and sewers) of chemical pollutants from industrial sites in England and Wales regulated by the Environment Agency (under the EC Integrated Pollution Prevention and Control Directive (IPPC). Operators must measure or make an estimate of the amount of emissions of each controlled substance every year. They must also specify "notifiable" releases in a year, which include any event such as an emergency, mismanagement, accident or plant failure which has caused pollutants to be released; and where the emissions exceed a set threshold for a substance, the operator must report this (even if the emission falls below the threshold level, it is to be reported, though the level is indicated by "<< (less than) threshold value"). From this data the Agency have created an inventory of 170 chemical substances and 65 radioactive substances released into air, water and sewers by sites in England and Wales.	Strategic	Environment Agency http://www.environment-agency.gov.uk/maps/info/pi/

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP3 (cont.)				Data from major industry such as power stations, chemical works and the metal and mineral industries has been collected since 1998. Data from landfill sites and waste transfer stations began reporting in 2002. Data from sewage treatment works was first collected in 2000, but only from the largest works for a limited number of substances. In subsequent years, data for smaller sewage treatment works has been collected for the full list of Pollution Inventory substances. Sites that dispose of radioactive substances began reporting their radioactive emissions in 2000, but reporting only became compulsory in 2004. These organisations include nuclear power stations, universities and hospitals.		

Table 11: **Industrial pollution** (cont.)						
Ref:	**Tool or Technique**	**Approach**	**Specialist expertise needed?**	**Summary**	**Possible application to LRF and FRS civil contingencies risk assessment**	**Notes & Source**
IP4	Waste Transfer Data	Data	Partial	From 1998-2002 site operators of waste transfer stations were required to provide information on the amount of hazardous and non-hazardous waste they transferred off site each year. They also had to provide a breakdown of whether this was disposed of (landfill, incineration, other) or recovered (as fuel, recycled, other). In 2003 a new system came into operation that requires operators to report the annual mass of waste they transferred in tonnes. This is broken down by waste type and Waste Framework Directive disposal and recovery (D&R) codes. A threshold of 0 is set for hazardous waste and 5t for non-hazardous waste. Sites that are licensed to use radioactive substances must report the quantities of alpha, beta/ gamma and tritium that they transfer for incineration, controlled burial or disposal at Drigg, as well as any other transfers.	High-level data available through the Environment Agency website interface "What's In My Backyard (WIMBY)". More detailed records are available under the freedom of information act through local area offices. The Agency charge for hard copies	Environment Agency http://www.environment-agency.gov.uk/business/444255/446867/255244/255281/?version=1&lang=_e http://www.environment-agency.gov.uk/maps/info/pi/969375/995987/?lang=_e

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP5	Landfill Sites	Data	Partial	Landfill sites are where local authorities and industry can take waste to be buried and compacted with other wastes. The Environment Agency licenses and regulates landfill sites to ensure that their impact on the environment is minimised. Using the WIMBY interface, maps show the boundaries of each landfill site drawn from plans. However, the small scale of these maps make it hard to be 100 per cent accurate. Generally, the boundaries follow field boundaries or roads and in most cases are within five metres of the actual boundary.	High-level data available through the Environment Agency website interface "What's In My Backyard (WIMBY)". More detailed information can be obtained free of charge through the local Environment Agency office. The license number of each site is included on the maps if you do want to ask for more details.	Environment Agency http://www.environment-agency.gov.uk/maps/info/landfill/

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP6	Urban Waste Water Treatment	Data	Partial	The Agency monitor the collection, treatment and discharge of urban waste water, and the treatment and discharge of waste water from industrial sites in accordance with the terms of the European Urban waste water treatment directive. The Agency also identify any sensitive areas in relation to the site which are shown spatially. Where waste water is released into such areas, it must undergo a secondary treatment which causes less impact on the environment.	High-level data available through the Environment Agency website interface "What's In My Backyard (WIMBY)". More detailed records are available under the freedom of information act through local area offices. The Agency charge for hard copies.	Environment Agency http://www.environment-agency.gov.uk/maps/info/uwwt/?lang=_e

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP7	Ground-water Source Protection Zones	Data	Partial	Groundwater is an important environmental attribute providing a third of drinking water in England and Wales, whilst also maintaining the flow in many rivers. In some areas of Southern England, groundwater supplies up to 80 per cent of the drinking water that you get through your taps. It is crucial to ensure that these sources and the water you drink are completely safe. The Agency have defined Source Protection Zones (SPZs) for 2000 groundwater sources such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area spatially. The closer the activity, the greater the risk. The maps show three main zones (inner, outer and total catchment) and a fourth zone of special interest, which is occasionally applied, to a groundwater source.	High-level data available through the Environment Agency website interface "What's In My Backyard (WIMBY)". More detailed records are available under the freedom of information act through local area offices. The Agency charge for hard copies.	Environment Agency http://www.environment-agency.gov.uk/maps/info/groundwater/?lang=_e

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP8	Environ-mental Protection e-Digest Statistics	Data		Defra are able to provide information aggregated at regional or local authority levels. The Environmental Protection e-Digest of regional statistics web pages provide a list of those currently available that may be downloaded from the Defra site. Each topic in the e-Digest has an extensive list of links and references to other organisations and government offices that have been useful in acquiring background information and data. The majority of data Defra provide here are available only at UK or England level. In a few cases there are data summarized England, Wales, Scotland or Northern Ireland. The primary sources for data at country level are the respective devolved offices and their environment departments or agencies.	High-level data open access through the website; more detailed information available through various agencies and departments	Defra/Environment Agency http://www.defra.gov.uk/environment/statistics/intro.htm
IP9	HSE Statistics	Data	No	Enforcement statistics are presented separately for HSE and Local authorities. For HSE, historic data are presented for Field Operations Directorate only, ie excluding Railways Inspectorate (RI), Hazardous Installations Directorate (HID) and Nuclear Safety Directorate (NSD). In addition, 2005/06 data are presented for all HSE Directorates excluding RI.	Strategic	HSE http://www.hse.gov.uk/statistics/regions/index.htm

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP10	Data Dictionary (DD)	Data	Yes	This is one of two tools being developed to assist first responders, risk assessors, and decision-makers. The DD includes compilation of primary and secondary data on toxicity, infectivity, dose-response, and health effects for NHSRCs priority list of chemical; biological and radiological agents. In addition to providing pertinent information to risk assessors and managers, the DD will support the ECAT by providing toxicity information and benchmarks, it will support the development of Provisional Advisory Levels for human exposure and will be used by the Water Infrastructure Protection Divisions (WIPD) Threat Ensemble Vulnerability Assessment (TEVA) modelling tool to fill in toxicity data gaps.	Strategic	US EPA's National Homeland Security Research Center (NHSRC) Threat and Consequence Assessment Division (TCAD) http://oaspub.epa.gov/eims/eimsapi.dispdetail?
IP11	AEOLIUS (Screen, Full and AEOLIUSQ Emissions)	Model	Yes	The Met Office, with funding from the DETR, developed a model for assessing air quality in street canyons. The model is available as a DOS PC program in a screening version, a full version, and an emission version. AEOLIUS Screen allows for quick and easy screening of likely concentrations of air pollutants in street canyons. AEOLIUS Full calculates hourly concentrations of air pollutant concentrations in street canyons, taking account of wind direction and street orientation. AEOLIUSQ Emissions is a version of the street canyon screening model for quick assessments during Second Stage Reviews of Local Air Quality.	Local	Met Office http://www.metoffice.gov.uk/environment/aeolius1.html

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP12	BOXURB	Model	Yes	This is a box model. It's an operational air-quality forecast model that has been adapted for simple, practical and portable application to urban air quality modelling, originally developed to meet the needs of the UK National Air Quality Bulletin System. It is used in many areas throughout the world as they experience rapid growth of air pollution from varied sources such as motor vehicles or forest fires. Because of the implications of this pollution, information about its dispersion is of vital importance for establishing how air-quality is affected in particular areas. Emissions data are incorporated on a 1km grid.	Local/Regional	Met Office http://www.metoffice.gov.uk/environment/boxurb/index.html

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP13	NAME	Model	Yes	The model is used to forecast a number of pollutants, eg in relation to air quality such as the levels of oxides in nitrogen, sulphur dioxide, carbon monoxide and PM10, or dust/sand storms or volcanic ash. It was originally developed as a nuclear accident model following the Chernobyl incident in 1986, but has since evolved into an all-purpose dispersion model capable of predicting the transport, transformation and deposition of a wide class of airborne materials. NAME is used operationally by the Met Office as an emergency response model as well as for routine air quality forecasting. Further applications of NAME include pollution episode analysis and attribution, scientific research work and commercial applications. NAME uses 3D global weather data and as an atmospheric dispersion model provides trajectory of contamination plume. It offers stand-alone computer models for industry to assist them in forecasting immediate accidental emissions, thereby enabling them to handle accidents on site and manage worker safety. Its applications covered include: plume rise, realistic boundary layer simulation and upper level transport; all spatial scales are catered for, and it includes a powerful suite of diagnostic tools; and 3D trajectories of air parcels are used to compute air concentrations and ground deposits.	Both dynamic and strategic; forecast levels used to determine Air Quality Index, which is used to inform/warn government agencies and/or the general public.	Met Office http://www.metoffice.gov.uk/environment/name.html http://www.wmo.ch/web/www/DPFSERA/Meetings/Wshop-DSC_Geneva2004/Doc5-1(5).pdf

Table 11: **Industrial pollution** (cont.)						
Ref:	**Tool or Technique**	**Approach**	**Specialist expertise needed?**	**Summary**	**Possible application to LRF and FRS civil contingencies risk assessment**	**Notes & Source**
IP14	CHEMET	Model	Partial	CHEMET is used to forecast the spread of fumes/vapours from chemical releases in fires or accidents. Experienced forecasters at nominated regional Met Offices will give immediate verbal indication of expected weather conditions (wind speed and direction) and anticipated behaviour of any plume. As soon as possible afterwards (normally within 20 minutes), a more-detailed forecast (written) and a map of areas at risk is faxed to the emergency services. The situation is constantly monitored, and updates given until the emergency is over. The area risk map is produced using ADMS software, though this will eventually be produced within the NAME model and output using GIS software.	Dynamic; service is designed to provide a quick reaction call to emergency services.	Met Office, in conjunction with Defra, Dti and MoD http://www.metoffice.gov.uk/publicsector/emarc/pollution.html

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP15	ALOHA	Model	No	ALOHA is appropriate for emergency response, both in planning and during an actual response. ALOHA is intended to give you as accurate an estimate as possible of the extent and location of the area that might be placed at risk by a particular chemical release. ALOHA accounts for many more of the factors that influence the dispersion of a hazardous chemical. You also can use ALOHA to analyse both worst-case and alternative release scenarios for toxic chemicals, but not flammable substances. ALOHA is designed to model short-term emergency releases as accurately as possible, it does not estimate dispersion distances more than 6 miles (10 kilometres) from the source. Note that you may encounter a problem if you use ALOHA to model very large releases.	Local	US EPA & NOAA http://yosemite.epa.gov/oswer/CeppoWeb.nsf/content/ds-epds.htm

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP16	Operator and Pollution Risk Appraisal (OPRA)	Technique	Yes	It is used to regulate the amount and type of pollution that business and industry produce and to assess risk. Environment Protection (EP) OPRA is used by the Agency as a charging mechanism with the scoring assessing risk. So, the more hazardous the pollution emitted is, the more stringent processes the operator needs to put in place. The Agency look at the environmental hazard and the operator performance to get the final score – the larger the number, the bigger the risk.	Strategic; The risk ratings are banded A-E, where A is performing well. The environmental risk of the specific processes is also scored from 1 (low hazard) to 5 (high hazard), which together give a total Pollution Hazard Appraisal (PHA) score. The Environment Agency is also responsible for regulating industry to limit the impacts of pollution in relation to IPPC regulations using this methodology and determine an Operator Performance Appraisal (OPA).	Environment Agency http://www.environment-agency.gov.uk/maps/info/epopra/?lang=_e

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP17	Procedures and communications in the event of a release of radioactive material (PACRAM)	Technique	Model	This package, developed in the 1980s, aims to comprehensively streamline the Met Office's response to any potential incident at a nuclear power plant (The Met Office form part of a vital and highly organised group of Government Departments and Agencies who will deal with nuclear releases). Two types of plan available: (a) where the incident occurs in the UK and could affect other countries (b) where it occurs overseas and threatens the UK. Allows nuclear industry and overseeing Government bodies access to dispersion predictions.	Provide emergency services, local authorities and Defra with meteorological forecasts, advice and specialist services in the event of a nuclear release into the atmosphere.	Met Office http://www.metoffice.gov.uk/publicsector/emarc/pollution.html
IP18	Environment Monitoring and Response Centre (EMARC)	Facility	Yes	EMARC has a dedicated bench up to 12 qualified forecasters specialising in atmospheric dispersion forecasting. The bench is manned 24 hours per day 365 days a year and is run out of the main operations centre in Exeter.	Dynamic	Met Office http://www.flood-fighters.com/MEDIA%20PDfs/6%20040-041%20crj2%204%20climate.pdf

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP19	Marine Pollution Emergency Response Support System	Tool	Partial	EMARC provides written forecasts to the Maritime and Coastguard Agency (MCA) in the event of an oil spill within UK Waters (Nav Area 1). EMARC can also run an oil spill prediction model. The NAME model is used to predict the movement of the fumes of volatile petroleum product and determine the spread of the fumes across the UK. A forecaster is deployed to the emergency incident room, and EMARC co-ordinate the dissemination of forecast information. Typical data for input into an oil dispersion model are wind speed and direction, and current, wave and swell information.	Dynamic	Met Office http://www.wmo.ch/web/www/DPFSERA/Meetings/Wshop-DSC_Geneva2004/Doc5-1(5).pdf http://www.flood-fighters.com/MEDIA%20PDfs/6%20040-041%20crj2%204%20climate.pdf

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP20	Rapid Toxicity Testing Systems	Technique	Yes	EPA's National Homeland Security Research Center as well as the U.S. Congress have funded a programme to examine promising rapid screening tests that could detect water terrorist acts. The verification test was conducted under the auspices of the U.S. Environmental Protection Agency (EPA) through the Environmental Technology Verification (ETV) program. The purpose of ETV is to provide objective and quality assured performance data on environmental technologies, so that users, developers, regulators, and consultants can make informed decisions about purchasing and applying these technologies.	Dynamic; bacteria-based biosensors are ideal for use as early warning screening tools for drinking water security because bacteria usually respond to toxics in a matter of minutes; In June 2002, the Safe Drinking Water Act (SDWA) was amended to require Community Water Systems (CWS) – applies to CWS serving over 3300 persons – to conduct antiterrorism Water System Vulnerability Assessments (WSVA) and develop water system response plans.	US EPA http://www.epa.gov/etv/verifications/vcenter1-27.html

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP21	Aerometric Information Retrieval System (AIRS)	Tool	Partial	AIRS is a computer-based repository of information about airborne pollution in the United States and various World Health Organization (WHO) member countries. AIRS is administered by the U.S. Environmental Protection Agency, and runs on the IBM mainframe computer system at the EPA National Computer Center in Research Triangle Park, North Carolina. AIRS contains all air quality, emissions, compliance, and enforcement information that the Office of Air Quality Planning and Standards (OAQPS) and state agencies need to carry out their respective programs for improving and maintaining air quality. Reporting capabilities allow states to access and use their data. It eliminates the need for individual states to maintain their own databases of air pollution information and to reformat or reorganise data for submission to the EPA's database. AIRS provides standard information requirements and information handling procedures, which enables OAQPS to compare and to use data from different states.	Static; AIRS Subsystems and applications include AIRS Graphics (AG) which integrates data from multiple AIRS subsystems into maps and charts that enable users to identify patters, trends, and anomalies in air pollution data. AIRS Graphics has interactive menus that make it easy to choose graphical reports, and to select options that control their contents.	US EPA http://www.epa.gov/airs/ag.html

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP22	Computer Aided Manage-ment of Emergency Operations (CAMEO)	Tool	No	It's designed to help first responders and emergency planners plan for and quickly respond to chemical accidents. Rapid actions by fire-fighters, police, and other emergency personnel are often hampered by a lack of accurate information about the substances spilled and the safe actions to be taken to protect responders and the public. CAMEO is intended to be a solution to this problem. The CAMEO suite includes: (a) a safety and emergency response database on over 4,700 chemicals and databases to track chemical inventories and to prepare emergency plans for facilities and chemicals in transit; (b) an emergency air dispersion model, ALOHA, to estimate the end points of toxic plumes, and; (c) a mapping application to analyse data spatially and to assess risk to vulnerable populations (MARPLOT). CAMEO was selected by the United Nations Environment Programme [UNEP website] as a tool for helping developing nations prepare for and respond to chemical accidents, and is part of the UNEP's Awareness and Preparedness for Emergencies at the Local Level (APPELL) program. It has been demonstrated or taught in 50 countries as part of the APPELL workshops	Dynamic/Strategic; to help emergency planners and responders in government and industry plan for and mitigate chemical accidents and to comply with requirements under the USA's Emergency Planning and Community Right to Know Act of 1986 (SARA Title III).	NOAA and US EPA http://www.epa.gov/ceppo/cameo/cam_down.htm

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP23	Hazards Analysis For Toxic Substances, Version 3 (HATS 3)	Tool	No	HATS3 is a menu-driven Harvard Graphics Screen Show presentation intended to be a self-directed orientation for emergency planners and responders new to the EPCRA program and as a refresher for those needing to review sections of the programme.	Strategic; HATS (August 1998) is intended to be a complete guide to hazards analysis in community planning for hazardous materials for Local Emergency Planning Committees (LEPCs). With HATS and either the data available in "Technical Guidance for Hazards Analysis" (1987, EPA, FEMA, and DOT) or that written into the Screening and Scenarios module in CAMEO, an Local Emergency Planning Committee (LEPC) can complete its planning requirements.	US EPA http://yosemite.epa.gov/oswer/CeppoWeb.nsf/content/ds-epds.htm

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP24	Emergency Con-sequence Assessment Tool (ECAT).	Tool	Yes	This is one of two tools being developed to assist first responders, risk assessors and decision-makers. ECAT is an interactive web-based software tool designed to provide a wide range of emergency response officials with accurate information in a rapid manner during a major environmental crisis caused by a terrorist attack or natural disaster. ECAT has been designed to include many critical features that will assist the needs of a wide range of emergency response officials including first responders, health advisors, and senior decision-makers. ECAT will be used as both a training tool and as an emergency response tool and is innovative in three ways. First, ECAT provides a holistic approach by integrating critical information across many scientific disciplines spanning the entire risk assessment and risk management paradigm. Second, ECAT provides instant access to key information and allows its users to conduct rapid analyses of complex data. Third, ECAT is versatile and can be applied by a wide range of users including first responders, health advisors, and senior decision-makers. This tool will undergo rigorous internal and external peer review to ensure scientific credibility and technical quality.	Strategic & dynamic;	US EPA's National Homeland Security Research Center (NHSRC) Threat and Consequence Assessment Division (TCAD) http://oaspub.epa.gov/eims/eimsapi.dispdetail?deid=151585

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP25	Basic On-Line Disaster and Emergency Response (BOLDER) Tool	Tool	No	Emergency planning for chemical spills. This tool has condensed nine US federal emergency response plans into a simple, clear and easy to understand requirements in a software tool. The software allows a facility to provide much more specific and detailed information, such as floor plans, roof plans, access hatches, chemical storage areas, shut-offs, fire walls, computerized chemical inventories and MSDS inventories. Even digital pictures of the facility can be put into the facility information. This information allows responders to most efficiently handle any facility contingency.	Strategic & dynamic; enables emergency responders pre warning before responding on-site through immediate access via laptops.	US EPA http://www.chemicalspill.org/bolder.html http://epa.gov/region09/innovations/bolder.html

Table 11: **Industrial pollution** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
IP26	EM Advantage	Tool	Yes	EMAdvantage is an automated decision-support system that expands the operational awareness of emergency response managers during planning, daily operations, and response. During planning, EMAdvantage helps managers pre-establish protective action recommendations and prepare emergency response plans. During daily operations, EMAdvantage provides information about community conditions and current activities that may affect a site's ability to respond to a potential event. During an incident, EMAdvantage combines incident characterization and protective action recommendations with information about community conditions so that managers can select and execute the best response plan.	Strategic & dynamic;	Commercial tool – Battelle http://www.battelle.org/environment/publications/EnvUpdates/Summer2005/article6.stm
IP27	FRAMES	Tool	Yes	FRAMES is a software platform that provides seamless and transparent communication between components. For the emergency responder applications, FRAMES uses a multi-thematic approach to provide a flexible and holistic understanding of how environmental releases potentially affect humans and the environment. It incorporates models that integrate across scientific disciplines, allowing for tailored solutions to specific activities. Combined with EMAdvantage, FRAMES provides meaningful, risk-based guidance to emergency response and technical managers.	Strategic	Commercial tool – Battelle http://www.battelle.org/environment/publications/EnvUpdates/Summer2005/article6.stm

Table 12: **Industrial fire and explosion**						
Ref:	**Tool or Technique**	**Approach**	**Specialist expertise needed?**	**Summary**	**Possible application to LRF and FRS civil contingencies risk assessment**	**Notes & Source**
F&E1	Riskat	Tool	Yes	Risk contour maps provide map of area where risk of dangerous dose exceeds designated levels. Available for all COMAH sites.		HSE
F&E2	Quick FN	Tool	Yes	A specialist tool that predicts frequency of events with numbers of deaths. Results are restricted.	Societal risk analysis from COMAH sites	HSE
F&E3	MISHAP, Pipeline Riskat	Tool	Yes	Risk assessment of pipelines carrying flammable substances. (See also below)	Suitable for pipelines. Could have application to other hazards	Implementation of View Risk – Project Brief and Project Plan Pipeline RISKAT – Project Brief HSL/2006/56
F&E4	PRA	Semi-Quantitative	No	Preliminary hazard analysis (PHA) is a semi-quantitative analysis performed to identify all potential hazards and accidental events that may lead to an accident. It ranks the identified accidental events according to their severity and identifies required hazard controls and follow-up action. Variants include Rapid Risk Ranking and Hazard identification (HAZID)	Good	Routinely applied in UK via H&S type risk assessments. Source: Various

Table 12: **Industrial fire and explosion** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F&E5	HAZOP	Quantitative	Basic: No Complex: Yes	Hazard and Operability studies (HAZOP) Facilities based application for the systematic examination of the process and engineering intentions of new or existing facilities. Assesses the hazard potential that arise from deviation in design specifications and the consequential effects on the facilities as a whole.	Good if applied to discrete facility based scenarios. Could also help with consequential based risk assessments arising out of civil contingency events	Wide acceptance in the process industries. Is an effective tool for plant safety and operability improvements. Source: Various eg HSE.
F&E6	FMEA	Quantitative	Basic: No Complex: Yes	Failure Mode and Effects Analysis (FMEA) Engineering reliability tool to determine potential failure modes of whole or discrete systems. Each mode is analysed to assess it effect on the system as a hole according to severity	Good if applied to discrete facility based scenarios.	Wide acceptance in many industries Source: Various
F&E7	FMECA	Quantitative	Basic: No Complex: Yes	Failure Mode and Effects Criticality Analysis (FMECA). As above but incorporating criticality analysis.	Good if applied to discrete facility based scenarios.	Wide acceptance in many industries Source: http://www.qualityamerica.com/knowledgecente/articles/fmea1.html
F&E8	FTA	Quantitative or Qualitative	Basic: No Complex: Yes	Fault Tree Analysis (FTA). Graphical technique that provides a systematic description of the combinations of possible occurrences in a system, which can result in an undesirable outcome. This method can combine hardware failures and human failures.	Reasonable if linked to consequential and related risk associated with civil contingency scenarios.	Wide acceptance in many industries Source: http://www.iee.org/Policy/Areas/Health/hsb26c.cfm

Table 12: **Industrial fire and explosion** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F&E9	ETA	Quantitative or Qualitative	Basic: No Complex: Yes	Event Tree analysis (ETA). Illustrative technique for showing a series of outcomes which may arise after the occurrence of a selected initial event. Primary role in consequence analysis for pre and post incident management.	Good if linked to consequential and related risk associated with civil contingency scenarios.	Wide acceptance in many industries Source:www.theiet.org/publicaffairs/health/hsb26b.pdf
F&E10	CCA	Quantitative or Qualitative	Basic: No Complex: Yes	Cause-Consequence Analysis (CCA) is a combination of FTA and ETA analytical techniques. Its primary purpose is to determine the chains of events that can lead to undesirable consequences	Excellent if linked to consequential and related risk associated with civil contingency scenarios.	Wide acceptance in many industries Source: Various http://www.yellowbook-rail.org.uk/
F&E11	MORT	Quantitative or Qualitative	Basic: No Complex: Yes	Management Oversight Risk Tree (MORT). Safety analytical tool for use with goal orientated management systems. Is a logic diagram encompassing a graphical index. Primary role in accident investigation	Limited.	Source Johnson, W.G., "MORT – The Management Oversight and Risk Tree," SAN 821-2, U.S. Atomic Energy Commission, 12 February 1973.
F&E12	SMORT	Quantitative or Qualitative	Basic: No Complex: Yes	Safety Management Organization Review Technique (SMORT). Simplified Scandinavian version of MORT	Limited	Source: No primary source identified
F&E13	DOW MOND	Quantitative	Yes	Provides a comparative measure of the overall risk of fire and explosion of a process, and are useful tools in the plant layout development stage since they enable objective spacing distances to be taken into account at all stages.	Reasonable when applied to in a generic format. Do not replace need fro detailed risk assessment	http://www.hse.gov.uk/comah/sragtech/techmeasplantlay.htm ILO, PIACT, `Major Hazard Control: A Practical Manual', 1988.

Table 12: **Industrial fire and explosion** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F&E14	ISI	Qualitative	Yes	Inherent Safety Index (ISI) based around two approaches. The Chemical Inherent Safety Index describes the chemical aspects of inherent safety, and the Process Inherent Safety Index represents the process related aspects. For the index score list, the reader should refer to Heikkilä et al. (1996) and Heikkilä (1999).	Full relevance not assessed.	Heikkilä and Hurme (1996 and 1999) and Palaniappan et al. (2002 and 2004)
F&E15	Riskplot+	Unknown	Unknown	Model used for the estimation of risks from COMAH/Consents sites which have activities involving sulphur trioxide, oleum or other water reactive chemicals, or to which the generic methodology applies.	Insufficient information	HSE http://www.hseresearchprojects.com/projectsearch.aspx?id=542
F&E16	LOP or LOD	Qualitative	No	Basic technique for prevention and mitigation of major accidents by understanding the principles of 'lines of defence' (LODs) or 'layers of protection' (LOPs). These lines or layers serve to either prevent an initiating event from developing into an incident or to mitigate the consequences of an incident once it occurs.	Good as part of wider risk management of scenario	HSE Lines of Defence/Layers of Protection Analysis in the COMAH Context http://www.hse.gov.uk/RESEARCH/misc.htm
F&E17	LOPA	Qualitative	No	LOPA is one of a number of techniques developed in response to a requirement within process industry to be able to assess the adequacy of the layers of protection provided for an activity.	Good as part of wider risk management of scenario	CCPS, (2001). 'Layer of Protection Analysis – Simplified Process Risk Assessment'. American Institute of Chemical Engineers, New York.

Table 12: **Industrial fire and explosion** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F&E18	TRAM	Qualitative	Yes	Technical Risk Audit Method (TRAM) is a risk based auditing and inspection tool for application at major hazard sites falling within the scope of the COMAH Regulations.	Good as part of wider risk management of scenario	HSE Lines of Defence/Layers of Protection Analysis in the COMAH Context http://www.hse.gov.uk/RESEARCH/misc.htm
F&E19	AVRIM2	Qualitative	Yes	AVRIM2 is an assessment and inspection tool developed for the Dutch Labour Inspectorate. The tool is currently used for the assessment of on-site safety reports Arbeidsveiligheidsrapporten (AVRs) for major hazard sites submitted to the regulator under the requirements of the Saves II Directive.	Good as part of wider risk management of scenario	HSE Lines of Defence/Layers of Protection Analysis in the COMAH Context http://www.hse.gov.uk/RESEARCH/misc.htm
F&E20	PLANOP	Qualitative	Yes	PLANOP (Protection Layer Analysis and Optimisation) is a tool developed by the Chemical Risks Directorate of the Belgian Ministry of Labour for the qualitative analysis of the protective layers at F&E21a process plant.	Good as part of wider risk management of scenario	HSE Lines of Defence/Layers of Protection Analysis in the COMAH Context http://www.hse.gov.uk/RESEARCH/misc.htm
F&E21	SCRAM	Quantitative	No	Short-Cut Risk Assessment Method (SCRAM) has been proposed as a means of prioritising accident scenarios for more detailed analysis (using QRA, for example).	Good as part of wider risk management of scenario	HSE Lines of Defence/Layers of Protection Analysis in the COMAH Context http://www.hse.gov.uk/RESEARCH/misc.htm

Table 12: **Industrial fire and explosion** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F&E22	KSPIs	Quantitative or Qualitative	No	Key Safety Performance Indicators (KSPIs) used for comparative benchmarking criteria.	No information.	Major Hazards Industry Performance Indicators Scoping Study HSL/2007/31 http://www.hse.gov.uk/RESEARCH/hsl/assessmt.htm
F&E23	RISKAT	Quantitative	Yes	Quantified risk assessment of pipelines carrying flammable substances. Development of the MISHAP system	Suitable for pipelines. Could have application to other hazards	Implementation of View Risk – Project Brief and Project Plan Pipeline RISKAT – Project Brief HSL/2006/56
F&E24	MISHAP	Quantitative	Yes	Risk assessment of pipelines carrying flammable substances.	Suitable for pipelines. Could have application to other hazards	Implementation of View Risk – Project Brief and Project Plan Pipeline RISKAT – Project Brief HSL/2006/56
F&E25	What If	Qualitative	Yes	Uses a creative brainstorming methodology, and can be used to evaluate any aspect of a process.	Suitable for a range of process based assessments	Review of Hazard Identification techniques. HSL/2005/58
F&E26	Concept Hazard Analysis	Qualitative	Yes	Literature review of previous incidents, allowing identification of areas of the process of specific concern. Performed during the concept and early design stages, and requires the process flow diagram, with any main add-on safety systems.	Suitable for concept and early design stages.	Review of Hazard Identification techniques. HSL/2005/58

Table 12: **Industrial fire and explosion** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F&E27	Concept Safety Review	Qualitative	Yes	Performed as soon as possible during the concept phase of the process. Defines the objectives and scope of the project, and identify the main hazards present (ie hazards associated with the chemicals present).	Suitable for concept and early design stages.	Review of Hazard Identification techniques. HSL/2005/58
F&E28	PHA	Qualitative	Yes	Preliminary Hazard Analysis (PHA) is used as an early means of hazard identification during the design and development of the process. Often used to follow-up on the hazards that have been identified during concept hazard analysis. Follows an approach similar to HAZOP.	Suitable for concept and early design stages.	Review of Hazard Identification techniques. HSL/2005/58
F&E29	FIHI	Qualitative	Yes	Functional Integrated Hazard Identification (FIHI) model of the system to be formally defined in terms of (i) Intents (ii) Methods and (iii) Constraints.	Limited	Review of Hazard Identification techniques. HSL/2005/58
F&E30	CEX	Qualitative	Yes	Critical Examination of System Safety (CEX) was the precursor to HAZOP, and uses brainstorming techniques to formulate a series of questions (such as What, When, How and Where) which can be related to a particular activity or operation.	Limited in view of HAZOP developments.	Review of Hazard Identification techniques. HSL/2005/58

Table 12: **Industrial fire and explosion** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F&E31	MOSAR	Qualitative & Quantitative	Yes	Method Organised Systematic Analysis of Risk (MOSAR) MOSAR uses a series of steps to examine the safety of the process. The process is taken as a series of interacting sub-systems and tables are filled out by members of the assessment team	No assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E32	GOFA	Qualitative	Yes	Goal Orientated Failure Analysis (GOFA) is a system analysis approach to develop a system diagram which is then used in the hazard identification process. It uses a top-down technique which is a hybrid of FMEA and FTA.	Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E33	Matrices	Qualitative	No	Used in early stages of process design and development. Used to identify potential hazards. Technique can be performed to varying levels of complexity, and cross-references a number of aspects of the plant.	Simple technique with wide screening potential	Review of Hazard Identification techniques. HSL/2005/58
F&E34	IHA	Qualitative	Yes	Inherent Hazard Analysis (IHA) is performed early in the design and development phase of the process. It is used to minimise the inherent danger of the process due predominantly to the presence of hazardous reactants, intermediates, or products.	Limited	Review of Hazard Identification techniques. HSL/2005/58
F&E35	MOp	Qualitative	Yes	Maintenance and Operability study (MOp) is performed during the early stages of the design.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58

Table 12: **Industrial fire and explosion** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F&E36	Maintenance Analysis	Qualitative & Quantitative	Yes	Used to identify equipment availability and can also be used to identify particular hazards associated with maintenance.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E37	Sneak Analysis	Qualitative	Yes	Developed in aerospace industry. Split into a number of separate paths for error	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E38	Reliability Block Diagram	Qualitative	Yes	Reliability Block Diagram is a pictorial representation of the reliability of a process.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E39	Structural Reliability Analysis	Qualitative	Yes	Examines the structures associated with the process to identify their in-built safety margins.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E40	Vulnerability Assessment	Qualitative	Yes	Vulnerability assessment is used to evaluate the safety of plant items if a failure occurs in a nearby item.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E41	DEFI	Qualitative	Yes	The DEFI method is used to evaluate the possible failures relating to a piece of equipment.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E42	CHAZOP	Qualitative	Yes	Computer HAZOP (CHAZOP) is based on the methodology used in HAZOP studies.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E43	Structured English	Qualitative	Yes	Used to expand ideas and functions from vague generalities, to precise statements in a hierarchical fashion. The method is given in terms of a set of logical conditions.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58

Table 12: **Industrial fire and explosion** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F&E44	Specification language	Qualitative	Yes	Similar process to that of Structured English and incorporates a graphical format known as "requirements net" (network), and uses more restrictive verbs and nouns.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E45	SADT	Qualitative	Yes	Structured Analysis and Design Techniques (SADT) are a way of expressing the activities of a control system by the use of diagrams that resemble conventional engineering blocks. The technique incorporates a graphical language and a set of methods and management guidelines	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E46	State-transition Diagrams	Qualitative	Yes	Graphical methods for indicating state machines. It represents the sequence of operation of programmable electronic systems through control loop diagrams.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E47	Petri-nets	Qualitative	Yes	Petri-nets applies a graphical methodology, and utilizes a number of bubbles and arcs to represent the process.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E48	GRAFCET	Qualitative	Yes	Grafcet (GRAphe de Commande Etat-Transition) is a graphical method of specifying control sequences. It defines the orders of the actions to be executed, and the actions themselves.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58

Table 12: **Industrial fire and explosion** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F&E49	Task Analysis	Qualitative	Yes	Task analysis is a systematic method for analysing a task in terms of its goals, operations and plans. The task is a set of operations/actions required to achieve a set goal.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E50	HTA	Qualitative	Yes	Hierarchical task analysis (HTA) uses the same methodology as task analysis, though a hierarchy is placed on the order of the tasks to be investigated.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E51	AEA	Qualitative	Yes	Action error analysis (AEA) uses the output from a hierarchical task analysis as its starting point. Each step is then analysed to identify all the errors which the human operators can commit, and their effects on the process can be evaluated.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E52	HRA	Qualitative	Yes	Human reliability analysis is used to quantify the human errors.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E53	Pattern search method	Qualitative	Yes	Pattern search method is used to identify hazards due to a number of errors. It attempts to look for a common cause which could lead to the appropriate errors, and identifies areas of importance for safety considerations.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58

Table 12: **Industrial fire and explosion** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
F&E54	PHEA	Qualitative	Yes	Predictive Human Error Analysis (PHEA) uses hierarchical task analysis to plan the task.	No obvious application. Not assessed in detail	Review of Hazard Identification techniques. HSL/2005/58
F&E55	Business continuity manage-ment (BCM)	Qualitative	No	The model requires both business impact analysis and risk assessment to be performed to determine the vulnerabilities. Model establishes the process, principles and terminology of business continuity management (BCM), providing a basis for understanding, developing and implementing business continuity within an organization and to provide confidence in business-to-business and business-to-customer dealings	Good framework for identifying and mitigating potential consequential risk scenarios	BS 25999-1:2006 Business continuity management (BCM)
F&E56	MCA	Qualitative	No	Mission Critical Activities (MCA) is a specific stage of performing effective BCM.	Good framework for identifying and mitigating potential consequential risk scenarios	BS 25999-1:2006 Business continuity management (BCM)

Table 13: **Wildfire risk assessment**						
Ref:	**Tool or Technique**	**Approach**	**Specialist expertise needed?**	**Summary**	**Suitability for Civil Contingencies**	**Notes & Source**
WF1	No name	Technique	Yes	A technique that predicts wild fire frequency by year and takes account of climate change.	Wild fire prediction	University of Manchester
WF2	Fire Severity Index	Tool	Yes	Provides prediction of wildfire risk over coming 5 days, per area.	Wildfire risk over next 5 days	Met Office

Table 14: **Security risk assessment**

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
S1	Facilitated Risk Assessment Process (FRAP)	Qualitative	Yes	FRAP adopts a qualitative risk analysis process to provide tested variations on the methodology selected.	Limited. Requires high knowledge base to apply.	Limited information on technique. Appears biased to security risk. Source: http://www.peltierassociates.com/frap.htm
S2	CRAMM	Qualitative and Descriptive	Yes	Central Risk Analysis and Management Method (CRAMM) identifies a recommended set of counter measures, necessary to reduce the risks to an acceptable level. These are presented in the form of a Management Report. Adopts an asset based approach describing up to 25 impacts, 35 threats and 7 measures of risk.	Good. When applied to discrete assets. Requires high knowledge base to apply.	The CRAMM method is owned, administered and maintained by the UK Security Service on behalf of the UK CRAMM is consistent with BS 7799:1995 — Code of Practice for Information Security Management. Source: http://www.cramm.com/
S3	OCTAVE®	Qualitative and Descriptive	Yes	Operational Critical Threat and Vulnerability Evaluation (OCTAVE). Is a risk -based strategic assessment and planning technique for security. Identifying critical assets and the threats to those assets. It is based on identifying the vulnerabilities, both organizational and technological, that expose those threats, by developing practice-based protection strategy risk mitigation plans to support the organization's mission and priorities.	Limited. Requires high knowledge base to apply.	Limited information on technique. Appears biased to security risk. Source: http://www.cert.org/octave/

Table 15: **Factoring in risk perceptions**						
Ref:	**Tool or Technique**	**Approach**	**Specialist expertise needed?**	**Summary**	**Possible application to LRF and FRS civil contingencies risk assessment**	**Notes & Source**
RP1	Social Amplifica-tion	Qualitative	No	Various frameworks and approaches used for gaining a greater understanding of risk perception. Techniques include: • Social Amplification Framework • Lexical Content Analysis • Diction program • SLIWC	No judgment made	Source: HSE CRR/367/2002 Quantifying risk amplification processes: A multilevel Approach
RP2	Model for Gauging Societal Concern for the railway industry	Qualitative	No	Technique for capturing key factors believed to influence publics perception of risk using a logic construct based on Boolean fault tree.	Good	Source RSSB. http://www.rssb.co.uk/r_and_d.asp
RP3	Stakeholder Engage-ment	Qualitative	No	Description of a variety of tools and approaches for assessing stakeholder engagement. Based on assessing stakeholder response to guide the appropriate approach to engagement	Good	Source RSSB. http://www.rssb.co.uk/r_and_d.asp
RP4	VPF	Qualitative	No	Definition of the Value to Prevent a Fatality (VPF) and the Impact of Societal Concerns. General research paper	No judgment made	Source RSSB. http://www.rssb.co.uk/r_and_d.asp
RP5	Societal Concern	Descriptive	N/a	Academic discussion taking account societal concerns about risk.	n/a	Source: HSE RR/035/2002 Taking account of societal concerns about risk.

Table 15: **Factoring in risk perceptions** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
RP6	Social amplification	Descriptive	n/a	Research project on social amplification of risk as applied to the media and the public	n/a	Source: HSE CRR/329/2001 Social amplification of risk: The media and the public
RP7	Safety decision making	Descriptive	n/a	Paper on how rail companies in UK take decisions that affect safety.	n/a	RSSB Report www.rssb.co.uk/pdf/reports/How%20safe%20is%20safe%20enough%20-%20Overview.pdf

Table 16: **Generic risk analysis tools**

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
G1	DRAM	Qualitative and Descriptive	Yes	DRAM (Delphi Risk Assessment Method). Provides continuous assessment of current risk against production systems or the evaluation of new technology deployments or application designs	Limited	Limited information on technique. Appears when the opinion of experts is required to support decision-making. Eg where there is no historical data, external factors or change overwhelm the relevance of data or subjective factors, such as ethical or moral concerns overwhelm data.
G2	GO Method	Quantitative or Qualitative	Yes	A success-oriented system analysis used to aid in model construction. Used in practical application where the boundary conditions for the system to be modelled are well defined by a system schematic or other design documents	Limited	Developed by Kaman Sciences Corporation during the 1960s Source: No primary source identified
G3	Digraph or Fault Graph	Quantitative or Qualitative	Yes	Adopts the mathematical and language of graph theory eg "path set"	Limited	Source: No primary source identified
G4	Marokv modelling	Quantitative or Qualitative	Yes	Modelling technique used to assess time dependent behaviour of many dependent systems	Good if applied to consequential and related risk associated with civil contingency scenarios	http://en.wikipedia.org/wiki/Hidden_Markov_model

Table 16: **Generic risk analysis tools** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
G5	DETAM	Quantitative or Qualitative	Yes	Dynamic Event Tree Analysis Method (DETAM) assesses the time-dependent evolution of plant hardware states, process variable values, and operator states over the course of a scenario. Used to represent a wide variety of operator behaviours, model the consequences of operator actions and act as a framework for the analyst to employ a causal model for errors of commission.	Good if applied to consequential and related risk associated with civil contingency scenarios.	Various proprietary packages exist. Source: No primary source identified.
G6	EBM	Qualitative	No	Evidence-Based Management (EBM) encompasses managerial decisions and organizational practices informed by the best available scientific evidence.	Reasonable as part of wider evaluation of risk.	http://en.wikipedia.org/wiki/Evidence-based_management
G7	BCP	Qualitative	No	Business Continuity Planning (BCP) is a process that helps manage risks to the smooth running of an organisation or delivery of a service, ensuring continuity of critical functions in the event of a disruption, and effective recovery afterwards. See also BCM.	Excellent.	http://www.ukresilience.info/preparedness/businesscontinuity.aspx See also Business Continuity Management standard BS 25999
G8	CBA	Qualitative	No	Well accepted generic technique for assessing projects.	Reasonable as part of wider risk evaluation.	http://en.wikipedia.org/wiki/Cost-benefit_analysis
G9	CORA	Quantitative	Yes	Proprietary quantitative risk management decision support system.	No details.	http://www.ist-usa.com/aboutcora.htm

Table 16: **Generic risk analysis tools** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
G10	AS 4360	Qualitative	No	Generic risk management standard suitable for any organisation.	Excellent as part of wider risk evaluation	Well embedded in many public and private sector organizations. http://www.riskmanagement.com.au/
G11	@Risk accelerator	Quantitative	Yes	Advanced risk analysis tool based on Monte Carlo simulation techniques.	Reasonable	http://www.palisade-europe.com/risk/riskaccelerator.asp
G12	Monte Carlo	Quantitative	Yes	Algorithmic technique for simulating the behaviour of physical or mathematical systems.	Reasonable	http://en.wikipedia.org/wiki/Monte_Carlo_method
G13	Risk Assessment	Descriptive	n/a	Identification of common pitfalls associated with risk assessment methodologies.	n/a	Source: HSE RR/151/2003 Good Practice and pitfalls in risk assessment
G14	ALARP	Descriptive	No	Generic application of the ALARP (As low as reasonably practicable) principle as embodied in the HSE's Tolerability of Risk (TOR) framework.	Good	Various including HSE http://www.hse.gov.uk/risk/theory/alarp1.htm
G15	Checklists	Qualitative	No	Use of empirical hazard identification by using generic or scenario specific checklists.	Reasonable but includes no risk information	www.yellowbook-rail.org.uk/site/the_yellow_book/volume_2/vol_2.pdf
G16	Brain-storming	Qualitative	No	Group based technique to acquire range of options around typically a single issue under examination.	Limited except at initial scoping stage	http://en.wikipedia.org/wiki/Brainstorming

Table 16: **Generic risk analysis tools** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
G17	DRACAS	Qualitative	Yes	Data Reporting Analysis and Corrective Action System (DRACAS) is a closed loop data reporting and analysis system. Used to aid design, to identify corrective action tasks and to evaluate test results, in order to provide confidence in the results of the safety analysis activities and in the correct operation of the safety features.	No detailed assessment	www.yellowbook-rail.org.uk/site/the_yellow_book/volume_2/vol_2.pdf
G18	Loss analysis	Quantitative or Qualitative	Yes	Loss Analysis comprises a systematic investigation of the safety losses associated with all incidents and accidents identified through Consequence Analysis. Can employ Potential Equivalent Fatalities PEF) or Value of Preventing a Fatality (VPF) as the basis for the benchmark	No detailed assessment	www.yellowbook-rail.org.uk/site/the_yellow_book/volume_2/vol_2.pdf
G19	Pros and Cons Analysis	Quantitative	No	Pros and Cons Analysis is a qualitative comparison method in which good things (pros) and bad things (cons) are identified about each alternative. Lists of the pros and cons, based on the input of subject matter experts.	Limited in most areas	Guidebook to Decision Making Methods. Department of energy 2001 emi-web.inel.gov/Nissmg/Guidebook_2002.p
G20	K-T Decision Analysis	Quantitative	Yes	Kepner-Tregoe (K-T) Decision Analysis is a quantitative comparison method in which a team of experts numerically score criteria and alternatives based on individual judgments or assessments.	Reasonable if applied to discrete areas	Guidebook to Decision Making Methods. Department of energy 2001 emi-web.inel.gov/Nissmg/Guidebook_2002.p

Table 16: **Generic risk analysis tools** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
G21	AHP	Quantitative	No	Analytic Hierarchy Process (AHP) is a quantitative comparison method used to select a preferred alternative by using pair-wise comparisons of the alternatives based on their relative performance against the criteria.	Reasonable if applied to discrete areas	Guidebook to Decision Making Methods. Department of energy 2001 emi-web.inel.gov/Nissmg/Guidebook_2002.p
G22	MAUT	Quantitative	Yes	Multi Attribute Utility Theory (MAUT) is a quantitative comparison method used to combine dissimilar measures of costs, risks, and benefits, along with individual and stakeholder preferences, into high-level, aggregated preferences using any convenient scale. Five, seven, and ten point scales are the most commonly used. In a classical MAUT the full range of the scoring scale.	Good. Could be used to help with consequential based risk assessments arising out of civil contingency events	Guidebook to Decision Making Methods. Department of energy 2001 emi-web.inel.gov/Nissmg/Guidebook_2002.p
G23	SMART	Quantitative	Yes	Simple Multi Attribute Rating Technique (SMART). Variant of MAUT.	Good. Could be used to help with consequential based risk assessments arising out of civil contingency events	Guidebook to Decision Making Methods. Department of energy 2001 emi-web.inel.gov/Nissmg/Guidebook_2002.p
G24	SWOT	Qualitative	No	Strategic planning tool used to evaluate the Strengths, Weaknesses, Opportunities, and Threats.	Limited	Various. http://en.wikipedia.org/wiki/Swot_analysis

Table 16: **Generic risk analysis tools** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
G25	Actuarial or historical	Quantitative	Yes	Process involves looking at the reliability of components or other factors within a system based on past experience or data.	Limited because of need for significant number of data points	http://www.defra.gov.uk/environment/risk/eramguide/07.htm
G26	Synthesized analysis	Quantitative or Qualitative	Yes	Logic based diagrams used to represent the propagation of events or faults through a system. See FTA & ETA.	Reasonable to good if linked to consequential and related risk associated with civil contingency scenarios	http://www.defra.gov.uk/environment/risk/eramguide/07.htm
G27	Risk Matrix	Quantitative or Qualitative	No	Simple method to present risk. Typically adopting a 5x5 matrix.	Good.	Various http://www.hse.gov.uk/RESEARCH/rrhtm/rr025.htm
G28	Bow Tie Analysis	Quantitative or Qualitative	No	Bow Tie Analysis uses a risk matrix to categorize various scenarios, and then carries out more detailed analysis (in the form of fault and event trees) on those with the highest risks.	Good	Various http://www.hse.gov.uk/RESEARCH/rrhtm/rr025.htm
G29	National Population Database	Quantitative	Descriptive	A sophisticated methodology for producing a national population database, drawing on multiple data sets and including populations located within residential, workplace, retail, transport and leisure land uses and within communal establishments involving particularly sensitive populations (such as schools and hospitals).	Insufficient information	HSE http://www.hse.gov.uk/research/rrhtm/RR297.htm

Table 16: **Generic risk analysis tools** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
G30	FN Curves	Quantitative	Yes	FN-curves are a graphical presentation of information about the frequency of fatal accidents in a system and the distribution of the numbers of fatalities in such accidents.	Good for certain applications	Various Ball & Floyd (1998);
G31	Met Office Rainfall and Evaporation Calculation System (MORECS)	Data	Partial	MORECS is the only nationwide service giving real time assessments of rainfall, evaporation and soil moisture. It can be used to: (a) Predict river flow and input to river-flow models, and evaporation from open reservoirs; (b) Estimate leachate from landfill sites; (c) Help insurers to service subsidence claims; (d) Assess drought stress in crops, and ensure chemicals are applied when the soil moisture is most suitable; (e) Enable balance-sheet irrigation scheduling by combining evaporation figures with rainfall measurements. MORECS calculates soil state and evaporation for both a 40 km by 40 km grid nationwide on a weekly operational basis, and at individual recording sites for hindsight studies.	Dynamic; tool with coarse resolution. Local application aimed at- use by a range of industries including water authorities, environment, insurance and agriculture.	Met Office http://www.metoffice.gov.uk/environment/morecs.html

Table 16: **Generic risk analysis tools** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
G32	NEXTMap Britain (also available country-wide as NEXTMap Europe)	Data	Yes	This 3D digital elevation model is orientated towards the insurance industry, amongst others, as the demand for accurate geospatial products as part of risk management has grown. It assists in regional flood modelling, storm surge, wildfire assessment, plume drift etc. and is used in conjunction with other data sets for many models.	Strategic; coarse high level digital terrain model	Commercial – Intermap Technologies www.intermap.com/corporate/greatBrit
G33	National Property Database	Data	Yes	There are several alternative geographically based databases which can be used to provide the number of properties in a defined flood risk area as listed in Table 3.8 of the Guide to Emergency planning. Includes rateable value of each non-residential property; may omit nonrateable property such as places of worship. Floor area may be estimated by dividing the rateable value by the rateable value/m^2 for that local authority, obtained from the Commercial and Industrial Floorspace and Rateable Value Statistics (Communities and Local Government).	Strategic; provides property number and gross area data	Environment Agency – now held by Ordnance Survey http://www.defra.gov.uk/environment/water/rs/pdf/reservoirs-emerg-guide/mainguide.pdf (Table 3.8)

Table 16: **Generic risk analysis tools** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
G34	Price paid dataset (address level)	Data	Partial	This data can provide information on property damage in relation to total destruction. It is available at levels from national down to four digit postcode. The data is available from 1st April 2000 and is updated on a monthly basis. Currently this dataset contains in excess of 5.8 million house transfers and is updated monthly. Approximately 100,000 additional sales are added each month.	Commercial – the data for an annual subscription plus a charge for each address bought: (a) annual subscription is £3,000 plus vat: (b) £0.0075 plus vat per address update supplied, for each product that incorporates the data (with a minimum payment of £50).	Land Registry http://www.landregistry.gov.uk/property_info/ppd_add/

Table 16: **Generic risk analysis tools** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
G35	Commercial and Industrial Floorspace and Rateable Value Statistics	Data	Partial	This was produced by the Office of the Deputy Prime Minister (ODPM) in collaboration with the Valuation Office Agency (VOA). It provides a summary of hereditament, floor space and rateable value statistics for non-domestic property in England and Wales as at 1st April 2005. The information comes from the administrative databases used by the VOA in the process of assessing the rateable value of non-domestic property in England and Wales. This can be used to estimate inundation damage by: (a) average floor area for non-residential property in the inundation area, by dividing the total area in a local authority area by the number of NRP in the area; (b) market value for building element of NRP, by dividing the rateable value by yield. The data are consistent within five yearly revaluation time periods, but it is not always possible to retain consistency between revaluations.	Strategic	ODPM and VOA http://www.communities.gov.uk/pub/769/CommercialandIndustrialFloorspaceandRateableValueStatistics2005PDF6100Kb_id1163769.pdf http://www.statistics.gov.uk/neighbourhood

Table 16: **Generic risk analysis tools** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
G36	Customer databases	Data	Yes	Strategic; eg Thames Water use a data warehouse, built by Informatica UK, to cross reference data from every aspect of their operations including customer interfaces, assets, government statistics, local development plans, local performance and usage, supplier and partner information, in short just about every aspect of their business.	Regional & individual application.	Confidential access. http://www.informatica.com/uk/customers/thames_water.htm
G37	Postcode Address File (PAF)	Data	Partial	The Postcode is a combination of between five and seven letters/numbers which define four different levels of geographic unit. It is part of a coding system created and used by the Royal Mail across the United Kingdom for the sorting of mail. The Postcodes are an abbreviated form of address which enable a group of delivery points (a delivery point being a property or a post box) to be specifically identified. There are two types of Postcode, these being large and small user Postcodes. A large user Postcode is one that has been assigned to a single address due to the large volume of mail received at that address. A small user Postcode identifies a group of delivery points. On average there are 15 delivery points per Postcode, however this can vary between 1 and 100.	Static; There are approximately 1.71 million Unit Postcodes in the UK. Local councils create the address information, which they send to the Post Office (which in turn sends it to the Ordnance Survey; revenues only generated by the Royal Mail and OS).	Commercial – Royal Mail http://www.govtalk.gov.uk/gdsc/html/frames/PostCode.htm

Table 16: **Generic risk analysis tools** (cont.)

Ref:	Tool or Technique	Approach	Specialist expertise needed?	Summary	Possible application to LRF and FRS civil contingencies risk assessment	Notes & Source
G38	OS Mastermap	Data	No	Digital representation of the real world containing more than 450 million uniquely identified geographic features. It is updated daily as a consistent framework for the referencing of geographic information in Great Britain.	Digital Mapping	Commercial – Ordnance Survey http://www.ordnancesurvey.co.uk/oswebsite/products/osmastermap/
G39	National Population database	Data	No	Varity of statistical sources on population data.	Population statistics	http://www.statistics.gov.uk/CCI/nugget.asp?ID=6 www.hse.gov.uk/research/rrpdf/rr297.pdf
G40	New Dimensions Risk and Resource Database	Data	No	Building collapse risk and US&R resources	Provides number of buildings at risk and likelihood and impact, along with resources available. Restricted and not updated.	Communities and Local Government
G41	Incident database	Data	No	Global list of major accidents	Useful source of information on major incidents. Not necessarily comprehensive.	FSC
G42	ProMap & NEXT map	Data	No	Software mapping solution	National Regional & Local	http://www.promap.co.uk/promap/index.jsp
G43	Historical maps	Data	No	Software mapping solution	National Regional & Local	http://www.envirocheck.co.uk/envirocheck/historical_maps.jsp

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